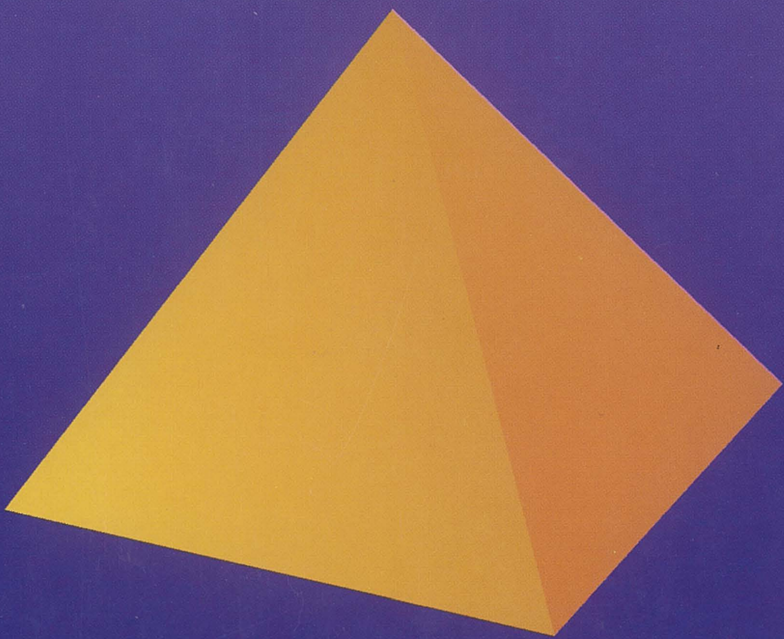
THE INFLUENCE OF THE SPATIAL-TEMPORAL STRUCTURE OF MOVEMENT ON INTONATION DURING CHANGES OF POSITION IN VIOLIN PLAYING

LAJOS GARAM



STUDIA MUSICA 1 • SIBELIUS-AKATEMIA

THE INFLUENCE OF THE SPATIAL-TEMPORAL STRUCTURE OF MOVEMENT ON INTONATION DURING CHANGES OF POSITION IN VIOLIN PLAYING

LAJOS GARAM

Esitetään Sibelius-Akatemian
suostumuksella
julkisesti tarkastettavaksi
Sibelius-Akatemian
auditoriossa,
Töölönkatu 28, 5. kerros
tiistaina 27. marraskuuta 1990
klo 12.00

Helsinki 1990

STUDIA MUSICA 1 • SIBELIUS-AKATEMIA

Garam Lajos
The Influence of the Spatial-Temporal Structure of Movement on Intonation during Changes of Position in Violin Playing
ISBN 978-952-329-223-9
https://uniarts.finna.fi/Record/uniarts.997944206249

THE INFLUENCE OF THE SPATIAL-TEMPORAL STRUCTURE OF MOVEMENT ON INTONATION DURING CHANGES OF POSITION IN VIOLIN PLAYING

LAJOS GARAM

STUDIA MUSICA 1 • SIBELIUS-AKATEMIA

Cover Mia Marjomäki

ISBN 951-95540-5-X
ISSN 0787-3757

Valtion painatuskeskus
Helsinki 1990

THE INFLUENCE OF THE SPATIAL-TEMPORAL STRUCTURE OF MOVEMENT ON INTONATION DURING CHANGES OF POSITION IN VIOLIN PLAYING.

402983A

F. The Results

FOREWORD

The arts of violin playing and making flourished in the 18th century, "the century of the violin". This period also saw the beginning of the serious study of violin playing with the violin tutors published by Geminiani (1751), Leopold Mozart (1756) and L'Abbé le fils (1761).It was not until the beginning of the 20th century, however, that violin playing became the object of scientific study when Steinhausen published *Die Physiologie der Bogenführung* (1902). Since then several outstanding violin pedagogues have left valuable works discussing problematical aspects of playing the violin for the enlightenment of following generations.

Carl Flesch, Konstantin Mostrass, Ludvig Capet, Joseph Szigeti, Ivan Galamian, Werner Hauck, Yehudi Menuhin and Kato Havas can be mentioned as examples of violinists who have engaged in important research and writing on the art of violin playing in addition to performing careers. David Boyden published (1965) a magnificent work treating the early history of the technique of playing the violin. Among those who have made use of scientific methods in approaching the subject, Juri Jankelevits (1956), Paul Rolland (1974) and Ottó Szende (1971 and 1977) deserve special mention.

In the 1930's and 1940's the scientific investigation of motor learning concentrated on the empirical psychology of learning. In the 1950's and 1960's the behavioristic concept and stimulus-response approach began to lose strength and it ceased to be the most important factor governing motor learning research (Christina 1986,p.26). A human being is no longer looked upon as a passive receiver of stimuli, but is rather considered to make use of many different thought processes and action strategies in learning.

According to this new point of view, a whole sequence of cognitive processes takes place between stimulus and response (Welford 1976, cf. Christina, p.27). Every sequence processes information into a form accesible to the following sequence (Massaro 1975, cf. Christina, p.27). Christina calls this new approach an "information processing approach" (p.27). Shea and Zimny (in press: cf. Christina, p.31) describe the information process in these terms: "...motor learning is controlled at the cognitive level and is substantially influenced by peoples' goals, by what knowledge they possess, and by the incorporation of new knowledge with old. This knowledge, combined in a mental representation or model of the task, is acted upon by strategic and heuristic processes" (p.1).

Scientists have thus during recent decades interpreted motor behavior primarily from the viewpoint of cognitive psychology. Christina (p.28) suggests that in the future, research into motor activity should adopt an "ecological approach" uniting biomechanical methods with various areas of cognitive science: psychology, philosophy, computer science (especially artificial intelligence), linguistics, antropology and neuroscience (Gardner 1985, cf.Christina, p. 31).

The true values of violin playing are, however, the personal interpretational views of any given violinist. It is these values that form the mystic half of the violinist's bipartite reality, without which his playing does not attain the status of art. It is extremely difficult to describe verbally both this mystical world of music and esthetic experience in general. On the other hand, the everyday side of the violinist's reality, the technical aspects of playing the violin and their study, are within the reach of language. There is nothing mystical about them: everyday reality is bound by real time and the strict laws of cause and effect. The absolute values of violin playing, precise intonation and a living pulse, are part of the everyday reality of the violinist, but at the same time they extend into the area of musical expression. They are the solid foundation that the violinist must build before he is able to express himself spontaneously through the medium of his violin.

Every violin teacher has come upon young violinists who - although they possess considerable musical talent - have not been able to express themselves freely when playing. The causes of this have been either psychological or physical hindrances that have smothered the player's interpretational abilities. Poor intonation, rigidness of movement and rhythmical clumsiness have ruined what might have been a good emotional interpretation. The absolute values of violin playing have not been practiced properly right from the beginning.

Playing the violin would be (relatively) easy without shifts, which can break a smooth legato phrase and are always the greatest source of poor intonation. In this study an attempt is made to throw light on the influence of the spatial-temporal structure of movement on intonation during shifts. The starting point for the three-part experiment has been the assumption that if the efficiency of the configuration of the movement (the path that the movement follows), its extent (the breadth of the interval) or its timing (the amount of time used in the various phases of the shifts) is increased, the intonation of the notes of the shift will also be improved.

A well-trained "violinist's ear" alone is not sufficient to ensure first-class intonation. Other factors that play a decisive role in the successful performance of shifts are mastery of the fundamental balances, the regulation of fingertip pressure, the correct use of glissando, the total integration of the shifting movement with careful attention paid to its preparatory and follow-through phases, the proper timing of the shift and the coordination between the right and left hands. Ignoring any single factor immediately affects all others and changes their position within the whole. Careful attention must therefore be paid to all these factors and the role they play within the structure of the shifting movement. The correct performance of all aspects of the movements used in playing the violin can free the violinist from undue motor concerns and allow him to concentrate on the most important thing: musical expression.

This study begins with a survey of works in the history of violin pedagogy that provide examples of research into the configuration, extent or timing of movements involved in playing the violin. It is surprising that in these works, written by violin pedagogues in past decades and centuries and including discussions of shifting technique, there can be found so little information and so few opinions about timing in shifting. There has indeed been a great deal written about the handling of rhythm and the choice of proper tempos, but no one seems to have been interested in ways of converting the musical pulse into a physical realization. In most cases it has been considered sufficient to leave the young violinist to his own natural instincts in striving to achieve a high level of shifting technique. In addition, the scientific studies into violin playing carried out by Jankelevits, Rolland and Szende are reviewed.

The violinist has a high calling: to interpret musical ideas with the aid of his instrument. In order to be able to serve as a medium between the composer and the audience, the violinist must be able to translate the language of music into the language of movement. The American cellist Helga Ulsamer Winold has expressed it strikingly: "Music making is thought and emotion translated into movements that are as varied as there are variables in music." (Musical Aspects of Motion Analysis. Concepts in String Playing, 1979, Indiana University Press,p.156). Since art only begins at the point where acrobatics stops, the movements employed in playing the violin are not pure acrobatics, even though their level of difficulty can be compared to that of the most virtuoso acrobatic exhibition.

The sound of the violin originates in extremely delicate muscular sensations that are constantly changing in accordance with the type of music being produced. The movements employed by a violinist to bring forth beautiful music could be called "resonant movements". When practicing and perfecting his technique, a violinist must always keep in mind that only resonant movements will produce the desired effect. In the final analysis, only the violinist's ear can tell him how to make the necessary movements.

Resonant movements represent one important aspect of the reality of movement. Through them a special form of beauty is transmitted, a beauty found only in music. Through the resonant sounds the insight of the composer is transformed into enjoyment for the listener. Without them no composition comes to life.

In the preparation of this study I have been able to call upon the talents of a number of friends. Without their unfailing support my efforts would never have come to fruition. Two people in particular have earned my sincerest gratitude: Professor Kai Karma and Professor Kenneth Chapman.

Kai Karma has served as my thesis director. I have admired his infinite patience when he has over and over again had to explain to me the principles of research theory and the scientific method. Without his skilful guidance I would have found myself inextricably lost in the labyrinths of statistics.

Ken Chapman has not only skilfully carried out the demanding task of translating my Finnish-language text, and checking the original texts of my German and Russian language sourcees, but has also offered much constructive criticism and suggested improvements at many points. At times when my mode of expression became too "artistic", imprecise, or deficient in proper references, his firm paternal counseling reined me in.

Ulla Agopov ,M.A., provided a reliable translation from Russian to Finnish of the section of Juri Jankelevits' doctoral dissertation that deals with the timing of shifts. Docent Matti Sintonen, Ph.D., helped me in my studies of the philosophy of movement in Western philosophy, while Timo Klemola, M.A., checked the section treating Eastern philosophy. Since the proportions of my study began to swell beyond reasonable bounds, it was necessary for me to leave out the separate section dealing with the philosophy of movement.

Petri Lehikoinen, M.A., has helped me with the location of studies of the biomechanics of movement, and Docent Eero Rechardt,M.D., has helped me locate pertinent psychological studies. Marja Vuori,M.A., Osmo Miettinen,M.A., and Ben Furman,M.D., have kindly assisted me in areas dealing with data processing. My good colleague Hannu Lehtonen has written out the musical examples exceptionally carefully and beautifully.

The stylishly drawn graphs in the empirical section are the handiwork of computer programmer Kari Kääriäinen. The only copy of Jankelevits's Russian-language dissertation to be found in Finland was kindly lent to me by Tomi Lintuniemi, M.A.

The directors of the West Helsinki and East Helsinki Music Schools, Satu Angervo and Dr.Géza Szilvay, allowed me to use their pupils as participants in my study. My good friend Kalevi Palin carried out the video-taping skilfully and professionally. The violin teachers of the Sibelius Academy who served as members of the evaluation jury patiently evaluated intonation on three sets of video tapes. The members of the jury were a number of the lecturers in violin at the Sibelius-Academy: Henrik Botway, Jouko Heikkilä, Jaakko Ilves, Henriette Rantalaiho and Kaija Saarikettu. My wife Mervi, who is also a qualified violin teacher, has with unbounded devotion and great skill handled all the text processing, and in addition has provided me with invaluable assistance in the planning and execution of the make-up of this dissertation.

My most heartfelt thanks to all those mentioned above for their indispensable assistance!

Finally, my warmest thanks to Leena Siukonen-Penttilä, M.A., lecturer in violin at the Sibelius-Academy, and Professor Kai Karma, who carried out the pre-reading of this thesis, and to the following foundations that provided financial assistance: The Finnish Cultural Foundation, The Finnish National Arts Council, The Paulo Foundation and The Sibelius Academy.

Helsinki, November 13, 1990

Lajos Garam

I THE INFLUENCE OF PSYCHOLOGICAL FACTORS ON HUMAN MOVEMENT.

1. Human Factors Affecting Movement.

Human beings do not move like machines. The movements of machines are totally uninfluenced by the type of factors that are decisive for human movement: psychological factors and cognitive factors. Complete control of motor functions is not enough for human beings: a person's emotions must also be under control and his mind in a state of balance. The slightest doubt about one's ability outweighs the strongest will or most highly developed technique (Garam, 1972, p.169). Negative psychological factors have a detrimental effect on physical factors:

Fear ⟶ Hesitation or Rushing
Tension ⟶ Irregularities of Coordination and Breathing.
Paralysis ⟶ Slowing of Reactions and Interruption of Performance.

Cognitive factors also affect physical performance:

Wandering Thoughts ⟶ Weakening of Performance Ability
Weak Concentrative Powers ⟶ Delay of Movements
Weak Attentive Powers ⟶ Forgetting or Failing to Notice Essentials

(Laura Jansson: Seminar at Sibelius Academy,1983).

Performance may also be affected by negative attitudes, lack of motivation or having too high expectations. If the above-listed psychological factors are not clarified and brought under control, no amount of attention devoted to the mechanical aspects of movement will produce successful results. Only when both "mental hygienie" aspects and matters related to violin technique are taken into consideration is it possible to begin to develop a sound motor performance.

2. Psychological Preparation Procedures.

The following psychological procedures are useful: 1. Strengthening of motivation 2. Relaxation exercises 3. Concentration exercises 4.Mental drills 5. Suggestive exercises.

A human being is a concentrate of needs and wants. Motivation- the desire to do someting - is the foundation of all performance. Problems can be caused by either too high or too low a level of motivation. Weakening of the motivation to practice may be the result of

1. Practice being boring
2. Practice not being demanding enough
3. Jumping from one area of endeavour to another.

Too strong a motivation to practice may be caused by

1. Inexperience on the part of trainer and athlete at setting goals (too high goals)
2. Trying too hard (over-practising) (Laura Jansson,1982,p.20). The level of motivation realistically creates the conditions for successful performance.

A performer's energy level can be regulated with the aid of relaxation exercises. It can be either raised or lowered. It is usually most useful to lower his energy level. If the performer is not able to learn to relax, he will not be in a position to make use of his skills. Relaxation cannot be learned instantly: it must become a way of life. There are various relaxation methods: the use of relaxation casettes, relaxation by suggestion, and yoga. The last named is one of the best relaxation methods. It activates the parasympathetic (regulatory) part of the autonomic vegetative nerve system. "Yoga frees internal strength, increases resolution, and brings the mind into balance... With the aid of regular yoga exercises

- one's state of mind becomes more peaceful and optimistic
- concentration becomes much more intense
- thought processes are quicker and muscles function more briskly
- all senses become sharpened
- one walks in a more relaxed and limber fashion
- one can work from morning to evening and the mind is clear the entire day
- one's general physical condition improves and there is a high level of metabolism
- an optimal energy level is achieved
- the "core" of one's personality remains constant under pressure, e.g., during concert performances" (Garam, 1984, pp. 56-57).

Assuming the positions (asanas) of Hatha Yoga developes body strength and vigor. Each position is divided into five phases:

active relaxation	entering the "statue phase"	the "statue phase" (motion-less,often without breathing)	leaving the "statue phase"	active relaxa-tion

The most important phases are the first and last. Active relaxation is something quite different from a limp, passive state of being. One must acquire the ability to relax actively by means of exercises. "In a state of perfect relaxation the control of balance and breathing reaches its highest point, at which all the functions of the body are rest and in balance. There is neither excessive tension nor a reduced level of activity in any part of the body. When the body is relaxed and at rest, the mind is at peace. Then new possibilities of observing the mind and examining its being are opened up" (op.cit.,pp.57-58). The correct energy level can also be attained by means of mental exercises if they are under perfect control. By "mental exercises" is meant the contemplation of movement (or movements) without any external physical performance. The following points concerning mental exercises are important:

1. At the moment of contemplation, the movement must be felt experientially, i.e., felt as strongly as if the physical movements had been performed.
2. The mental image of the movement must be correct; otherwise the mental exercise is damaging from the standpoint of future performance.
3. The thoughts must move at the same speed as when the movement is normally performed.

Different types of suggestive exercises are the use of a mantra (a repeated word), remembering and repeating in the mind past successes, various breathing control exercises, warming the limbs or making them feel heavy by repeating certain sentences (autosuggestion) and hypnosis (autosuggestion by means of hypnosis).

3. Mental Control and Proper Attitude.

In Zen philosophy one finds the concept of <u>emptiness (the void)</u>, by which is meant primarily the universal spirit, the Absolute, which cannot be reduced to logical categories. A second type of emptiness-concept, mushin, the void mind, refers to the correct state of mind of the pupil during battle. This means that he must not allow his mind to fasten on any external event or thought. The mind must be allowed to flow freely and without restriction. If his mind comes to rest, a skilful opponent might be able to take advantage of it. A swordsman must keep his mind void and free of all selfish thoughts. "When such a state of mind has been achieved and the battle has indeed lost all meaning, technique can at last be fully and freely realized" (Klemola,1988, p.79).

Gichin Funakoshi (1868-1957), who started the spread of karate around the world in the 1920's, emphasized the importance of the mushin frame of mind in his teaching. One of his karate aphorisms goes:"Technique takes place when the void has been found" (loc.cit.). Thus in Zen philosophy the deciding factor in battle is the correct attitude,the state of mind. Pure technique alone is not enough in fencing. Skill reaches its peak only when it is based on spiritual insight.

The invincible samurai MIYAMOTO MUSASHI wrote his famous *A Book of Five Rings*, on the strategy of the art of fencing for his favorite student in 1645. He called his philosophy The Way of the Warrior. It requires from the traveller on it splendid technique, but above all masterful control over his mind and the correct attitude toward life.Concerning this Musashi writes: "Both in fighting and in everyday life you should be determined though calm. Meet the situation without tenseness yet not recklessly, your spirit settled yet unbiased. Even when your spirit is calm do not let your body relax, and when your body is relaxed do not let your spirit slacken. Do not let your spirit be influenced by your body, or your body be influenced by your spirit. Be neither insufficiently spirited nor over spirited. An elevated spirit is weak and a low spirit is weak... With your spirit open and unconstricted, look at things from a high point of view. You must cultivate your wisdom and spirit. Polish your wisdom: learn public justice, distinguish between good and evil, study the Ways of different arts one by one" (Musashi, pp.43-44).

Eugene Herrigel's famous book *Zen and the Art of Archery* gives a penetrating view of how movement occurs of itself as soon as the proper attitude has been attained. Many musicians have read it and found in it many insights of value to their own playing: "But why is it that he, who has long since learned....to keep a cool head, to conserve his strength, and who now feels inured to long-drawn combats and can hardly find an opponent to match him in all his circle - why is it that, judged by the highest standards, he fails at the last movement and makes no headway? The reason, according to Takuan, is that the pupil cannot stop watching his opponent and his swordplay; that he is always thinking how he can best come at him, waiting for the moment when he is off his guard. In short, he relies all the time on his art and knowledge. By so doing, Takuan says, he loses his 'presence of heart': the decisive thrust always comes too late...." (pp.95-96). "What is to be done? How does skill become 'spiritual'....? Only, so we are informed, by the pupil becoming purposeless and egoless. He must be taught to be detached not only from his opponent but from himself" (p.96).

"Then, one day, after a shot, the Master made a deep bow and broke off the lesson, 'Just then "It" shot! 'he cried, as I stared at him bewildered...'You remained this time absolutely self-oblivious and without purpose in the highest tension, so that the shot fell from you like a ripe fruit. Now go on practising as if nothing had happened' (p.74) .

II THE ELEMENTS OF HARMONIOUS MOVEMENT.

1. Form in Human Movement.

Form in movement is technique judged from an aesthetic point of view. The aspects of form as a whole are the sum of the characteristics of the individual movements. Good form in movement is both effective and aesthetically pleasing, and serves perfectly the type of movement involved. Even a layman can evaluate good form in athletic performance. E.g., it is possible to distinguish easily between the form of different swimmers. A first-rate swimmer moves easily from one end of the pool to the other. His form is graceful and his body is in excellent balance with the water element. On the other hand, even a naturally gifted person who has not been systematically taught to swim, flounders in the water and has difficulty making progress, even though he may be physically strong enough. Such a person's swimming form is primitive and ineffective. We can quite easily express our opinion about countless other types of movement as to whether they show good form or not (e.g., ballet, ice dancing, diving, gymnastics).

However, even though two people proficient in the same type of movement both demonstrate "good form", their form is rarely identical. "If a number of athletes practicing the same athletic discipline make use of the same technique, the characteristics of strength, speed and motion curves displayed by each will be similar. The absolute values of the curves are, however, not identical, because they will be determined by the degree of development of both general and specific physical and mental qualities and the degree of command of technique of the individual athletes" (Hochmut,1967, p. 183).

"One can also note differences between the performances of one and the same athlete. These differences are based on the fact that the external and internal conditions for athletic performance vary with time. It is for this reason not possible to repeat an athletic performance exactly. During a long period of training, the curves of the parameters of motion of a given athlete can indeed vary greatly if a marked development in performance takes place during that period" (op.cit.,p.184).

2. Technique and Skill.

A movement must satisfy two conditions in order to function properly:

1. It must have the correct kinematic form
2. It must be carried out with the correct technical timing.

When a movement is reduced to its simplest elements it assumes its most efficient extent. When a movement includes all phases of a consummate movement and when the durations of those phases are in the correct proportion to each other, the movement has been carried out with the correct technical timing. The "technical timing" of a movement means that a) the movement is performed at the correct moment with respect to other movements ("timing"), and b) that the components of the movement occur at precisely the correct moment in respect to each other ("fine timing").

"Skill" is a much broader concept than "technique". Skill is the technical control of performance under changing conditions. Thorough learning of a skill requires purposeful practice and thousands of repetitions during many years or decades. Virtuoso skill also requires masterful timing. Correct technical timing of movements at high speed is one of the central problems in all types of skill movements.

3.The Phases of Harmonious Movement.

Paul Rolland's views of the different phases of movement form the basis of the present investigation. He defines three phases of movement: preparation phase, execution phase and follow-through and/or recovery phase (Rolland, 1974, p.38). This representation can be broadened by adding to the above-mentioned visible phases the <u>invisible</u> phases of movement: a) thought, mental image, a view of the movement before its execution, and b) a mental image of how the movement was executed and comparison of it with the original mental image (feedback). The order of the phases of one movement would then appear thus:

brain activity	muscular activity			muscular activity	muscular activity	brain activity
mental image	anticipation	order	delay	execution	follow-through	mental image

The "invisible movement" of the brain is always the point of departure for the visible movement and the audible sound. Harmonious movement both begins and ends with forceful mental activity. When the movement has come to an end the individual concerned must have a clear idea of how succesful it was. In order for this to be possible, the mental image preceding the movement must be forceful, otherwise there is no basis for comparison: if the mental image is to be sufficiently forceful, there must be enough time for it to be formed before the movement is carried out. This is the basis for correct timing in harmonious movement.

3.1. Anticipation in Harmonious Movement.

Following the formation of the mental image, anticipation (the preparatory phase) is the next most important phase. It is also the sequentially next phase. Correct anticipation ensures that the execution phase takes place as if automatically. This is due to the fact that during the preparatory phase, part of the execution phase is actually already being carried out and the movement is already partially completed when the execution phase begins. In the performance of a harmonious, unbroken movement the preparatory phase is relatively long compared to the execution phase (cf. the empirical section of this investigation). Care taken with the preparatory phase promotes maintenance of balance and the circular nature, smoothness and continuity of the movement. On the other hand, if the preparatory phase is lacking or is rushed, the movement is awkward and interrupted, and it is difficult to maintain balance throughout it. If there is no anticipation, the movement is imperfect and its timing flawed, causing a performance break-down.

3.2. The Execution Phase.

The performance of a movement has been properly carried out if a) the most effective form of the movement is under control, b) the preparatory phase in the timing of the movement is properly taken care of, and c) sufficient time (but not too much) is expended in the execution phase itself.

3.3. Follow-Through in Harmonious Movement.

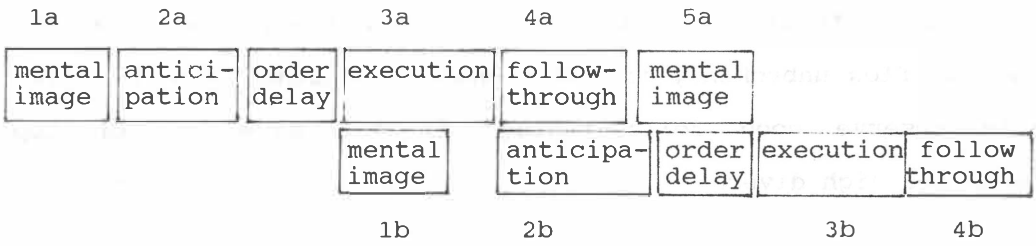
A movement is not complete without a follow-through. A good example of masterly follow-through is to be found in top-level ballet dancers, who produce uninterrupted legato movements through the use of graceful extensions of hands, arms and legs. Their buoyant movements flow unbrokenly from one phase to another. One can also clearly observe good follow-through in the movements of top gymnasts and high divers.

3.4. Order and Delay.

Following anticipation, an order is given to perform the movement. The time required to carry out the order is called the delay. As a movement is practiced, the delay shortens. The delay is, on the average, of the same duration in all people. According to research carried out by Hathaway, Corser (1974) and Norman and Kom (1979) the delay is of the magnitude of 40-50 microseconds (electromechanical delay) (Cooce-Diggles, 1984, pp.348-363). Sport psychologists have determined that when one's powers of concentration are weak, the length of the delay increases and performance is retarded (Laura Jansson: Seminar at Sibelius-Academy, 1983).

3.5. Overlapping of Stages of Movements.

In a smooth, harmonious movement there is, at the moment of culmination, an overlapping of the follow-through of the preceding movement (4a) and the anticipation for the following movement (2b, cf. diagram below). Slightly before the culmination point the muscules required in the following movement begin to prepare themselves for their task (Anticipation, 2b). The muscles that have executed the preceding movement gradually cease functioning, but continue it until it is finished (follow-through, 4a). At the culmination point the "seams" of the circular movements overlap each other slightly, i.e. the movement does not entirely stop (beneficial retardation).



3.6. Deficient Movement (Fine Timing Error) .

If one tries to imagine what possibilities there are of making timing errors in the different stages of a movement, one quickly discovers that there are countless variations. The weakest performance is represented by a movement that is comprised of only a short execution phase (which cannot be entirely lacking since without it there is no movement at all). The mental image of the movement may be weak or nonexistent, the preparatory phase may be lacking or be too short (rarely too long), there may be no follow-through at all (the movement breaks down halfway) or extremely little time is used on it.

The movement may also be fairly well carried out: then it is comprised of fairly long segments of all five phases of harmonious movement, two invisible and three visible. However, the lengths of the different phases are still not ideal.

A deficient movement is interrupted; it does not proceed smoothly. This is quite understandable: if parts are lacking from the whole, or those parts are of incorrect size, the whole cannot function properly.

3.7. The Nature of Deficient and Harmonious Movements.

Harmonious movement is by nature "slow" = sufficient time is spent on the preparatory, execution and follow-through phases. Thought is speeded up, and the movement of the fingers is retarded. When adequate time is spent on anticipation, there is no need to reserve (relatively speaking) so much time for execution as for the other stages of the movement. Preparation for the movement is already being made as far as possible during the anticipation and the execution is born, as it were, of itself. The concept of playing "slowly" (i.e., in keeping with the nature of harmonious movement) can be clarified as diagrammed below. In a properly executed movement, the movement is made

1 initially	2 then	3 finally	
SLOWLY	MORE QUICKLY	QUICKLY	= tempo of execution
"SLOWLY"	"SLOWLY"	"SLOWLY"	= the nature of the movement

In a movement that is not executed properly, the movement is made

1 initially	2 then	3 finally	
SLOWLY	MORE QUICKLY	QUICKLY	= tempo of execution
"QUICKLY"	"QUICKLY"	"QUICKLY"	= the nature of the movement
		CATASTROPHE	

(1 = initial (technical) phase of practice, 2 = intermediate (interpretive) phase, 3 = final (performance) phase).

The timing of the movement is thus not primarly a question of the <u>tempo</u> in which the movement is executed, but the <u>temporal structure of the movement,</u> i.e., <u>the temporal relationship of its stages,</u> the nature of the movement. Musashi understood this: "Speed is not part of the true Way of strategy... Speed implies that things seem fast or slow, according to whether or not they are in rhythm.

Whatever the Way, the master of strategy does not appear fast... Really skilful people never get out of time, and are always deliberate, and never appear busy... What is known as speed is especially bad in the Way of strategy.... If you try to cut quickly, as if using a fan or short sword, you will not actually cut even a little... When your opponent is hurrying recklessly, you must act contrarily and keep calm" (pp. 94-95).

4. The Relationship between Speed and Direction (Configuration) of Movement.

The faster a runner runs, the more his body has to be tilted forward. The angle of the forward tilt is thus dependent upon the runner's speed and the force required to attain it (Diagram 1). The greater a high jumper's running speed, the farther from the crossbar he can start his leap: Arrow B shows the trajectory of the leap made farther from the crossbar at greater running speed than in the case of Arrow A (Diagrams 2 and 3), when the leap is made at lower speed. The speed of the movement thus affects the direction (configuration) of the movement and vice versa: a change in the configuration of the movement can either increase or decrease the speed.

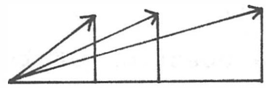


Diagram 1

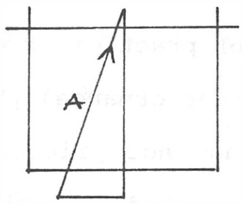


Diagram 2

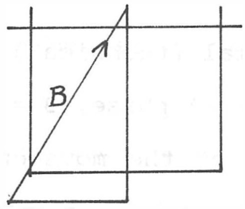


Diagram 3

In the performance of rapid movements, sufficient speed is attained in the execution phase by tilting the body sufficiently energetically in the direction of the movement in the preparatory phase. If this is not done, the force of gravity of the earth slows down the movement during the execution phase and the performance breaks down.

5. The Significance of Balance.

Perfect body balance, i.e., a state in which the force of gravity has minimum effect on the body, must be achieved in both the preparatory phase and the follow-through phase and also at the moment of culmination. Proper balance produces the correct angle of tilt in the preparatory phase, allowing the execution phase to begin at the right moment and in the intended direction, producing a movement with the correct configuration. Balance is maintained through the moment of culmination with the aid of the follow-through.

The control of balance at the moment of culmination of a movement can be seen clearly, e.g., at the highest phase of a ballet dancer's leap: the movement stops for an instant and the impression is given that the dancer is hanging motionless in the air. The same phenomenon can be seen clearly in high diving, when the diver remains for an instant motionless at the point of culmination of the dive. The control of balance (the state of minimum effect of gravity) at all phases of a movement means that the configuration and coordination of the movement are both correct and that the movement is proceeding at a natural speed.

Equilibrium can be either passive, active or dynamic. It is passive and static when one is completely relaxed. A state of equilibrium is active and static when the body is held motionless in a pose in which muscular force is required to overcome the force of gravity. Equilibrium is dynamic when one is actively performing some sort of motion in such a way that one remains in a given position over a moving base of support.

A state of stable equilibrium is achieved when the potential energy of a body is at a minimum and when force must be applied to it to change its position. Equilibrium is unstable when the potential energy of the body is at a maximum and little force is required to change its position. This state can change very quickly into a state of dynamic equilibrium. A state of equilibrium in which the potential energy of the body remains constant is called neutral equilibrium (Gowitzke and Miller, 1980, pp. 75-77).

Good muscular balance is an absolutely necessary prerequisite for the performance of any highly skilled movement. A state of balance provides the possibility of achieving perfect coordination and the functioning of the muscles in the proper sequence. In addition, good balance increases the strength and efficiency of the muscles and makes possible perfect muscular balance.

Poor posture due to weakness of the muscles of the calves, stomach and lumbar region causes forward tipping of the pelvis. "Weak stomach muscles are probably the single main cause of inadequate musclar equilibrium, resulting in forward tipping of the pelvis and the development of excessive curvature of the spine. The muscles of the lower back are overactivated and their elasticity and ability to relax gradually weaken. The result is a state of disequilibrium in the supporting ligaments" (Ahonen, 1988,p.305).

"The "secret" of skill and efficient performance is the ability to minimize, through practice, the energy required to maintain balance to avoid all unnecessary use of muscles, to direct the movement of the limbs in the right direction and to minimize the activity of muscles antagonistic to the movement during the time of performance. The development of a skill depends critically on the sensitivity of the individual's kinesthetic perception, i.e., the ability to be cognizant of the amount of force used in the movement and the position of the joints during the movement" (op.cit.,p.63).

III MOVEMENT IN VIOLIN PLAYING.

1. Similarity in the Multiplicity of Styles.

Playing the violin is not an athletic endeavour: art just begins where acrobatics ends. Playing music, however, cannot be classified as merely an intellectual-aesthetic event. That would be fitting only if a consummate, artistically completely valid performance could be produced by the transformation of a particular clarity of thought into a clarity of expression without the necessary middle stage: transmitting the thought for "interpretation" by the muscular groups and joints.

It is sound that distinguishes the playing of music from other branches of physical exercise. The ear, which in the final analysis guides the player's movements, seeks out "resonant movements". A movement that does not produce a pleasing sound is of no use in music. This fact makes the judging of movements in violin playing and of different styles of violin playing problematical: it would seem to be a very simple fact that the violin can be played excellently in many styles that, at least apparently, differ greatly from each other.

It is possible to be unanimous about the final results (e.g., beautiful sound, sufficient brilliance and, naturally, artistic contribution) produced by many outstanding virtuosi who, however, adhere to different playing styles. It would seem nevertheless sensible to assume that there are certain characteristics common to all playing styles that produce good- sounding results. We can consider these common characteristics to be basic features on the basis of which differing good styles have been formed.

A movement full of life produces a living sound, a stiff movement a hoarse sound. The famous American concertmaster and violin pedagogue Louis Persinger (who was, among other things, Yehudi Menuhin’s teacher) described violin playing simply and radically:"...anything that looks strange is incorrect" (Samuel and Sada Applebaum, The Way they Play, Book One, p.359). A smooth style of playing makes possible first-class coordination of movements and the production of intonation that is pure and free of extraneous vibrations. The coordination of movements will be one of our main concerns as we continue this investigation.

2. Efficient Movement in Violin Playing.

Successful movement in violin playing must fulfill two conditions: first, the configuration of the movement must be correct and kinematically expedient, and second, both the coordination of it with other movements and the coordination of its components with each other must be as precise and perfect as possible from both a kinetic and artistic standpoint. These conditions can, however, be realized only if there is a) perfect balance, and b)sufficient kinetic muscular tension (tonus).

3. The Fundamental Balances.

The key to smooth performance is balance. There is a close interactional relationship between balance, muscular relaxation and the configuration of movement in violin playing. When a state of balance has been achieved, the movement feels free and easy: the effect of the force of gravity has been minimized. Kato Havas (in *The New Approach to Violin Playing*,p.14) and Paul Rolland (in *The*

Teaching of Action in String Playing,p. 32) have used the image of the see-saw to provide an excellent description of this phenomenon. It is possible to move even very heavy objects easily when they are in balance. This ease of movement brought on by a state of balance makes it possible to initiate movement with a minimum expenditure of energy. On the other hand, a state of imbalance makes it necessary to expend extra energy in order to regain balance and get it under control, putting the muscles under greater strain than during the initiation of natural movements. Thus a state of balance leads to muscular relaxation and is, in fact, the prerequisite for relaxation.

Menuhin writes that there are three stages in the development of technique:"The first stage is complete softness of the joints, as in a baby, each checked separately. The second stage is the co-ordination of soft movements and the development of elasticity and resilience, both in stretching and compressing actions. The third and final stage is the development of strength and firmness, and freedom. These stages cannot occur in any other order" (Menuhin,1971,p.16). Each of these conditions must be satisfied if one wishes to play smoothly.

In order to advance this far, however, the fundamental balances must prevail in the body. The joints cannot move freely if all parts of the body are not in balance. The muscles can neither be relaxed nor can they function maximally freely if they are forced to be under tension because the force of gravity is allowed to affect excessively the various parts of the body. Menuhin considers an upright posture to be important precisely because it eliminates undue influence of the force of gravity on the parts of the body. He describes several means of counteracting the tendency of the joints to collapse under the force of gravity: standing erect with head held high, chest forward, stomach in, thighs forward, knees back, and weight slightly on the outside edge of the feet. The back should also be held straight (op.cit.,p.18).

One achieves a feeling of lightness in dancing and running by stretching the body to its full length and supporting it, as it were, from above. Thus good posture brings about the most important prerequisite for flowing playing technique: controlled body balance. But it also brings with it other benefits. It is worth repeating Werner Hauck's words at this point: "There is no doubt that breath control is essential for all violinistic technique... By conscious activation of breath control...it is possible to establish a direct connection with every technical process in violin playing" (Hauck,1975,p.57). Hauck quotes Julius Parow:"Breathing movements can only be perfect if they are in complete harmony with an ideal shape of the body. This, however, exists only when the spine is straight" (Parow,1953,pp.7-11).Good posture thus frees the organs of respiration and the musculature in the shoulder region and at the same time makes possible freedom of movement.

Menuhin provides us with an observation that casts light on the concept of balance: when playing the violin (or performing any movement at all) one must try to remain as close as possible to the centre of the movement (Menuhin,op.cit.,p.106) - then balance is preserved, and the movement proceeds at natural speed. Such a movement is reduced to its simplest elements and functions efficiently. "Natural" speed promotes an ideal formation of coordination of the movement. A movement performed with stiff muscles does not move at "natural" speed, according to Menuhin (op.cit.,p. 25). In order to be able to recognize the centre of a movement, one must be familiar with its extremes. At the end of his book Menuhin recommends various "compensatory exercises": movements are consciously extended as far as possible, so that one learns to recognize the limits beyond which one should not play (op.cit.,p. 107).

If the trajectory of a movement is too wide, i.e., extends too far from the centre, its balance is disturbed, its rhythm interrupted and its configuration broken. It leaves its natural trajectory and shatters. The formation of a new movement requires both extra energy and time. Kato Havas has expressed it succinctly:"...good violin playing... depends on the co-ordination of a host of delicate balances which in turn demand a high degree of mental discipline" (Havas,1973, p.2).

3.1. The Main Principles of Balance in Violin Playing.

The violin is not dangled, but rather supported (the shoulder is conceived of as the balance point of a see-saw). The bow is not pressed against the string, but it too is supported and simultaneously the weight of the arm is used to apply pressure.

The act of playing is conceived of as being <u>horizontal</u> (i.e., the movements involved in playing take place primarily horizontally) and both arms are allowed to move freely starting from the shoulder joint. The muscles of the shoulder and upper arm take an active part in the performance of even the smallest playing movements, while the muscles of the forearm are in a relaxed-passive state. The fingers are "freed" from all extraneous responsibility: the player does not concentrate on controlling movements performed only by the fingers.

3.2. The Significance of Playing Position in the Achievement of Balance.

We can define the ideal playing position by adding a few points to the definitions of Szende and Neuhaus. According to Szende, the best playing position is one in which the smallest possible amount of muscular activity is required to maintain balance (Szende,1977, p.14). This is an excellent definition. According to Neuhaus, the best (arm) position is one that can be changed most easily and quickly into the following position (Neuhaus,1973, p.118, Finnish edition). The next point can be added to these definitions: the best playing position is one that makes possible the greatest opportunities for musical expression.

The concept of playing position can be subdivided into several aspects: posture and holding the violin, as well as the position of the left and right arms and hands.

3.2.1. Balance in Posture.

In order to describe ideal balance in playing the violin, it is first necessary to define the best possible playing stance (posture). It is essential that the knees are not rigidly retracted, causing the knee joints to lock and the thigh muscles to freeze. It is best to stand with feet slightly apart with the weight of the body distributed evenly on both feet. While playing, the weight may be shifted from one foot to the other as is suitable. E.g., in playing a broad forte it is easier to get the bow "into" the string if the weight of the body is placed more on the left foot. The back should be straight, the shoulders down.

3.2.2 Balance in Holding the Violin.

In modern violin playing, in which one must have command over a large number of different left-hand positions (e.g., in the playing of chords, different stretches and chromatic runs), the player's hold on the violin must be dynamic, i.e., it must change in accordance with different situations. In pedagogic practice the concept "playing position perspective " is used. This refers to the degree of difficulties the violinist in question is able to overcome by changing the playing position. The more skilful a given violinist is, the broader the perspective. It is possible to play Händel's sonatas quite respectably using a static playing position, but not the Paganini caprices.

Even though every violinist holds the violin differently, there are nevertheless basic principles by means of which it is possible to find the most advantageous playing position. These principles are anchored in psychological, anatomical and mechanical factors. In determining the anatomic-mechanical factors affecting his way of holding the instrument, each violinist must make compromises in four different areas: 1) where he places his chin in relation to the tailpiece, 2) does the neck of the violin point more to the right or left as seen from the player's point of view, 3) how high the neck of the violin is held, and 4) how horizontal the body of the violin is (the degree the body of the violin is tilted).

During the 17th and first half of the 18th century the chin was placed on the right side of the tailpiece.Both upper arms were held close to the body. The old German school of violin playing recommended holding a book in the right armpit in order to support the bow stroke as much as possible. When the neck of the violin was lengthened and the higher playing positions were taken in use, it was necessary to increase the mobility of the left arm. The violin was placed more in the direction of the sternum and the chin now rested on the left side of the tailpiece (the first to suggest this position was L'ABBE le fils in 1761). This made it possible to have greater command of the entire fingerboard. It was then necessary to hold the instrument comfortably under the chin: this came about when Ludwig Spohr invented and took into use the chin rest in 1820. Posture and playing position were also improved, and thus it was finally possible to move into the higher positions.

The relationship between the four dimensions mentioned above depends to a great degree on the anatomy of the player: the length of his arms and neck, the size and construction of his hands. A violinist with short arms can hold the instrument relatively low (dimension 1) and use a chin rest located to the left of the tailpiece. It is an advantage to a player with long arms to raise the violin higher and use a chinrest that can be fastened in the center of the instrument, over the tailpiece. It is also to the advantage of a tall player to hold the neck of the violin a bit to the left (dimension 2). It is advantageous for any violinist to hold the neck of the instrument high (dimension 3),because it eases moving into the higher positions and also creates the conditions for the production of a first-class sound (e.g., it is easier to determine the proper sounding point, i.e., the distance from the bridge at which the string is bowed). The tilt of the violin (dimension 4) can be adjusted by the use of a shoulder pad or support. The use of a shoulder support that is too high on the bowing hand side results in too horizontal a position of the violin and puts both hands in an unnatural position. Children should not use a shoulder support at all: a shoulder pad of chamois or plastic foam is more suitable for them.

There is divided opinion concerning at how many points the violin should make contact with the body. Most violinists prefer to hold the instrument so that it makes contact at three points: the collar bone, the chin and the shoulder. However, some outstanding violinists (e.g., Milstein, Kogan and Menuhin) support the violin with the left hand so that there is no contact with the shoulder except under exceptional circumstances, such as during downward shifts. Menuhin writes: "There are only two sources of support necessary for the violin: one passive - the collarbone - which is relatively fixed (the violin is moved on the collarbone); the other active - the left hand - which is constantly mobile or ready to move (the hand moves the violin)....It is preferable to do without a shoulder-pad or a shoulder-rest. If used as a support, the shoulder is restricted in its freedom of movement, and if actively 'clamped', the shoulder is 'frozen'" (Menuhin,op.cit.,p.52).

Balance in holding the violin is achieved as follows: the violin is placed on the collarbone with a relatively quick movement (the slower the movement, the heavier the violin and arm feel). The left arm, which supports the violin in the same way that the right hand supports the bow, lowers the violin softly onto the shoulder. The left arm must not, however, just hang down from the violin, but must stay in balance with the shoulder-joint free and relaxed (cf. later: left hand balance). The left hand does not hang from the violin, nor does the bowing hand press down on the string; both arms are supported and in balance. When, in addition, playing the violin is conceived of as a horizontal action, the entire playing position stays in balance.

There is a close relationship between playing position and the coordination of movements , as well as musical content. The primary criteria in musical interpretation for any movement or playing position is whether or not it can be used to produce the desired quality of performance. It is obvious that it is precisely a natural and comfortable playing position and free movements that will produce a beautiful, vital sound. In the interpretation of works of art, the sound must serve various styles and moods. The performer must be able to give expression and life to the music. The primary purpose of musical performance is to provide nuance and variety. In order to achieve this, playing position, movements, sound and musical content must be welded inseparably together.

3.2.3. The Natural Bow Hold.

The most natural bow hold possible can be arrived at in the following way: the pupil places his hand , palm up, on the edge of a table or the teacher's knee. If the hand is completely relaxed, the fingers are slightly curled. The teacher lowers the bow (or as a preparation in the case of small beginners, a pencil) carefully into the pupil's hand so that the stick touches the fingers in the following way: 1) the index finger between the first and second joints, 2) at the tip of the little finger. Then the pupil is allowed to place the tip of his thumb opposite the second finger. The natural bow hold is complete when the teacher has moved the pupil's index finger just a shade farther away from the second finger. During all of this the pupil must keep his hand relaxed and passive, so that all fingers - including, most importantly, the little finger and the thumb - remain curled.

3.2.4. Left Hand Balance.

Kato Havas' view of how left hand balance is achieved would seem to be exeptionally well formulated. Her conception is as follows (*The Twelve Lesson Course*, pp. 3-4): The left arm is raised in the direction of the neck of the violin as if it were one half of a see-saw with the balance point at the shoulder joint. The invisible half of the see-saw (imagined to be behind the player's back) and the left arm are felt to be of equal weight. Then the left arm remains in position as if balanced there. It is supported by the muscles of the back and it moves freely from the shoulder joint. It floats up so high that the neck of the violin comes to rest relatively deep between the index finger and thumb. The wrist is completely relaxed, the palm turned slightly outward (looked at from the player's point of view). In this basic position the elbow is not forced to the right (from the player's point of view), as has traditionally been the case, but is allowed to remain in the position it naturally assumes when it is raised in a relaxed manner as described above. On the other hand, some rotation of the lower arm is necessary to facilitate getting the third and fourth fingers in position above the strings.

3.2.5. Bowing Arm Balance
is achieved by raising the upper arm with the muscles of the back and shoulder until it is horizontal and then suspending the lower arm from it. Once again, the shoulder joint is imagined to the balance point of a see-saw. The upper arm is then moved on a horizontal plane to right and left (Havas: Private lessons, London, 1978). This is still not a genuine bowing movement, in which the upper arm also moves from the shoulder joint. Havas emphazises that it is important to learn to distinguish between <u>raising</u> and <u>suspending</u> the arm (op. cit., p. 4). The extremely important role of the upper arm in bowing is seen when the hand is placed in playing position: it controls and regulates the motion of the bow at every instant.

3.2.6 The Role of the Left Thumb in the Establishment of Balance. Attention must be focused on two more important factors involved in the establishment of the fundamental balances: the position and activity of the left thumb, and the height of the left hand relative to the fingerboard. The correct position of the left thumb makes possible the balance needed to perform both vibrato and changes of position. With the aid of the thumb the violin is placed in such a position and such a state of balance that the other fingers are able to function with maximum ease. This applies especially to playing in the higher positions, when the thumb must be moved under the neck of the instrument to make possible the proper distribution of the pressure applied by the playing finger. In downward shifts (from the fourth position down) the thumb is released from the neck of the violin and moved into its new position ahead of the hand. In upward jumps the thumb makes a preparatory movement by moving under the neck of the instrument. In vibrato, the finger pressing down on the fingerboard is balanced by the thumb so that not too much pressure is placed on it.

The thumb must be supple and follow the movement of the elbow, so that the movement of the hand does not freeze. In so-called Paganini-technique, in which the thumb remains in position during shifts, it must function very elastically. The thumb must thus be both supple and independent. On the other hand, it must also often be completely passive. The most fatal mistake in violin playing is squeezing the neck of the violin tightly between the thumb and the index finger, what I call the "gorilla grip". It completely cramps left-hand technique.

The action of the thumb is treated in many different ways in the pedagogic literature. Several excellent maestros have made the mistake of giving very detailed instructions concerning this matter, which is in the final analysis extremely personal. Leopold Mozart (1756,p.157) explains that the thumb should be located toward the second and third finger. Campagnoli says that it should be opposite the middle finger, which plays B on the G-string (Jankelevits,in Koch-Rebling, 1979, p.62). Auer maintains that the thumb should be located opposite the second finger, which plays F on the D-string (op.cit.,p.63). Joachim is of the opinion that the thumb should placed at the index finger position (loc. cit.) and Koeckert (a Belgian pedagogue, Caesar Thompson's assistant) announces that the thumb should be under the neck of the violin (loc.cit.), with the tip of the thumb pointing away from the player. All of these rules have been provided by recognized authorities. Each of them had "found" a basic thumb position suitable for himself. It was, however, a mistake for them to make a general rule out of their own personal solution.

Many teachers have solved the problem of explaining the function of the thumb by using photographs or drawings. Flesch states: "The point, however, at which the thumb comes in contact with the neck, depends less upon itself than upon the remaining fingers, or, to be more exact, upon their length; and here the proportions vary in every case" (Flesch,1924, Book One,p.17). He subsequently warns against placing the thumb under the neck of the violin except in long stretches and shifts. In the photographs in his book, the thumb is shown located opposite the index finger.

Auer lashes out in his book: "Altogether too much is made of the thumb's importance, it seems to me." He explains in more detail:"Let the thumb rest lightly against the neck of the instrument and follow after the first finger in moving into the various positions" (Auer,1921, p.35).

Galamian, in his book *Principles of Violin Playing and Teaching*, points out: "The thumb needs very special attention. It is the member of the hand which is most often responsible for excessive pressure and for the clutching of the neck of the instrument" (p.17). He warns against this since he feels that it hinders vibrato and shifting. Concerning the positioning of the thumb he limits himself to saying that it should not project too much above the fingerboard and that it should neither be too straight nor too bent (p.18). In the pictures in Galamian's book, the thumb is positioned opposite the low position of the second finger in the case of a short-fingered player, and opposite the index finger in the case of a long-fingered player. Concerning the action of the thumb in shifting, Galamian says that in general the thumb moves simultaneously with the rest of the hand, except in downward shifts, where he recommends that the thumb precede the hand slightly (Galamian,1962, p.24).

Menuhin, in his book *Violin, Six Lessons* places great emphasis on the importance of the flexibility and independent action of the thumb for left-hand technique (Menuhin,1971, p.52). He provides a wealth of exercises designed to develop the resilience and agility of the thumb (op.cit.,pp.57-59).

The height of the hand above the fingerboard is discussed below in connection with Rolland (cf.pp.162-63 below). This is an important point in the establishment of the fundamental balances. Concerning the thumb of the bowing hand, it can be briefly pointed out that the mobility of the other fingers is to a great extent dependent upon the thumb: if the thumb is rigid, it is impossible for the other fingers to move freely, and then string changes and bowing changes are not smooth. A flexible thumb straightens out a bit when playing at the point and flexes when playing near the thumb of the bowing hand plays an important role in the production of differences in dynamics: the regulation of the pressure produced by the rotation of the arm is transmitted to the bow primarily by the leverage of the index finger and thumb.

4. The Basic Movements of Violin Playing.

The violinist must master, in addition to the fundamental balances, the basic movements of violin playing.Their importance has been emphasized especially by Carl Flesch and Max Rostal, who carried on Flesch's work. When playing the violin, the violinist's arms and body naturally work together as a unit. There is good reason for him, however, to pay special attention to separate movements of the hands and arms during the learning phase. In this way he can avoid the typical beginner's clumsy arm movements, which are caused precisely by a failure to distinguish between the tasks performed by different muscles. If the player is not able to use the different parts and muscles of the arm in such a way that certain muscles function more actively than others under given conditions, it is impossible to attain the fundamental balances. There are six basic movements of the bowing arm and seven of the left arm:

<u>Basic movements of the bowing arm.</u>

1. Movement of the upper arm in the direction of the bow
2. Vertical movement of the upper arm
3. Movement of the lower arm in the direction of the bow
4. The rotation of the lower arm around its axis
5. The bending of the wrist up and down (or sideways)
6. The extension and contraction of the fingers (NB: when practicing the basic movements the fingers are flexed actively, while they flex passively during actual playing).

<u>Basic movements of the left arm.</u>

1. The movement of the upper arm from left to right and back ('pendelling')(Menuhin, op.cit., p.116)
2. The movement of the upper arm toward and away from the player
3. The movement of the lower arm toward and away from the player
4. The rotation of the lower arm around its axis
5. The bending of the wrist up and down (back and forth)
6. The vertical movement of the fingers from the knuckles ('hammering')
7. The horizontal movement of the fingers from the knuckles

The student should practice each basic movement by itself, paying special attention to the rotary movement of the arm and the movements of the wrist. Once he is able to use any given part of the arm actively while the other parts remain motionless, the smooth cooperation of all the various groups of muscles in a unified set of movements can more easily be achieved.

5. The Fundamental Balances in Shifting.

Changes of position are carried out by rocking from one finger in balance to the following finger in the playing sequence, which is then brought into balance (by seeking out a pleasant, relaxed feeling and taking care that there is a minimum of pressure under the tip of the finger), which the hand is immediately prepared to leave and move to yet another finger. Changes of position are thus simply a rocking from one balance point to another. Balance on the tip of the finger is brought about by a delicate raising of the upper arm that produces an appropriately light pressure of the finger. The mechanics of shifting, the regulation of pressure, the use of glissando and proper timing all play a central role in the formation of balances in changes of position. These matters will be looked into in the experimental part of this study.

The student must first be taught the fundamental balances and how they are controlled. If the pupil becomes familiar with the natural fundamental balances from the very beginning, his technical development will be rapid. When the fundamental balances have become second nature, his style of playing will be natural and free and he will be able to direct his attention toward strictly musical aspects of his art. The freer a violinist's technique is, the more completely he is able to concentrate on the depths of his musical experience.

6. The Regulation of Muscle Sensation in Violin Playing.

Before we can turn our attention to details related to the configuration and coordination of movement in violin playing, we must first clarify the extreme importance of muscle sensation in this activity. No matter what type of movement is involved, achievment of the most efficient and economical technique always means that the movement is reduced to its simplest elements, i.e., all unnecessary activity is avoided. The situation is the same in regard to muscular tension: the expert achieves <u>the greatest possible effect with the least possible effort.</u> The key words are <u>minimal tension, minimal pressure, minimal angles.</u>

The violinist must clarify for himself the following important matters:

1. How the arms feel <u>when they are totally relaxed,</u> i.e., what is the feeling of the condition of minimal tension in arms and hands,

2. What, in any given situation, is the minimal tension, minimal pressure and minimal angle sufficient to carry out smoothly the movement or series of movements in question.

This does not mean, however, that all movements in violin playing should be carried out under conditions of minimal tension, pressure or angle. Tension in the violinist’s muscular structure varies continuously during the act of playing. It is not possible to produce music without tension. What is crucial is learning how to regulate tension and select the muscle sensation appropriate to differing situations. In general, the smallest possible amount of tension is the most advantageous. Only a fraction of the great muscular strenght that even a small child can produce in his arms can be made use of in playing the violin.

When an inexperienced young violinist does his best to learn a new piece of music, his intellectual exertions are reflected in extraneous muscular tension, and the result is a clumsy performance. What can be called "parasitic activity" arises, characterized by the use of too many groups of muscles and excessive muscular energy. The physical activity involved in playing the violin requires only a small amount of energy. The "parasitic actitivy" of the excess muscles of an inexperienced player impedes efficient and natural movement. Unnecessary tension in violin playing can be compared to a golf cart that is designed to carry two players and their clubs. If an extra 250 kilograms of stones are loaded onto it, it will move more slowly and clumsily and make deep ruts in the earth.

It is often difficult for a beginning violinist to understand that his arms will be able to function efficiently although they are not tensed. He is not able to distinguish between a feeling of limpness and relaxed preparedness. However, the secret of facile violin playing is to be found in the following diagram:

FLEXIBILITY = RELAXATION + PREPAREDNESS

The violinist should begin his practice sessions by striving for a muscular state that is as relaxed as possible. The master violinist Isaac Stern has said (Samuel and Sada Applebaum: *The Way They Play*, Book Nine, 1981, p.113) that he begins his day's practice by being very careful for the first five or ten minutes not to place any strain on his hands. This is the advice of a master violinist who knows the violin literature from stem to stern (!) and has total control of his instrument.

In a situation in which there is minimal tension, movements become maximally reflex-like and muscles function almost automatically, as if by their own accord. Muscular energy is required only to counteract the force of gravity. When the arms feel as "fluffy as cotton" the state of minimal tension has been attained. Such a state of being is the prerequisite for the establishment of the fundamental balances.

6.1. The Coordination of Muscular Tension.

As far as the coordination of muscular tension is concerned, it must be remembered that the violinist must learn to make use of different levels of tension in his two arms at the same time. The levels of tension in the two arms are rarely equal. The level of tension in each arm must be adjusted completely independently of that in the other arm.

The basic rule can be considered to be that the tension in the left hand must be independent of the musical dynamics being produced with the help of the bow. If, for example, it is necessary to play a rapid passage forte (e.g., at the beginning of the solo part of the Brahms concerto), which requires a firm grip on the bow (however, avoiding excessive tension in the muscles), one must be very careful to maintain the elasticity and delicacy in the left hand demanded by the rapid passage work. If the player is not succesful in this, the figure can easily stiffen and intonation become unclear. The opposite situation can be found, e.g., at the beginning of the Debussy sonata, where the bow must be used lightly and elegantly at the same time that the left hand is producing an intense vibrato.

The muscular tension in the two arms can thus be quite different under different conditions when producing an artistically valid performance on the violin. E.g.,

Left arm		Right arm
minimal tension	↔	maximal tension
maxmimal tension	↔	minimal tension
little tension	↔	rather great tension
rather great tension	↔	little tension
increasing tension	↔	decreasing tension
decreasing tension	↔	increasing tension,etc.

Naturally, all possible combinations of these conditions can take place. In addition, there are, of course, also situations in which the same level of tension is to be found in both arms.

7. Imagination in Violin Playing.

Playing the violin is an activity controlled by a complex network of images, the nature of which depends on the type of performance to be given. The violinist must have a clear image of both the overall musical form and a myriad of details in the piece of music he is performing. He must also have a clear image of the delicate feeling of balance that must be present all the way from the body stance to the contact between the finger tips and the string if the resultant sound is to be first-class. Furthermore, he must have a clear image of the correct form of the necessary movements and series of movements, i.e., an image of the effective technique, plus a clear image of which of his muscles function most actively in any given situation. Finally, he must have a precise image of the different stages of the performance,i.e., of the efficient coordination of all the movements. It is not possible for a violinist to give a balanced interpretation of a piece of music without these various images.

We are not able to measure the strengh and clarity of these images in any other way than by their external expression,i.e., the visible movements and the resultant sound. It is very easy for a violin teacher to hear from a pupil's playing whether or not the pupil has a clear image of what he is playing. The contribution of imagination to a musical performance can be strengthened through mental exercises. By this is meant reading through the music without the instrument while experiencing the music and imagining how to play it.

The importance of imagination in playing the violin has been emphasized by the master violinists Fritz Kreisler and Jascha Heifetz. Kreisler said:" I believe that everything is in the brain...These are fingers. Nothing" (Applebaum, Book One, 1972, pp.96,98). He recounts that when he was learning the Elgar Violin Concerto before its premiére performance he studied the work exclusively on the basis of the score, but spent six hours practicing one especially difficult passage on the violin (loc. cit.).

8. Anticipation in Violin Playing.

Succesful coordination is a great challenge to the violinist. He must at any given moment have full control over a myriad of different velocities of movements and parts of movements. The different parts of a single hand are usually moving at different speeds and, in addition, the extension of the bowing hand, i.e., the bow, is moving at its own speed. It has been estimated that during a two-hour concert a violinist performs as many as hundreds of thousands of different movements. Since the configuration, extent and speed of those movements vary greatly, it is clear that keeping them under control is an extremely demanding task. The violinist manages to accomplish everything necessary by means of anticipation. Even in rapid passages the playing of an accomplished performer gives the impression of being composed and balanced. A good example of this are Menuhin's recordings of the Paganini concertos, which despite their virtuosity sound calm.

Perhaps the most important musical feature that is made possible by controlled anticipation is <u>artistic rubato,</u> i.e., a temporary change of tempo that increases the artistic effect. Through rubato, time is "stolen" (rubato = participle of Italian <u>rubare</u> "to steal"), and then immediately given back so that the music retains its basic pulse. On the other hand, the tempo can be stretched out and then hurried up slightly so that it preserves its unity (cf. Leopold Mozart's view of rubato). Distorting the tempo because of an undeveloped sense of musicality or deficient technique is not the same as rubato, which is always carefully thought-out variation in tempo.

From the standpoint of succesful anticipation, the choice of a suitable tempo is extremely important both while practicing and during performance. Leopold Mozart emphasizes the correct understanding of the various tempo markings, i.e., the selection of a natural tempo on artistic grounds (Mozart,op.cit.,p.33, Paragraph 7). This is musically decisive. The choise of the proper tempo allows the player sufficient time to form a clear image of the music and to carry out the preparatory phase of the movements necessary. If the tempo is too quick, it is not possible to do this, and the musical pattern shatters.

The less time the player has at his disposal, the more precisely he has to anticipate. E.g., when practicing Paganini caprices it is useful to prepare a precise strategy concerning the technical coordination of movements, in which special attention is paid to the preparatory phase (cf. the examples on pages 87-90 concerned with coordination problems in Paganini’s Caprice No. 20).

The determination of the position of the hands forms an essential part of anticipation. The position of the left hand varies greatly in different playing positions. If the player does not have the ability to find a comfortable hand position in each and every situation,the result is clumsiness and stiffness of movement. E.g., if a change of position involves a long jump, it is useful to test the position of the hand as it will be in the end position before the shift itself is practiced. The movement involves moving from one position to another. When practicing the actual shift, one then attempts to change the position of the hand as much as possible already during the preparatory phase to that position it will have in the end position.

9. The Automatization of Movements.

During the early phase of practice, the player should be as consciously aware as possible of the overall shape of the movement being practiced. During the most advanced phase, however, the movement should proceed, as it were, of its own accord: it should become as automatic as possible so that no conscious thought is necessary in its performance. Conscious awareness of the details of parts of the movement during the final phase of practice impedes the smooth functioning of the muscles. When the movement is under control, it has already blended thoroughly with surrounding movements. Conscious thought is then focused only on large units, groups of movements, the overall "flow" of movement. F.A. Steinhausen writes: "Practice improves and refines the overal plan of the movements, eliminates unnecessary movements, promotes useful and productive movements, until each separate movement has been seamlessly incorporated into the whole" (Steinhausen,1928, pp. 48-49).

In the following analysis the process of practicing is divided into three parts:the visualizing phase, the refining phase and the stabilizing phase (cf.Meinel,1977,p.235). In the visualizing phase a cognitive image is visualized. The inner pattern of the movement begins to take form. Performance is still uneven because only the main outlines of the program of action have been formed, and are thus deficient. In the refining phase the various movements are coupled together into whole and unbroken series. The partial actions take place automatically and the player's energy can be directed toward controlling larger entities and paying attention to interpretation.

When practicing has advanced to the refining phase the musical form of the work gradually begins to be clarified. At the same time the central strategies of violin playing once more take shape: fingerings and bowings begin to set. Muscle feeling becomes more sensitive and precise: the accuracy and speed of movement increases. A strong personal view of the music has already formed, but on the other hand a clear image of the corresponding movements has not yet been completely built up. The conscious mind still controls the individual movements and attempts to make them more accurate, at the same time, however, that it is now able to reign over increasingly larger technical units.

In the stabilizing phase, the only thing that should be present in the conscious mind is a strong view of the music. Reflex movements (series of movements) that have now become automatic should be capable of being set in motion by as infrequent impulses as possible and to continue independently on the subconscious reflex level. In this phase the mental image of technical performance should have become "fused" into a subconscious automatic pattern of activity that can be set into motion by minimal conscious input. The conscious mind has been freed to interpret the music.

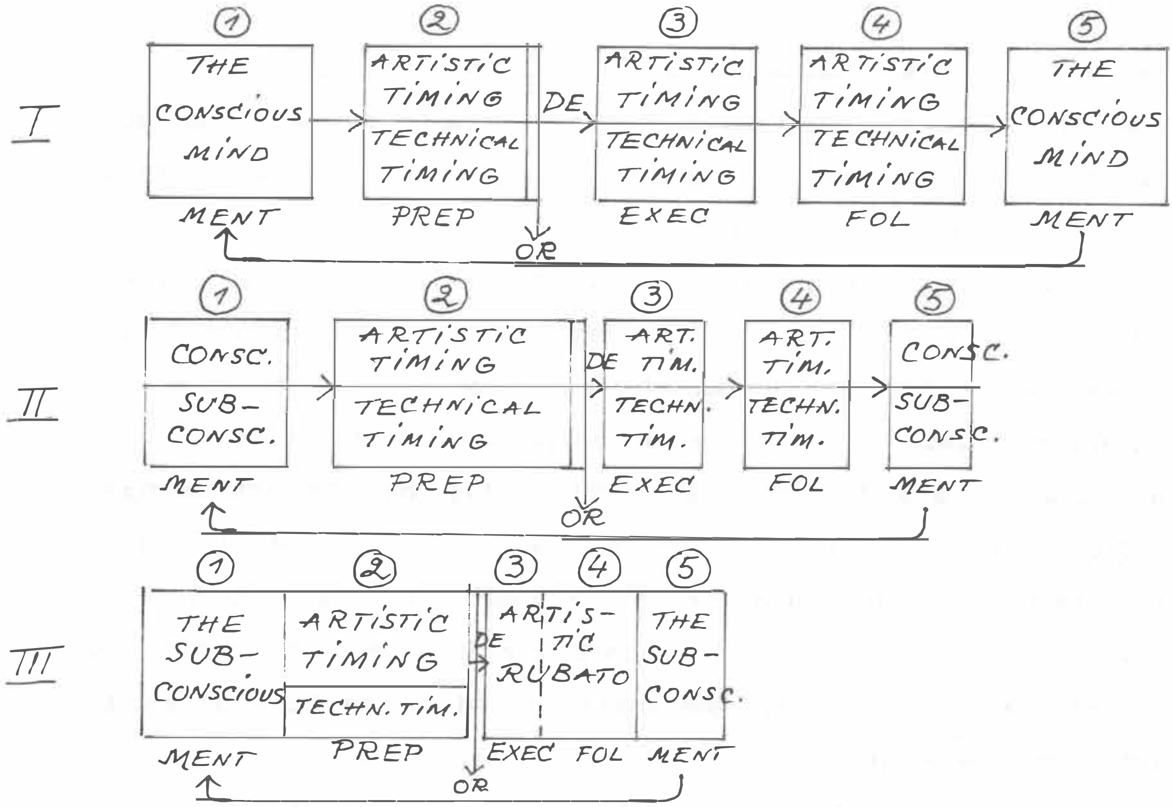
In moving from the visualizing phase to the refining phase, anticipation was increased and conscious input decreased. In the stabilizing phase, mental image and anticipation have fused into one entity (cf. diagram). Similarly, the carrying out of movement and subsequent follow-through have become one. When movements have become automatic, delay is minimal:

MENT = mental image, PREP = preparatory phase, OR = order, DE = delay, EXEC = execution phase, FOL = follow-through.

I = Visualizing phase: consciously controlled movement (the cortex supervises performance.

II = Refining phase: half-automatic movement.

III = Stabilizing phase: automatic movement (movements guided by reflex).



Regular practice and unremitting repetitions produce the result that the player moves from one practice phase to another almost without noticing it. The observation of increasingly more delicate coordination distinctions is made possible by continuous repetition. The coordination of movements becomes smoother and smoother.

When movements have become automatic they are "photographed" again. Each repetition must be as the preceding one. It is useful for the player to make a pause of a few seconds between each repetition. This allows him to think about the sound of the pattern in advance and simultaneously to create a strong mental image of the corresponding series of movements necessary. The "photographing" of the movement (series of movements) during practice appears thus:

First repetition ⟶ Second repetition

MENT	ANT	EXEC	FOL	MENT	2 sec.pause	MENT	ANT	EXEC	FOL	MENT	etc.

Christina sets forth an interesting point of view regarding the automatization of motor performance that diverges from earlier points of view: "For a number of years many of us held the view that early in motor learning our performance was predominantly under conscious cognitive control, and that later in learning, following an extensive amount of practice, we delegated conscious cognitive control to automatic processes. However, recent evidence (Annett, 1985) suggests that while automatization of performance can occur in highly skilled individuals after much practice, conscious cognitive control may actually increase rather than decrease. This is an intriguing hypothesis, to say the least, but it will have to be subjected to future research before its validity can be ascertained" (Christina,1986, p.32).

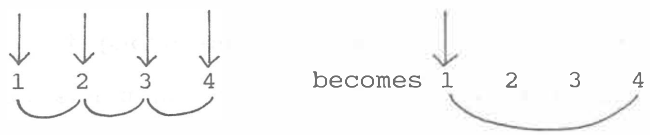
10."Phrase-Impulses" and Harmful Impulses.

Impulses - the orders that bring about muscle activity - should be strong, clear and properly timed, i.e., precise. The player must, however, consider carefully how often he gives orders to the muscles, since extraneous impulses at the wrong time disturb the smooth progression of movements. In a work that has been practiced to perfection, one single impulse may be enough to initiate a series of movements that become automatic.

In the stabilizing phase, impulses should be given to the muscles at points of musical stress: at the beginning of musical phrases, on the most important notes in a melody, and in general on stressed beats of the measure. Impulses are given in order to clarify phrasing, no longer to solve technical problems. Such impulses can be called "phrase-impulses".

A player who has a strong conception of the music and gives his muscles clear phrase-impulses succeeds better in solving complex problems related to technical coordination than a player who constantly gives his muscles orders in order to get through the technically difficult passages of a work. The player who concentrates exclusively on technical aspects, pays too much attention to details and gives his muscles impulses too often. The same error trips up many a player who is plagued by stage fright and whose field of perception narrows down so that he is unable to handle broader entities in a controlled fashion. He starts to stumble over details and in desperation gives a surfeit of extraneous orders to his muscles, resulting in technical breakdown.

When moving from the refining phase to the stabilizing phase of practice, the number of impulses should be decreased and a quite extensive series of movements should be initiated by a single impulse. When a single impulse is provided for a group of several notes, the delay that is necessary to provide each note with a separate impulse is eliminated. The shortening and elimination of delays is one of the main goals of practice:



In the following example we see how the same two measures can be played with 6,4 or only 2 impulses, depending upon the tempo:

Artistic timing includes the ability to phrase properly, i.e., to be able to conceive of the music in broad rhythmic groupings and, when playing at quick tempos, to give as few phrase-impulses as possible to the muscles. In this respect artistic timing affects the succesful carrying out of technical coordination to a great degree (cf. p.73 in this study). The following example illustrates the principle of correct phrase grouping:

Mozart: A Major Violin Concerto, First Movement

Mozart wrote this movement in 4/4-time, but for the purpose of producing an impression of lightness and promoting ease of technical accomplishment, it is advantageous to think of these measures alla breve and provide two pulses per measure. There are many such passages in the first movement of this concerto in which it is useful to think in these terms.

11. The Coordination of the Movements of the Arms.

The violinist's two arms move completely independently of each other. At the same time, however, the movements of the arms are closely interrelated. The coordination (synchronization) of the movements of the arms is one of the most important factors in the achievement of overall coordination in violin playing. It is also a decisive factor in the production of good intonation.

The following rule-of-thumb applies to matters of synchronization: the proper temporal order of movements (involving split seconds) should be as follows: first elbow movement and change of string (involving both arms), then change of position, then the dropping of the finger onto the string, followed by change of bow and finally the new bow stroke. A final rule must be added to the above list of movements: the new bow stroke must never be begun before all the other necessary movements have been completed.

Not all the operations mentioned above need be involved at every point in the music; if, e.g., no change of string or position is involved at a given point, it is only necessary to make sure that the finger drops onto the string a split second before the new bow stroke is made. Imperfect synchronization, which is extremely common in the performances of inexperienced violin students, causes unclear articulation and poorly focused tone. Coordination of movements and synchronization of the movements of both arms can be improved in the following ways:

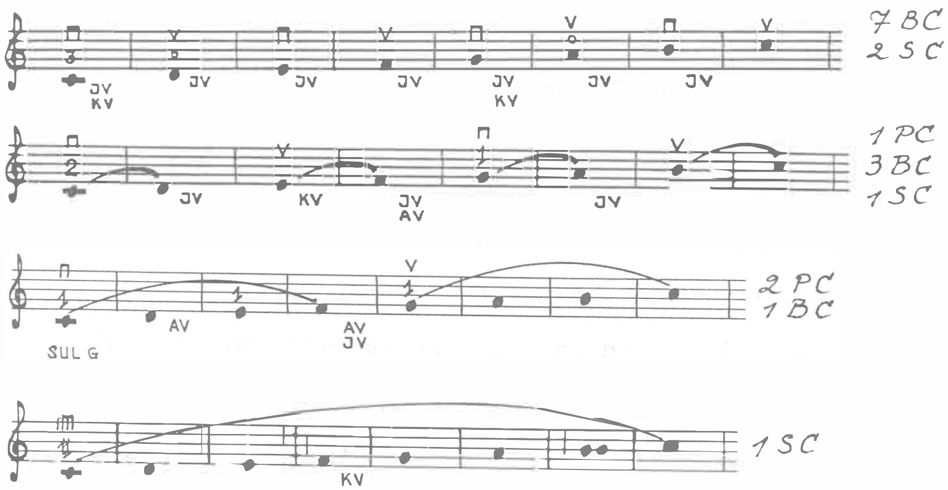
1. by playing very slowly and precisely
2. by playing faster than the final tempo calls for
3. by decreasing and increasing the tempo while playing
4. by making use of rhythmic variations.

The method proposed under point 2 and 3 can be used only on the condition that extra errors are not made and that intonation does not suffer. If the piece of music involved is still being learned, fast tempos should not yet be used. In such a case, it might not be possible to increase the tempo even cautiously without the quality of playing suffering.

IV VARIOUS TYPES OF CHANGES IN VIOLIN PLAYING.

Various changes in violin playing are a major source of disturbance affecting smooth technical performance and are one of the main obstacles to natural artistic timing. If a violinist does not have full command of the technique (the mechanics of movement) of these changes, the smooth and supple forward progress of the music will be seriously impeded. Below will be found examples of these various changes in the playing of a C major scale: the number and location of the changes depend on different fingerings and bowings that are chosen to make for convenient execution of the scale. (NB: the vertical lines in the examples are not bar divisions).

Abbreviations: PC = Change of position (shift)
BC = Bow Change, SC = String Change



1.Changes of Position.

Leopold Mozart (op.cit.,p. 132) considered that there were three reasons for the use of the positions: first, if it was unavoidable; second, for technical convenience; and third, to achieve elegance of execution. He also divided the use of the positions into those that are made for reasons of technical fluency and those made for artistic reasons.

Joachim, Auer, Flesch and many other notable violin pedagogues emphasize the central role of position-changing (shifting) in left-hand technique. Abram Jampolski was of the opinion that shifting was the very foundation of left-hand technique (Jankelevits,in Koch-Rebling, p.77). Juri Jankelevits, one of the most outstanding Russian violin pedagogues, whose students won a total of 17 prizes in international violin competitions, considers changing positions to be such an important matter that he wrote his doctoral dissertation on the subject in 1956 (J.Jankelevits,*Pedagogical Heritage*. Editions "Musica". Moscow, 1983).

Changes of position can be roughly divided into five basic types:

Changes made

I while playing an open string

II with the same finger

III from a lower to a higher finger

IV from a higher to a lower finger

V by extending or contracting the finger (more precise definitions will be given in the experimental part of this study).

Modern shifting technique makes use of many extensions. It has even been suggested that traditional changes of position (French and Russian glissando) should be abandoned. This would mean, however, that the violinist would be deprived of much of the elegance that can be produced by means of glissando.

2. String Changes.

It is very easy for the violin student to forget string changes when he is occupied with left-hand technique. String change exercises are a great aid in developing bowing technique, and therefore Menuhin has provided so many of them in his book (Menuhin,op.cit.,pp.83-95). Inflexibility in bow changes impedes the natural, smooth flow of the music (e.g., in sautillé). If the player does not succeed in making string changes properly, they should be separated from the action of the left hand: the passage should be written out as an open-string practice and the bow changes thus practiced separately.

3. Bow Changes.

Bow changes are an extremely important area in modern violin technique. In the ideal bow change, no change in sound is to be heard. The most common error in the playing of students is the "swallowing" of the final tone in a legato line, i.e., it is not given its full value. This is, however, very harmful from a musical standpoint and completely destroys the legato line. The bow stroke must be slowed down slightly before the change. Uneven bow strokes tend to produce an increase in bow speed before the change.

From a technical standpoint, the bow change is carried out best if one conceives of its profile as being in the form of the keel of a boat and figure-eight shaped when looked at from above (cf. Steinhausen, Rolland). When the bow stroke is carried out in accordance with this conception, it involves a slight raising of the elbow - followed by a slight raising of the frog of the bow - in a down-bow as the stroke approaches the tip of the bow. When approaching the frog at the end of an up-bow, the elbow and frog are lowered slightly. Steinhausen, Rolland, Menuhin and Rostal (in master classes in 1963, 1964 and 1972) have come to the conclusion in their research into the mechanics of bowing that this produces the best results, both from the standpoint of the timing of the bow change and from the standpoint of tone production. It is also the best way to increase bow pressure at the tip at the end of a long down-bow and lighten it at the frog during an up-bow.

4. Factors Affecting Succesful Shifting.

Changes of position in violin playing involve a sequential, complex horizontal or horizontal-vertical movement of the left hand and/or wrist. A good shift is a swinging from one finger in balance to another. Shifting - as is the case with all aspects of violin technique - is affected by a plethora of visible and invisible factors. The mechanics of lower and higher positions, the regulation of pressure in both hands, various types of glissando, the proper configuration of movement of the left hand and the coordination of the movements of the two hands are all problematical aspects of shifting technique.

The following factors are among those affecting succesful shifting:

4.1. Selection of the Correct "Path" (= the Shortest Distance).

The shortest distance between two points is the correct path for movement in changes of position. The shortest possible shifting distance is achieved by fingerings that employ half-tone steps. The same principle lies behind the so-called "retarded" shift, in which the shift is initiated by extending or contracting the finger: the distance between notes is "shortened" during the preparatory phase of the shift so that the distance to be traversed in the actual shift is as short as possible. Keeping the fingers as close as possible to the strings (when the final finger in the shift is not in contact with the fingerboard during the shift) also makes the distance traversed as short as possible.

4.2. Balance in the Playing Position (Stance, and Contact between Body and Violin).

If there is any extraneous tension in the legs or trunk, it will also cause tension in the muscles of the shoulders and arms. This will happen if the standing or sitting position is not perfectly balanced or if the violin is not resting in a natural fashion against the body. It is in this connection once more worth repeating Ottó Szende's definition of the best playing position as being one in which the smallest possible amount of muscular activity is required to maintain balance (cf.above,p.34). Any and all measures taken to develop good posture help keep the body from collapsing and thus automatically improve balance in the playing position.

4.3. Balance of the Arms and Hands.

The act of playing must be conceived of as being horizontal, which means that the instrument is supported lightly by both arms. The left hand does not hang from the violin , nor is the bow pressed down by the right hand. The shoulder joints function as the balance point of a seesaw.

4.4. Flexibility of the Joints, Relaxation of the Muscles.

The point of departure for the controlled regulation of muscle sensation is the ability to settle into a state in which there is a minimum of bio-electric activity in the muscles, i.e., a state of relaxation, to which is added a tiny bit of preparedness. The joints must be free, the muscles resilient and strong.

4.5. Reduction of Finger-tip Pressure before Shifting and its Increase at the End of the Shift.

An attempt should be made to reduce the friction between the tip of the finger and the fingerboard to a minimum during the shift. In rapid passages there must in general be very little pressure, since there is not enough time to regulate it. The bow pressure is also sometimes reduced before shifting in connection with bow changes. The role of the left thumb in regulating pressure is of great importance.

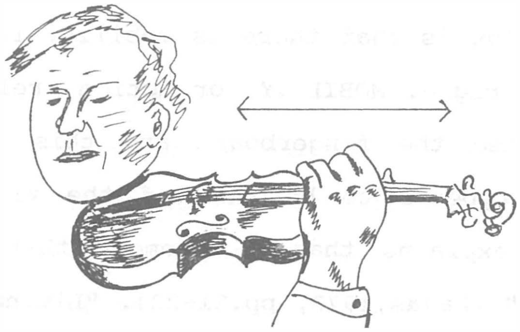
Two factors determine how much the pressure of the finger-tip is to be reduced before shifting:

1. Dynamics and the nature of the piece of music. In music expressing great pathos, there is a relatively great amount of pressure between the finger-tip and the fingerboard. One must be careful not to maintain too much pressure during the shift, so there must be a considerable release of pressure.
2. The tempo with which the notes follow each other. In rapid shifts there must be almost no pressure.

4.6. The Speed of the Movement ("Schwung").

Appropriate speed increases freedom of movement. The direction (configuration) of the movement has a direct bearing on the formation of pressure in changes in position and thus on the speed of the movement. A good example of this is a shift from fourth to first position.

a) Hand in 4th position



b) Incorrectly executed downward shift

The upper arm is immobile and the elbow is not able to move in the direction of the fingerboard. The pressure at the tip of the finger increases excessively during the shift. The hand pulls the neck of the violin down. (The arm is hanging from the fingerboard of the violin).

c) Correctly executed downward shift

The upper arm is able to move freely in the direction of the fingerboard. There is no excessive increase of pressure at the tip of the finger during the shift. (The arm supports the violin).

The mobility of the upper arm plays a decisive and central role in the production of movement in the right direction and the correct configuration. Flesch took up this matter in his day. Later on, Menuhin spoke about momentum, which, following thrust, carries the movement foward (op.cit., pp.25-26). William Primrose maintains that stiffness in the hand and fingers can be relieved with the help of vibrato. "I find that the vibrato relaxes the hand... More the point is that there is mobility in the hand so that it doesn't become rigid. MOBILITY, or motion, relaxes the finger after it has contacted the fingerboard and this is accomplished by a motion which appears to be that of the vibrato (Dalton,1988, p. 130). Havas explains that a movement that lacks speed contains "dead weight" (Havas,1973, pp.21-22). "Living weight" in a rapid movement means that the arm's own weight comes into play in connection with the force of gravity.

4.7. Use of the Proper Type of Glissando.

Both French glissando (sliding on the final finger of the old position) and Russian glissando (sliding on the initial finger of the new position) must be under control if shifts are to be carried out correctly. Normal shifts are executed with French glissando. It can be heard during the learning of a piece, but gradually it disappears (through lightening of pressure). Russian glissando is shorter than French glissando. It is used as a means of artistic expression in the performance of shifts upwards. It is generally not used in downward shifts, since it then sounds in poor taste. In practice, the violinist frequently has to resort to the use of a type of glissando that includes both a short initial glissando and a short end glissando.

The use of so-called intermediate notes no longer serves any purpose in shifts that have been thoroughly practiced. The oscillographic analyses that Jankelevits made show that no intermediate notes can be observed in the shifts of such great violinists as D. Oistrakh, D. Tsiganov and J. Rabinovits (Jankelevits, 1983, pp. 151-52).

The teacher should emphazise the importance of glissando as soon as the pupil begins to learn to shift. The various elements of left-hand movement must be linked smoothly together. The exaggeration of one element at the expense of others destroys the unity of the movement: e.g., excessively energetic striking of the fingers onto the fingerboard (excessive pressure) or sudden, awkward shifts (jerking) both cause the horizontal element of left-hand technique to lose its integrity. Uneven, jerky shifts are the most common error committed in connection with changing positions. The shift between the 1st and 4th positions is carried out as a horizontal movement of the arm (muscles of the upper arm). In higher positions the movement of the arm also includes rotation of the lower arm, sidewise movement of the upper arm and a vertical movement of the entire arm.

4.8. The Correct Coordination of the Shifting Movement (Different Phases of the Shift).

In order for both the overall timing and fine timing of the shifting movement to be succesful, it must comprise all the phases of harmonious movement: mental image, anticipation, order, delay, execution, follow-through and once again mental image. The most important parts of the shifting movement are a strong mental image, carefully executed anticipation and follow-through. The mental image of both the music and the movement must be strong. It is well to remember that the speed of impulses along motor fibres is 80-120 microseconds (cf. Szende, p. 169 below): there is time for everything, if only the order is clear and properly timed.

Each and every shift requires a certain amount of time and may - if it is not properly timed - disturb or even interrupt the forward progress of the music. For this reason it is very important to pay attention to the preparatory phase of the shift. The departure from the initial position must be conscious and precise. Jankelevits discovered that when master violinists performed shifts, their upper arms made an "assisting" (= preparatory) movement slightly in advance of the shifts itself. Their upper arms moved (as seen by the players themselves) either to the right (before an upward shift) or to the left (before a downward shift). This assisting movement is especially important when performing jumps: just before the shift (upward), the position of the arm must be changed to allow the hand to pass easily over the edge of the violin. According to Jankelevits the thumb makes an assisting movement before a downward shift from a high position: it disengages slightly from the neck of the violin and begins to pull the hand after it into the new position.

4.9. String Changes and Bow Changes in Connection with Shifts.

Szende spoke about bilateral coordination, i.e., symmetry of arm movement that is a disturbing factor in violin playing (Szende,1977, pp. 213-214). The violinist must strive to achieve bilateral isolation, in which the movements of the arms take place at slightly different times. The correct order of events is as follows: first the change of position (shift), then the string change and finally the bow change (the time differences are of the order of fractions of seconds).

4.10. The Timing of Respiration.

It is not possible to control breathing continually while playing the violin. However, for the purpose of not running the risk of placing emphases at the wrong places in the musical phrase, it is wise to try to regulate breathing so that inhalations are made during up-bows and exhalations during down-bows. According to Szende's research, 80.6 % of professional violinists' inhalations occurred during up-bows, and 78.6 % occurred close to the change of bow (cf.p.176 below). The most important thing, however, is that one should breath calmly and deeply while playing the violin, no matter what sort of technical difficulties there may be.

5. The Phases of Shifts:

5.1. The Creation of the Mental Image (Movement in the Mind).

The coming note sounds in the mind. An image is formed of the mechanics of the shift: does the movement take place with the entire arm or primarily with the wrist? Which will be used: traditional French glissando or finger extension? An image is formed of the muscle sensation and position of the arm and fingers which will produce the correct pitch of the new note(s) and from which it will be easiest to move into the following position of the hand. The shift has been initiated: the muscles have received a "hint" of the execution of the shift. The attention of the mind is concentrated on carrying out the coming shift.

5.2. Preparatory Phase (the Preparatory Movement of the Muscles and Joints).

Decrease of pressure in both hands (the vertical element of the shift). If a long jump is to be performed, the entire left arm starts to move either to the right (upward jump) or to the left (downward jump). The thumb makes a preaparatory movement aimed at creating balance in the shift: in downward shifts it moves downward in advance. In upward shifts where the hand passes over the edge of the violin, the thumb moves under the neck of the instrument. In situations in which modern "retarded" shifting technique is used, the final finger moves into position next to the initial finger.

5.3. Performance Phase (Executing Movements of the Muscles and Joints).

When pressure under the finger-tip is at minimum, the shift is decisively executed, with a movement involving the entire arm, insofar as that is possible. In slow shifts the performance phase begins calmly and accelerates toward the end. The shift is a swinging, as it were, between a finger in balance and a finger seeking to achieve balance. Either French or Russian glissando is used, depending on the circumstances. The glissando should, in general, be inaudible in a polished performance. In upward shifts from higher to lower finger, glissando occurs on both final and initial fingers, in downward shifts only on the final finger.

5.4. Follow-through (bringing the Movement to an End).

The first finger in the new position seeks a comfortable feeling of balance on the fingerboard (the vertical element) at that point which produces the appropriate pitch of the first note in that position. The ear "suspects" the pitch of the new note. If the note does not satisfy the ear, the finger corrects the pitch as quickly as possible to a new place on the fingerboard. A small correction is usually carried out with the aid of vibrato. The thumb functions as a counter-balance.

5.5. The Formation of a Mental Image of what has taken place (Comparison with Original Mental Image).

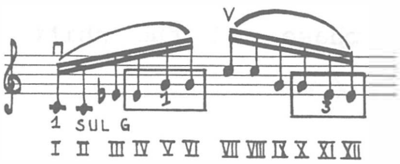
The executed movement is "mirrored" against the original ideal image and the similarity of the two images is judged. Differences are registered in the mind. It is important, before the next attempt is made, to solve the problem of how to eliminate the extraneous aspects of the previous attempt, its "parasitic activity".

6. The Phases of the Shift in Double Time (Flesch: Das Skalensystem)

a)

Each eight-note is divided into two "pulses" (I-XII):

b)



	MENT	PREP	OR DE	EXEC	FOL	MENT
Upward:		IV		IV-V	VI	
Downward:		X		X-XI	XII	

MENT = Mental image, PREP = Preparatory phase, OR = Order, DE = Delay, EXEC = Execution phase, FOL = Follow-through.

In an upward moving figure the phases of the shift take place as follows:

<u>The preparatory phase</u> of the shift takes place during the second "pulse" of the tone (E-flat) preceding the shift (IV). The hand moves away from the neck of the violin, the thumb is placed under the neck, the arm rises, the first finger moves close to the third

finger (the second finger rises out from between the first and third fingers).

The execution phase of the shift takes place between pulses IV and V. The pressure of the third finger on the string (E-flat) diminishes to a minimum. The third finger releases the E-flat and begins to glide upward along the string (French glissando). The third finger releases the string and the first finger moves into the location of the new tone (G, fifth position). The pressure of the first finger on the string changes from minimum to normal pressure.

The follow-through of the shift (completion phase) takes place during pulse VI. If the G is out of tune (pulse V), the placement of the first finger is quickly adjusted in the right direction.

In the downward-moving figure all the phases of the shift take place conversely during pulses X,X-XI and XII.

V MUSICAL AND TECHNICAL TIMING IN VIOLIN PLAYING.

Ivan Galamian explains the differences and relationship between musical and technical timing in the following way:" A necessary differentation must be made between what might be called musical timing and technical timing. Musical timing means the actual sounding of the notes in the exact rhythmical pattern and the exact speed required by the music. Technical timing means the making of the necessary movements of both left and right hands at the exact moment and precise speed that will insure correct musical timing" (Galamian,op.cit.,pp. 22-23).

Music is art that moves forward in time. The division of the time is the musician's most important task, and the manner in which he accomplishes it depends to a great extent on how he applies the language of movements to it. A live performance of music is rather like riding in a horse race: an experienced musician stays effortlessly in the saddle from start to finish, but the inexperienced player is easily thrown, and his performance is ruined. A first-class performance is impossible without a clearly pulsating conception of time. Just imagine the Third Movement of the Sibelius Violin Concerto performed monotonically in strictly regular time by someone lacking the ability to bring its strong pulse alive! Or what would the Wieniawski Polonaise sound like in a mathematical, mechanical tempo ?

1. Timing Factor.

A musical performance is succesful if the performer has a highly developed sense of musical timing and in addition solid technical timing skill. He is then able to fulfill the musical demands of the work performed. Musical timing means getting the notes to sound within the framework of the vital and sensitively changing pulse required by the music.

In a artistically valid performance musical timing is, of course, a determining factor from the standpoint of technical timing. If one wishes to produce correct musical timing in a performance, absolute control over technical timing under all circumstances is necessary. A talent for musical timing (which is closely related to the talent for conceptualizing music) is in turn a great help in noticing weaknesses in technical timing during systematic practice and in correcting them: in fact, such weaknesses cannot, in many cases, be noticed without a well developed talent for musical timing. These two factors must be present in any first-class musical performance and go, therefore, hand in hand and influence each other very strongly.

Those who have a very highly developed conception of time relationships are most successful at dealing with technical difficulties in music. They are able to conceive of the relationships between notes of different durations instinctively correctly and "divide up" the music immediately in a natural manner. Ivan Galamian speaks (op.cit.,p. 23) about the "factor of timing" that can be developed by means of intense practice. It is a strong awareness of the movement of music, of the forward progress of music, the ability to feel the pulse, that manifests itself by, among other things, forcing the person who possesses it to continue producing a flow of living music in spite of technical difficulties or occasional mistakes.

2. Changes of Tempo.

The study of tempo changes includes both switching from a slow movement of a piece of music to a fast movement (or vice-versa) in a natural manner, and managing to play stylishly a bridge passage between such sections in which the basic pulse changes. It also includes the ability to make music in a balanced manner employing rubato within the framework of a fixed pulse. Flesch recounts that Liszt explained rubato to a pupil in this manner: "Do you see those trees? The wind toys with their leaves, it develops life among them; the tree remains the same; that is *Chopin's* rubato" (Flesch, op.cit.,Book Two,1930, p. 57).

In a musically and technically properly timed performance, there is seamless coordination between the artist's thoughts and hands in all different tempos, rhythms and above all in changes of tempo. This is possible only if the artist has the ability to experience the unbroken flow of the music and he has had both the intelligence and stamina to overcome the technical timing difficulties in the work through practice. Controlled technical timing means that a clear and distinct musical pattern is set in motion through the medium of the violin in a controlled,strictly defined tempo and pulse so that the pattern remains whole and clear in all situations independently of any technical difficulties. In other words,the exact, necessary movements are made at exactly the right moment.

3. Technical Timing.

Let us imagine that we have a performance of one of the Paganini caprices on video tape. When the tape is played in slow motion, the various phases of the movements of the violinist can be observed: tiny, tiny details follow one after the other in precise order and at exactly the right time. The trajectory of every movement is different in shape and size and also differs in respect to speed from all the others. Technical timing means fitting all these differently shaped movements together so that they form a seamless, solid and technically clear whole.

In practice, the violinist comes face to face with his technical timing deficiencies when he has to play a piece together with an accompanist after too little individual practice. Since he has not yet had time to overcome and polish all the technical details of the work, his technical timing is not sound and his playing is forced. Common examples of imperfect technical (and at the same time musical) timing are those situations in which even a good violinist either slows down or speeds up the tempo completely independently of musical factors. This reveals that the violinist has technical deficiencies at the point in question.

The precise coordination of the two hands is an important part of technical timing. In this respect it is essential that the muscles in the hands and arms are able to carry out the orders of the brain in a split second. Technical timing is thus to a great extent a matter of practice, even though factors of innate talent are also involved. Some people are simply born with greater gifts of dexterity, balance and speed of reaction.

4. Errors in Technical Timing.

Errors in technical timing arise very easily in violin playing. Most common are the following:

1. Excessively large movements slow down the natural pulse of the music and result in stiffness of expression. It is very common, e.g., that the fingers of the left hand are raised too high and that string changes are made by tipping the bow at too great an angle to the string.
2. There is a tendency to slow down the tempo during changes of position, string or bow if the player does not master the technique reguired or does not play economically enough.
3. The use of long bow strokes encourages slowing down the tempo, while the use of short bow strokes induces rushing. Few violinists are able to produce a broad detaché that is at the same time both rich sounding and supple. A rapid sautillé easily becomes frantic and uncontrolled.
4. String changes in rapid spiccato and, especially, sautillé passages disturb smooth performance.
5. Changes of tempo, in which a transition is made from slow to faster tempo or vice versa, create difficulties precisely when there must be a change from spiccato to sautillé or vice versa. If it is necessary to play for a rather long time in such a transition stage where the spiccato does not function well (i.e., at too quick a tempo for spiccato), but in which the sautillé does not yet quite "catch fire" (i.e., at too

slow a tempo for sautillé) it might be better to switch radically to a clean detaché, otherwise it could turn out to be impossible to achieve correct technical timing.

6. It is often difficult to coordinate the action of both hands after working on a technical problem concerning one of them (e.g., sautillé).
7. A poor fingering can totally destroy all chance of succesful technical timing, whereas a well thought-out and suitable fingering may in certain cases completely solve a problem of technical timing.
8. An inability to think in clusters, i.e., to be able to read several notes at a time and conceptualize the musical pattern formed by them, impedes both correct musical and correct technical timing.
9. Shifts that are not under control and planned ahead of time are a common cause of imperfect technical timing. A "rhythm-blind" player, or one who has a deficient shifting technique, generally makes shifts too quickly by jerking his hand frantically into the new position. Good shifting technique is an absolutely necessary prerequisite to natural musical-technical timing. Without it, good timing is not possible.
10. Stage fright can cause rushing of tempos in general(and at the same time loss of the ability to control timing), or occasional sudden accelerandos that destroy the natural pulse of the music and give the performance an unstable, hurried or even frantic character. In such cases it is not a matter of lack of ability on the part of the player, but rather that he is not able to control the tempo of his thoughts due to nervousness.

5. Timing in the Action of the Bowing Hand.

Proper timing of the action of the bowing hand depends on precise observation and control of the division of the bow, of different types of bowing, bow changes and string changes. A beginner, of course, is not able to divide the bow properly. It is the job of his teacher to see to it that he employs bow divisions that serves the musical phrase.

Bow division can be surprisingly unsophisticated in the playing of even quite technically advanced students. The only conclusion that can be drawn from this is that such a student is still musically immature and lacks sufficiently strong will to give expression to the music. As far as timing is concerned, it is generally excellent in rapid, virtuoso passages in the playing of this type of student, but cantilena passages do not breathe freely and they sound monotonous. The slow sections of short works and sonatas and slow movements of concertos are the most revealing indicators of how far a student has advanced in his musical development.

6. Coordination between the Hands.

The contribution of each hand in matters of timing varies according to the situation. There are passages in which the action of the bowing hand (e.g., by providing sharp accents) regulates the timing. On the other hand, the clear articulation of notes by the left hand or the definite stressing of a given note can be decisive in keeping timing both musically stylish and technically beyond reproach.

Generally, the bowing hand functions, so to speak, as "conductor" and provides the music with the required pulses. The bowing hand would seem to be in a key position also in tending to matters of timing. But the contribution of the left hand is also important, e.g., in the playing of rapid legato passages (i.e., with one bow stroke). First, the passages must be precisely planned, with the notes properly grouped and the string and position changes in the right places. Second, the shifts must be planned and practiced so that when necessary they occur on stressed beats of the measure. The player must decide which hand he should pay the most attention to in any given situation, so that coordination between them functions properly and he does justice to the music. This is especially important in the case of those (extremely many) violinists who have a tendency to pay an excessive amount of attention to only one hand (usually the left).

7. Factors Promoting Technical Timing.

The violinist should pay special attention to the following factors that promote technical timing:

1. The speed of thought should be increased and the speed of the movements of the hands decreased. This is an important basic rule.
2. Thinking in clusters is indispensable in the playing of rapid passages. I.e., it is necessary to think of as many different notes as possible at the same time. If, e.g., an eight-note legato is to be played, one should think about all eight notes at one time, not one after the other. (Isaac Stern says that he always thinks a measure or two ahead when playing: Applebaum,op.cit.,Book Nine, p.118)
3. Care must be taken that the following events take place in this order (with split seconds between them): elbow movement, string change, change of position, finger action, bow change and, not until then, bow stroke.

4. One should always play in absolutely strict rhythm during practice:e.g, shifts of different length must be performed at different speeds within a rhythmic framework so that the precision of the pattern is preserved, etc.
5. Practicing should first be done at a slow tempo and with slow movements and then (if the final tempo requires rapid shifts) the passage should be played again at a slow tempo with the shifts performed quickly.
6. The note preceding the shift must be released at exactly the right moment and also dynamically, so that the shift can be carried out as calmly and evenly as possible.
7. The fingertips should be kept as close to the fingerboard as possible while playing, and as small angles as possible should be used in string changes.

8. The Influence of Technical Timing on Intonation.

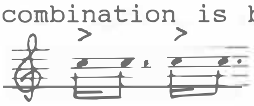
It has already been mentioned above that correct technical timing is indispensable in the production of tasteful musical timing. Correct technical timing also determines to a great extent the success with which various other factors affecting the quality of violin playing are carried out. Intonation and tone quality depend largely on details of technical timing. It is obvious that one of the main factors affecting intonation is when (and at which angle) the fingertip strikes the fingerboard (ignoring for the moment the role of the ear).

So-called slow practice is especially of use when fine-polishing intonation in violin playing. The essential thing in slow practice is not at all that the playing tempo is slowed down, but that the player has the ability to slow down the movements of the fingers and prevent their striking the fingerboard too early. The proper timing depends to a large degree on whether the preparatory movements have been completed before the "real" movement is carried out. Just as a skilled automobile driver has to anticipate traffic situations and react to them in time, the violinist must prepare all movements carefully if he wishes to play in tune.

Tone quality, for its part, is clearly dependent on how the bow is placed on the string, with what speed it is drawn, how much of it is used in different situations, the relationship of the speed of the bow to the distance from the bridge at which it intersects the string, the pressure applied, and the speed of left-hand movements. Attention to technical timing is absolutely indispensable if one wishes to develop good intonation and good tone quality, and also produces relatively quick results.

9. Timing Strategy in Playing the Sarasate Tarantella.

In order to see by what sort of detailed guidelines (followed by patient practice) it is possible to develop impeccably functioning technical timing, we will take a close look at the last two pages of Sarasate's *Introduction and Tarantella.* We will stop at a number of points at which strictly violin-technical problems can interrupt the furious pace of the tarantella and at the same time spoil both technical and musical timing.

1. In playing "drumming" varieties of bowing (cf.Garam,1972, p.60), it is essential that the shorter note is played with an active movement of the hand and that the dotted note is played with a relaxed reflex movement. This combination is best practiced if the shorter note is accented:  etc. This bowing pattern must be played with a very short bow stroke, close to the string. It works best if the fingers hold the bow quite firmly.

2. The string change must be made very carefully and consciously; otherwise the movement of the bowing hand is easily disturbed. The string change is effectuated by lowering the upper arm.
3. It is best to make the shift before the short note, because the bow is then off the string and the shift will therefore not be heard.
4. If the sixteenth notes are to be played in tune, the preceding notes must be released in good time, i.e., early enough.
5. The shift should be carried out with glissando and the use of an intermediate note (so-called normal shift with French glissando)
6. The shift (jump) must here be executed boldly, relying on kinesthetic muscle feeling.
7. The first finger remains on the E-string while the second finger is placed on the G-string.
8. When playing the double stop, care must be taken to apply the same bow pressure to both strings (i.e., sufficiently on the lower string). The string changes must be checked if intonation problems arise.
9. This fingering is perhaps a bit heretical, but it is quite satisfactory if the preceding fifth is released quickly enough.
10. Use an appropriately very short and sharp bowing movement and take care to play at the correct point of contact on the string so that the sound stays firm and strong.
11. The order of performance must absolutely be as follows: first the change of position (which must be made quickly even when practicing slowly), then the striking of the finger onto the fingerboard, and then finally the new bow stroke. If the bow stroke is made too early, the pattern becomes blurred.

12.Do not "swallow" the note (c) played with the fourth finger before the shift down. In this case, the release of the old position must be slightly delayed.

13.The change of string to the E-string with a down-bow (which is more difficult to do than an up-bow) must be carried out with as small a movement of the upper arm as possible, accompanied by a slightly larger movement of the lower arm and wrist.

14.The long jump can be made to seem short by performing the shift with a sharp bending movement of wrist.

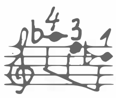
15.In order to make the first note in the new position (d) sound in time, the old position must be left as quickly as possible.

16.The position of the left elbow must anticipate the playing of the rapid passage in the new position, so that the fingers strike the fingerboard at the right angle immediately.

17.One must be clearly conscious of the fact that the last note in the old position is played with the third finger, and that the distance to the following note played by the first finger is relatively long.

18.One must be conscious of the difficult down-bow string change to the E-string and carry it out with a small movement of the upper arm accompanied by a slightly larger movement of the lower arm and wrist.

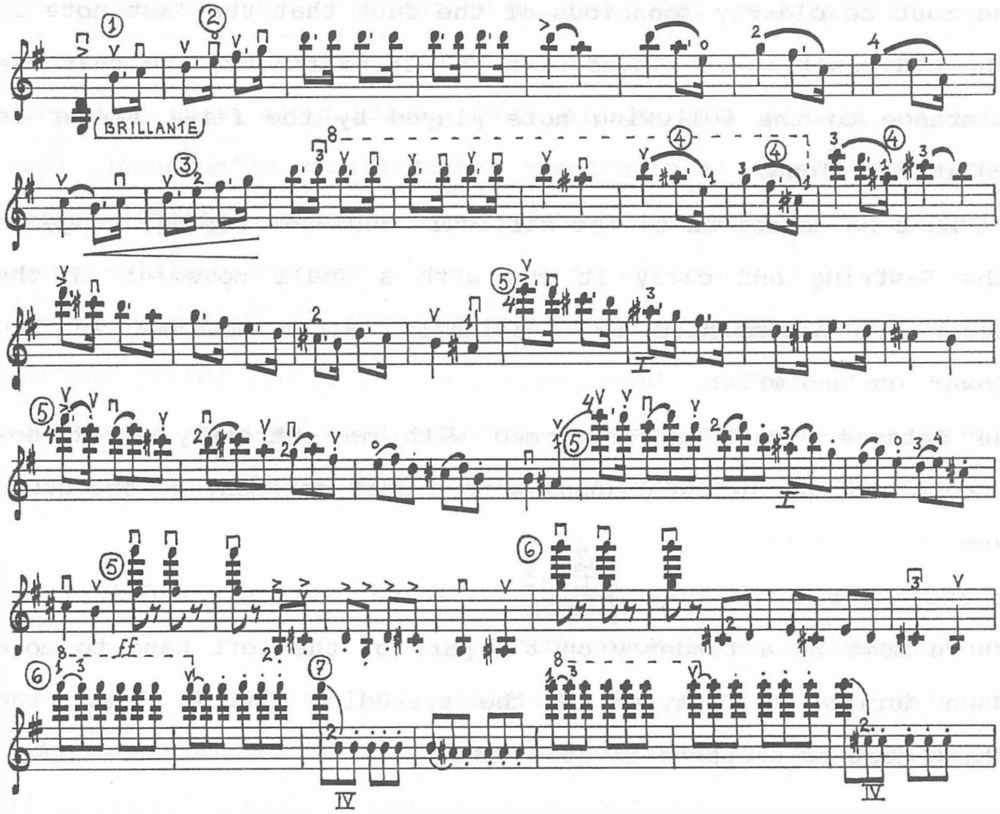
19.The detaché must be performed with an extremely short bow stroke and the string changes with a soft movement of the upper arm.

20.In order for the figure 

to sound precisely and in tune, there must be a tendency on the part of the left hand to move down during the playing of the preceding figure. I.e., the shift must be prepared in good time.

21. These figures are to be played with an extremely short detaché stroke (unless one wishes to use a sautillé stroke).
22. The whole and half tone steps in the fingering 1-2-3-1-2-3 must be noted, and it must be remembered that in the second and third shifts the distance to the first finger in the old position is relatively long.
23. The down-bow string change to the E-string must be noted, and it must be made with a small movement of the wrist.
24. The chord is to be played with a strong movement of the entire arm, so that the string change is carried out by lowering the upper arm actively.

Sarasate: Tarantella (from Introduction and Tarantella op.43).




SUL G
BRILLANTE
DIM..
CRESC..
PIU PRESTO
CRESC
CRESC..
a. TEMPO
SAUTILLE

Many seemingly hopeless technical problems can be cleared up through practice if there is an understanding of the importance of directing the attention to correct coordination and it is planned carefully. Just as, e.g., faultless shifting technique and total control of the bow belong to the conditions that must be present if we are to hear first-rate violin playing, both tasteful musical timing and completely polished technical timing are among those pillars upon which a consummate and satisfying musical performance are built.

10. Timing Strategy in Playing the Paganini Caprice no. 20.

We will now look at a few examples of movement strategy related to timing in the Paganini Caprice No.20. Just as in the case of Sarasate's Tarantella, 30 points have been selected where it is easy for the smooth progression of movements to break down if timing strategy is not planned ahead of time.

1. The shift must take place before the change of bow.
2. As above; the third finger must strike the string at the same time as the second finger. Determination of string level: left hand -- left elbow position, right hand -- upper arm.
3. Chord breaking: bow division; timing of shift.
4. String change with passive, relaxed wrist; the movement is, however, all of one piece and is initiated by the upper arm (cf. Steinhausen's principle).
5. New fingering. Distance longer = shift must be quicker.
6. The fingers must be separated so that the D-string can vibrate freely between them. Be conscious of the string change made by the bow.
7. The third and second fingers do not always move the same distance. In the first four shifts, e.g., the two fingers move in different combinations of whole and half tone shifts, as follows:

   third finger: whole - whole - half - half

   second finger: half - half - half - half

8. The first and third fingers exchange strings: the former moves from the G-string to the D-string, the latter opposite. They must both strike the fingerboard at the same time.
9. Choice of bowing styles: if the dotted notes are played sautillé the effect is more striking than if they are played with a flying staccato, but the problem arises that during the up-bow the bow must return to the point on the bow from which the following down-bow begins. If this is not done smoothly, the effect is choppy. The flying staccato gives a more graceful impression, makes a rapid tempo possible and eliminates bow-division difficulties. (Both styles of bowing are used).
10. The changes of position must be prepared carefully and carried out with a movement of the entire hand toward the new position.
11. Be conscious of the release from the old position. Fourth finger balance must be found in the new position = the relaxed support of the entire forearm moves from the second finger (the last finger in the old position) to the fourth finger (the first finger in the new position).
12. The hand position must be adjusted as soon as the first finger has arrived in the new position so that the second and third fingers are able to fall comfortably onto the fingerboard to play their notes and so that the fourth finger does not play flat.
13. There is a long jump between the two positions, so that the shift must be carried out very quickly; i.e., the left hand must perform its function well in advance of the bowing hand.
14. The slight downward stretch of the third finger moves the hand from the fourth position into the third position.
15. As in point 12.

16.The fingers are spread during the shift-jump into the position needed in the new position. The left hand shifts quickly, so that the fingers are on the fingerboard before it is time for the bow stroke.

17.Be keenly aware of the exceptionally long jump and the feeling of balance and muscle tension in the fingers and entire arm. The shift is made boldly.

18.If the figure (sestina) is started with a down-bow, the change of string from the G-string to the E-string will be very difficult, but the dotted notes can be sounded sharply since they can be played spiccato. It is best to keep the upper arm at A-string level the entire time. The change to the E-string can be made efficiently with a small, sharp pull of the upper arm. The movement as a whole is initiated in this case, as always, from the area of the shoulder and upper arm (cf.Steinhausen's principle).

19.The entire arm swings quickly into position before the bow stroke starts.

20.,21.,22. as in point 19.

23.,24.,25.,26 as in point 16.

27.The bow changes (in the air) back to the frog must be made very quickly.

28.Movement of the entire arm. The elbow moves to the right (as seen by the player). The first finger moves farther in the shift than the fourth finger.

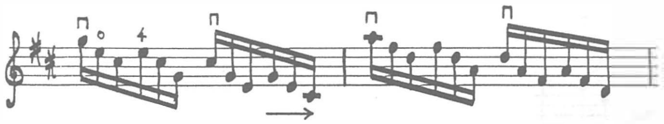
29.String change movement with the upper arm. Very little bow used.

30.as in point 10.

Paganini: Caprice no 20

11. Additional Examples Related to Timing.

Beethoven: Violin Concerto, Third Movement

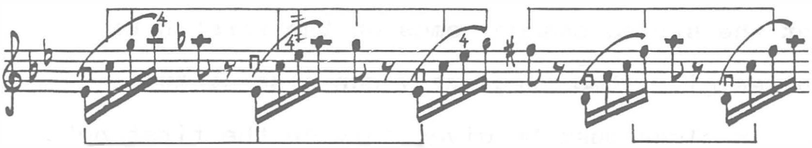


In order for the first note of the second measure to sound precisely in time, it is necessary, on account of the time-consuming string change, to play the three last notes in the preceding measure a bit hurriedly, i.e., rubato, "stealing" a bit of time.

Saint-Saens: Violin Concerto in B-minor, Third Movement

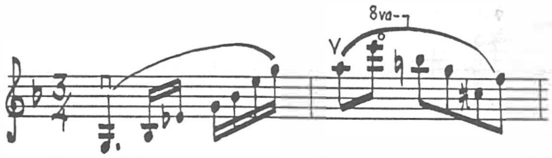
In order to reach the highest notes in time the movement of the left hand must be active and in good time, and the wrist action must function supply in the high positions. The position of the hand in the various positions should be checked ahead of time and used as a basis for the actual shifts.

Vitali: Chaconne



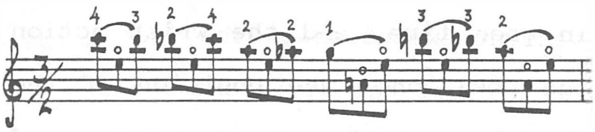
In playing the violin we often have to leave the fingers in place on the fingerboard. This is necessary in many cases for the purpose of achieving both correct timing and pure intonation. In the example above the notes connected by brackets are to be played without lifting the fingers.

Sibelius: Humoresque, Opus 87, No. 1



In order to play this figure smoothly from beginning to end, the elbow must be set early enough to the right (as seen by the player). The position of the left hand must be such that every finger is at the proper distance from the fingerboard in every instance and at every moment. If the distance of any finger from the string becomes too large, the timing of the movement is disturbed.

Shostakovich: Sonata for Violin and Piano. Opus 134, Allegretto



In this example, concentrating solely on the figure in the left hand can produce irregularities in timing when suddenly the bow hand has to make a quick string change. (Of course, the passage can be fingered so that the string change comes on the first note of the triplet). Impulses given too frequently can also disturb the flow of the figure; impulses must be given only on the first note of every sextuplet.

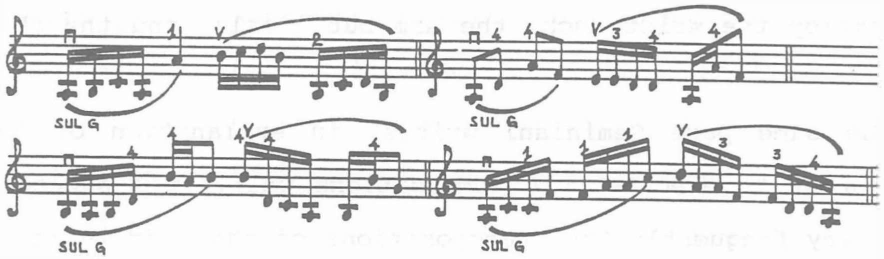
Wieniawski: Violin Concerto in D-minor; First Movement

If the difficult string changes are to be carried out succesfully, there must be full control of the configuration and timing of the movement, which is made by the upper arm with the bow making contact with the string slightly above its mid-point. The timing can be gotten under control by making a slight pause just before the down-bow during practice. In this way one can be sure that the string change takes place before the new bow stroke. The variation of the Corelli La Folia below should be practiced in the same way, since it displays the same timing problem due to the string changes:

Corelli: La Folia

In the fingering exercises by Tibor Varga reproduced below, the balances of the left hand, the kinesthetic muscle feeling, the pressure relationships and configuration and timing of movements must all be perfect in order to produce a brilliant performance:

Varga: Hammering exercises



VI THE CONFIGURATION AND TIMING OF MOVEMENT IN THE HISTORY OF VIOLIN PEDAGOGY.

The Middle of the 18th Century
Francesco Geminiani, Leopold Mozart, L'Abbé le fils.

The first important works of violin pedagogy appeared around the middle of the 18th century: Francesco Geminiani's *The Art of Playing on the Violin* in England in 1751, Leopold Mozart's extremely thorough *Versuch einer gründlichen Violinschule* in Germany in 1756 and L'Abbé le fils' *Principles du Violon* in France in 1761 (this was preceded in France by Corrette's work (1738) *L'Ecole d'Orphe'e*, in which he, e.g., detailed for the first time in the history of French violin playing the use of (7) different positions).

Geminiani's work is built up of 24 "examples" and 12 pieces of music, including only 9 pages of text discussing problems contained in the examples. It is obvious that it is not possible to include a very detailed analysis of problems of timing within such narrow constraints. Geminiani, however, does treat both the configuration and timing of movement. On page 5, e.g., he sets forth the following guiding principles: "In this Example are contained 16 Variations, most useful in Regard to Time, to the Bowing, the stopping in Tune and the Execution. Again you must be careful to keep the Fingers as firm as possible on the Strings, and also in bowing employ the Wrist much, the Arm but little, and the Shoulder not at all."

On the same page Geminiani writes, in explanation of Example XII:"In order to execute this Compositions well, 'tis necessary to examine very frequently the Transpositions of the Hand in it, until they are entirely impressed on the Mind;..." On page 6 (Example XVI) Geminiani maintains that "he who does not possess, in a perfect Degree, the Art of Bowing, will never be able to render the Melody agreeable NOR ARRIVE AT A FACILITY IN THE EXECUTION " (my emphasis. LG).

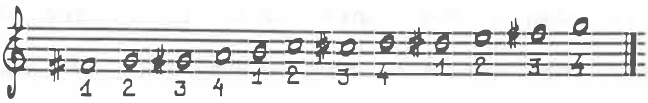
Geminiani also directs attention to the fundamental balances in playing the violin and the factors influencig them, viz., the playing position of the instrument: "Observe also, that the Head of the Violin must be nearly Horizontal with that Part which rests against the Breast, that the Hand may be shifted with Facility and without any Danger of dropping the Instrument" (p.2, Example I,B).

It can be seen from Geminiani's and Leopold Mozart's works that violinists of their day developed left-hand technique by systematically playing scales up through the seventh position. Geminiani lays out seven positions in his book and Mozart writes that a violinist should be acquainted with how the positions are used on all strings and that all seven positions should be mastered. "L'Abbé le fils also gives seven positions in his systematic exercises; and in the compositions in his treatise he occasionally goes even higher to the ninth or tenth positions" (i.e.to d'''')" (Boyden,1965, p. 377).

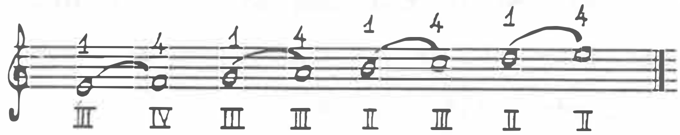
When Vivaldi played a cadenza "his fingers almost touched the bridge, so that there was hardly any room left for the bow." (loc.cit.). Boyden mentions that evidence of this is also given by Vivaldi's compositions .

Geminiani and L'Abbé le fils even seriously make use of the second position, and Tartini in his letter from 1760 recommends a certain piece exclusively in the second position to his pupil Maddalena Lombardini.

Nowhere in the literature on violin playing of the 18th century is the mechanics of shifting treated. On the other hand, one finds in this literature many examples of different fingerings that have an influence on the configuration, extent and timing of the shifting movement. Geminiani was especially intrested in fingerings in which the fingers are positioned closely together. He proposed the following revolutionary fingering, that was not "rediscovered" until the 20th century:



Geminiani writes that ".. two Notes cannot be stopped successively by the same Finger without Difficulty, especially in quick Time" (Example II). He criticizes fingerings of chromatic scales that employ a great deal of sliding on the same finger. On the other hand, he provides exercises in which the mobility of the hand is improved by performing repeated shifts between the first and third positions (Boyden,op.cit.,p. 379):



Leopold Mozart writes that there are three reasons for using the various positions:necessity, convenience, and elegance (Mozart,op.cit., p. 132). He provides no specific advice for carrying out shifts between positions, but does explain when and how it is best to shift primarily in descending passages:

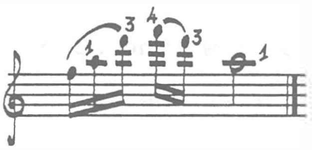
- while a note is being played on an open string
- by using similar fingerings in similar passages
- when the same note is repeated

- following a dotted note (ibid.,pp. 138-139).

Mozart emphasizes that shifting back and forth between positions should be avoided: one should remain as long as possible in the same position (ibid.,p. 138).

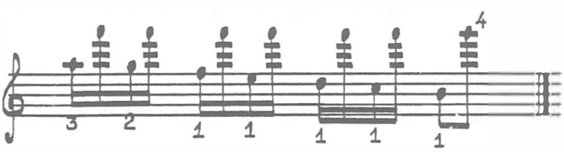
L'Abbé le fils agrees with Mozart that shifts should be carried out in short steps (Boyden,op.cit.,p. 379). Early in the history of violin playing the device of stretching the fourth finger a half tone toward the second position was introduced. Leopold Mozart gives examples of double stretches, i.e., stretching on the part of two fingers one after the other (Boyden,op.cit.,p. 382):

L. Mozart



L'Abbé le fils and Mozart treat stretching downward without change of position. This type of stretching makes possible the playing of ninths, tenths or even twelfths on the violin (Boyden,op.cit.,p.383):

Vivaldi



Modern violin technique makes use of many stretches that make it possible to avoid standard forms of shifting. This was well understood already in the 18th century and L'Abbé le fils in particular gives excellent examples of this type of technique (Boyden,op.cit.,p.383):

L'Abbé le fils

Leopold Mozart analyzes in his book the proper way of holding the violin and bow (Mozart,op.cit.,pp.54-60), emphazises the significance of the proper teaching of tempo (pp. 30-42), explains various aspects of fingering and also treats many features of musical performance such as embellishments, keys, tempo markings and bowings. He touches upon problems of the configuration and coordination of movements in his presentation of the eight basic rules of violin playing (ibid.,p.58-61):

1. The violin must be held neither too high nor too low. The scroll should be on the level of the player's mouth, or at the highest, of his eyes.
2. The bow should not be played so much on the side of the hair that the wood is allowed to touch the string.
3. The different parts of the bowing arm must move with different degrees of freedom, the shoulder least, the elbow more, the wrist naturally and freely.
4. The pupil must learn from the very beginning to play with long strokes of the bow.
5. The bow must not be drawn either too near the fingerboard or too near the bridge.
6. The fingers must not be laid flat on the string.
7. Inactive fingers must remain in position over the string.
8. All unnecessary movement of the violin or twisting and rocking of the body is to be avoided.

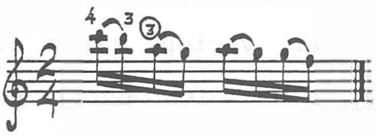
Mozart admonishes the violinist: "He who does not, right from the beginning, become thoroughly familiar with the position of the notes through frequent playing of "the musical A B C ", and who does not by diligent practice of the musical scale arrive at that point where the stretching and contracting of the finger, as each note demands, becomes so to speak second nature, will always be in danger of playing out of tune and with uncertainty" (ibid.,p.61).

Mozart does not treat problems of coordinaation directly, but he emphasizes that the pupil must be able to discover the correct tempo for each piece, and he must be in full command of the various rhythms in it before he begins to play. He writes: "Time makes melody, therefore time is the soul of music" (ibid.,p.30). It not only animates the music, but holds all the component parts of the music together. "One must lay before (the pupil) various kinds of time, and not allow him to undertake anything else until he understands thoroughly all that has been explained " (ibid.,p.42, sec.12). At the end of his book, Mozart supplies a table in which a half-note melodic passage is repeated in 20 different rhythmic patterns.

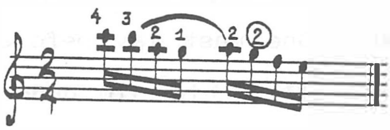
Leopold Mozart is of the opinion that the violin pupil should first be taught to beat the time of a given piece and only then set to play it on the violin (ibid.,pp.33-34,sec.8). He explains this in greater detail:"But now we come to an important point, namely, the question of speed. Not only must one beat time correctly and evenly, but one must also be able to divine from the piece itself whether it requires a slow or a somewhat quicker speed....Every melodious piece has at least one phrase from which one can recognize quite surely what sort of speed the piece demands. Often... the phrase is forced into its natural speed " (ibid.,p.33, sec.7).

Mozart's examples of fingering patterns clearly show that he thought it important that shifts be carried out inaudibly. Many of his examples are well planned, but are in practice actually difficult to realize (e.g.,ibid.,p.142, sec.4; p.142, sec.5; p.144, sec.9). He also recommends that shifts between positions be practiced in rapid passages in whole-tone steps. The advantage in practicing thus is, in his opinion, that one learns to shift in a descending passage on any given note. In the following examples Mozart has indeed sacrificed intonational accuracy and coordination to theoretical speculation despite that fact that the bowings provided aid in carrying out the shifts:

example no 2



example no 5 (ibid.,p. 146)



On page 147 Mozart explains how the violinist must be able " to deceive the ear of the listeners; that is, so that they may not perceive the change and swift descent of the hand." The fingerings that he provides for the musical examples on the same page, however, do not in all cases promote the principle of unnoticeable shifts. The examples contain a number of whole-tone shifts.

L'Abbé le fils' work brought new possibilities to French violin playing. His book contains various innovations, of which the most noteworthy are, from the standpoint of our topic:

1. He recommends, for the first time in the history of violin playing, that the violin be positioned with the chin to the left of the strings (both Geminiani and Mozart placed the chin to the right).

2.He recommends finger-stretching both downward and upward (as did also Mozart).

3.He provides examples of the use of the half position.
4.He uses the ninth and tenth positions (Boyden, op.cit., pp.359-386).

There is no information concerning the question of the fundamental balances in violin playing in 17th-century sources except for elementary instructions concerning how to hold the instrument. Geminiani's recommendations have already been mentioned: placing the violin on the collarbone in such a way that the chin was located to the right of the tailpiece. However, he also mentions the method of resting the violin on the player's chest.

Leopold Mozart explains that there are two ways to hold the violin: the unconstrained shoulder position, and the same position but with the difference that the violin is held by the chin on the right side of the tailpiece. Mozart clearly is in favor of the latter method. He provides pictures of both positions in his book (cf.Mozart,op.cit.,pp.55,56).

L'Abbé le fils goes one step further than Mozart: he recommends placing the chin to the left of the tailpiece. Not many players adopted this, however, perhaps in part due to the fact that no chin support was employed at that time. The chin support was not invented until 1820 (by Louis Spohr).

David Boyden writes : "Paradoxically, we know too few and too many details of violin playing in the 18th century: too few, because a number of questions about performing the music cannot be answered with any degree of assurance; too many, because there is sometimes a bewildering variety of answers. Such copious information suggests that there is not one but a variety of eighteenth-century styles. Indeed, these different styles correspond loosely to the difference between national styles and sometimes to the differences between professional and amateur players. While each national style has a certain consistency in itself, it is not definable in rigid terms, and for this reason, among others, there is no such thing as one definitive and authentic performance of a piece of eighteenth-century music to the exclusion of all other performances" (Boyden,op.cit.,p.366).

The Beginning of the 20th Century

F.A.Steinhausen.

There is not a single work in the violin pedagogical literature of the 19th century in which the nature and coordination of movements employed in playing the violin are treated in an intresting fashion, or even mentioned. It was not until the beginning of the 20th century and its early decades that several extremely valuable works saw the light of day, e.g.,F.A. Steinhausen's *Die Physiologie der Bogenführung* (Hannover, 1902; Fünfte Auflage, Breitkopf und Härtel, Leipzig, 1928) and Carl Flesch's monumental standard work *Die Kunst des Violinspiels* (1923; in English *The Art of Violin Playing*, 1928).(In 1921 Siegfried Eberhardt published a unique work, *Paganinis Geigenhaltung*, in which he maintains that all problems involved in playing the violin disappear if the instrument is held precisely the same way that Paganini held it. Eberhardt was an extremely productive publisher (around 15 pedagogical works on violin playing), but his ideas move predominantly on the level of intuition).

Steinhausen was a medical doctor and a violinist. This combination produced a book that is still today of primary importance, in spite of a few idiosyncrasies. (Steinhausen "swears by staccato", so to speak, and maintains that the height of bowing technique is to be found in staccato playing. He boasts of being able to play 70 notes on a single bowing stroke). Steinhausen's book is a watershed in the history of violin pedagogy. It was a worthy beginning to the "scientific" study of playing the violin that has continued down to our day, and is still continuing.

Steinhausen's most important contribution lies in his being the first violin pedagogue in history to explain the natural working mechanics of the muscles and joints of the arm. Not even today are there many pupils of violin playing who have a correct picture of the hierarchy of movements of the muscles and joints. Steinhausen takes a sound principle as his point of departure:"We can teach our body nothing; we can only learn from it" (Steinhausen,1928, p.10).

Steinhausen discusses the following physiological errors made in bowing:

1. An attempt is made to correct movements of the upper arm with movements of the lower arm.
2. The rotary motion of the forearm is lacking.
3. Excessive muscular tension appears in the upper arm.
4. The player has the wrong conception of practicing: he repeats a passage again and again with tensed muscles and joints.
5. Non-musical gymnastic exercises are practiced, leading to "a sterile, unnatural technique lacking musicality" (op.cit., p. 21).
6. The differences between piano and violin technique are not observed.

The Joints.

Steinhausen points out that there are 27 different bones in the hand, which in itself is an indication of the delicate structure of the hand (ibid.,p. 24). He considers the shoulder joint to be the king among all the different joints: it can move freely throughout

270 degrees, of which actually only forty to eighty degrees are used in bowing technique.

(The shoulder joint, ibid.,p.25)

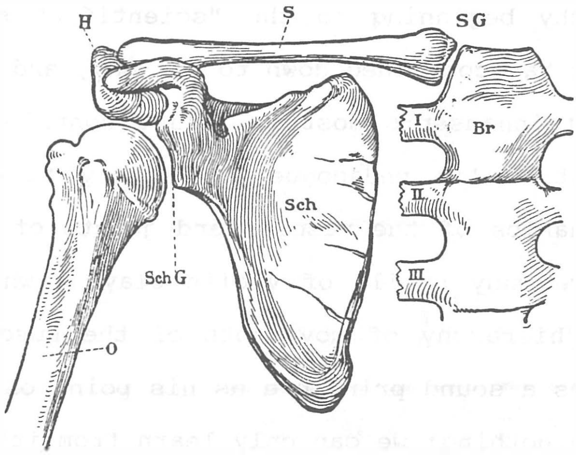


Fig. 1. Rechtes Schulterskelett von vorn nach Abtragung der Rippen. *Br* Brustbein. *I—III* 1. bis 3. Rippe (entfernt). *SG* Schlüsselbein-Brustbeingelenk. *S* Schlüsselbein. *Sch* Schulterblatt. *O* Oberarmbein. *SchG* Schultergelenk. *H* Schulterhöhe, hinter dem Schultergelenk gelegen und dasselbe überdeckend.

The muscular structure of the shoulder region is so highly developed that the arm can move freely through all the positions allowed by the shoulder joint, making it possible to perform with great precision all the many varieties of bowing, including those requiring the tiniest movements. Steinhausen underlines this: "This important fact is emphasized here because it is precisely the shoulder joint to which the hand is indebted for its ability to move freely and delicately in all directions" (loc.cit.).

The elbow joint is a double "cylinder joint" that allows only two types of movements: extension of the forearm (and the opposite movement), and a rotary motion of the forearm about its axis. Steinhausen emphasizes that this rotary motion should not be confused with the movements of the wrist.

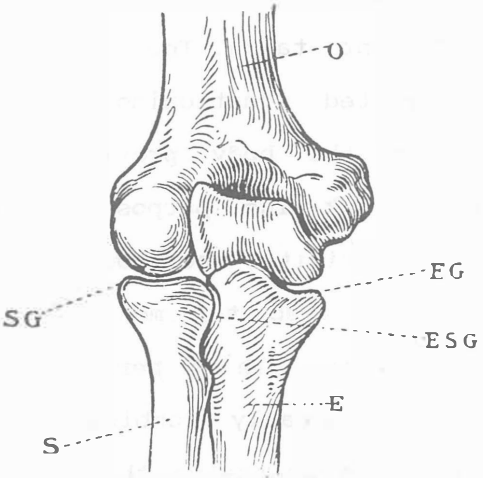


Fig. 2. Rechtes Ellbogengelenk von vorn.
O Oberarmbein mit seiner Doppelgelenkfläche. E Elle. S Speiche. EG Ellengelenk (Scharniergelenk). SG Speichengelenk (Kugel- oder Rollgelenk). ESG Rollgelenk zwischen Elle und Speiche.

(The elbow joint, op.cit.,p.26)

The wrist also makes possible only two types of movement: up-down and right and left. In his discussion of the muscles, Steinhausen emphasizes that individual muscles never function seperately, but always jointly and in groups. For this reason tension in one part of the arm leads to the simultaneous tensing of several muscles. The influence of some muscles extends not only to the area around the immediate joint, but to that around two or even three joints. This takes places through mediation by the tendons. E.g., the hand contains such tendons, which also hold the hand together.

(The wrist joint,ibid.,p.29)

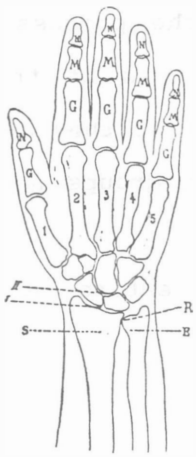


Fig. 4. Skelett der Hand nach Röntgenaufnahme. Man sieht die beiden Handgelenke, das eine (I) zwischen Speiche (S) und Handwurzel, das andere (II) zwischen den beiden Reihen der Handwurzelknochen gelegen. Zwischen S und E (Elle) das untere Rollgelenk (R). 1—5 die fünf Mittelhandknochen. G Grundglieder. M Mittelglieder. N Nagelglieder.

Cooperative Functioning of the Joints and Muscles.

The different joints perform different tasks. The joints are assembled in such a way that the restricted functioning of those located farthest from the trunk of the body provide greater motility to those closer to the trunk. The purpose of this restriction is to combine strength and motility. The shoulder joint has to perform the most extensive,but also the most delicate, movements of the entire arm. The elbow is able to perform only a limited extension-retraction movement, usually combined with a simultaneous rotary movement. Steinhausen maintains that from the standpoint of violin playing, this restriction is beneficial. It is precisely this functional hierarchy of the different parts of the arm that makes possible the fine control of all the movements involved.

As the seat of movement moves toward the muscles and joints located farther from the trunk of the body, the movements become progressively simpler. The movements of the wrist and fingers are extremely restricted. Just as in the case of the wrist, the fingers of the left hand are able to move in only two directions: up-down and forward-backward. Thus the action of the entire arm originates in the area of the shoulder, from which it progresses (in steps:cf.Rolland) through the upper arm and elbow to the wrist and fingers, becoming simpler by nature during the process (ibid.,p. 38). The muscles that control the various parts of the arm are always situated closer to the trunk than the parts they control.

The joints of the arm are divided into two groups according to their structure and function:

1. Two main joints, by means of which the entire mechanism is controlled: the shoulder and the elbow.

2. Twenty-two subsidiary joints: those in the wrist, palm and fingers. The movements of these joints are controlled from the main joints.

The muscles of the arm are also divided into two groups:

1. 130 muscles in the shoulder and upper arm that actively control movement.
2. 122 muscles in the lower arm, hand and fingers that react passively (ibid.,p. 39).

Steinhausen also discusses the role of the senses in violin playing. He emphasizes that it is important that the violinist learns to distinguish between muscular activity and passivity, and between muscular relaxation and slackness. Complete relaxation (which involves being prepared to act = a tiny amount of bioelectric activity: cf. Szende) differs from slackness, in which there is no preparation to act. It is precisely this least possible degree of activity, that lies on the border of passivity, that the violinist must learn to distinguish (ibid.,p. 42).

Steinhausen distinguishes between sustained and oscillating movements (ibid.,p. 43). He gives as examples from everyday life the lifting of a load (a sustained movement) and the throwing or swinging of some object (an oscillating movement). Steinhausen explains that the difference between these two types of movements lies in the duration of the effect of muscular activity on the object that the muscles cause to move. There is a different feeling in the muscles during sustained and oscillating movements: this difference can be felt when we lift our own arm (our arm is the "load") or swing it quickly.

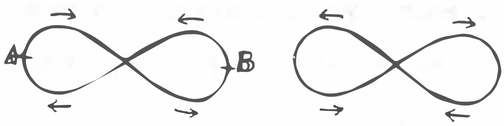
In playing the violin only a small part of the range of movement of which the shoulder is capable is employed, and similarly only a fraction of the muscluar power that the arm can produce is made use of. Steinhausen also explains the reduction of movement to its simplest elements, pointing out that, in order for a movement to be efficient, all extraneous, harmful aspects must be eliminated. Such movement can be termed ideal movement.

Every unrehearsed movement is more or less stiff, clumsy and awkward (ibid.,p.50). This is a result of too many muscles unconsciously and unnecessarily taking part in the performance of the movement. This type of extraneous muscular activity is to be found not only in nearby muscles, but also in more distant muscular areas. Such extraneous muscular activity is not present in well rehearsed, properly prepared movements. The removal of such extraneous activity results in greater "smoothness, fluidity and elasticity ", in Steinhausen's words (ibid.,p. 51).

In describing the motion of any given point on the bow, Steinhausen distinguishes between the size and direction of the curve it makes, and the degree of curvature (ibid.,pp. 100-102). In this description Steinhausen analyzed for the first time in the history of violin pedagogy the configuration and extent of this motion. In slow bowing patterns (legato), bow changes (with possible string changes) describe according to Steinhausen elliptical forms, if the bowing is performed correctly:

A = beginning of down-bow

B = beginning of up-bow



(ibid.,p.102)

Fig. 25.
bei *a* Beginn des Abstrichs.
bei *b* Beginn des Aufstrichs.

Rapid bowing movements (e.g., jumping bowing types such as spiccato, sautillé, ricochet, staccato arpeggios, but also a rapid detaché played on the string) describe, in Steinhausen's opinion, elliptical forms, or are at least partially elliptical. The down-bow (A) and up-bow (B) appear thus:

down-bow-pronation (A)

up-bow-supination (B)

Fig. 22.

Abstrich-Pronation. Aufstrich-Subination.

(ibid.,p.101)

Steinhausen points out that the ellipses present in the movements employed in playing the violin are in general extremely narrow; one reason for this is the necessity of avoiding touching neighboring strings in bowing. Steinhausen also considers that the timing of the bowing stroke must decrease more or less rapidly toward its end, and at its endpoint = 0. "Similarly, every stroke begins from speed = 0, from which it more or less rapidly increases. In any case, the speed of one movement must = 0 before the following can begin" (ibid.,p.103) (In this matter Rolland has advanced further: in his opinion the movement of the bow must not stop at all when it changes direction). Steinhausen maintains (as does also Rolland) that if the bow change is to be inaudible, the bow stroke has to resemble a double ellipse (Rolland explains that the movement does not stop completely at the endpoint precisely because it has the form of a loop). In order for the bow stroke to maintain the proper speed, it is necessary in Steinhausen's opinion to make as active use as possible of the upper arm (this same thing was later emphasized by Nathan Milstein, cf.Applebaum,1972, Book I, pp. 132-135). It is also important to remember this same principle in connection with shifting between positions.

In Steinhausen's opinion the large muscles of the upper arm are capable of regulating precisely the varying speeds used in the bowing stroke. The movement that initiates from the upper arm imparts the proper speed to the bow (Steinhausen,op.cit.,pp.24-25,125).

Steinhausen's book reveals that he was more a doctor than a violinist. He deserves credit for having attempted to analyze the mechanics of bowing, but his presentation of different types of bowing is rather modest. Knowledge of the nature of bowing appears thus to have been on an elementary level at the beginning of this century. In any event, Steinhausen's book was a harbinger of a new era in the history of violin pedagogy: an era of investigative research.

The 1920's

Leopold Auer.

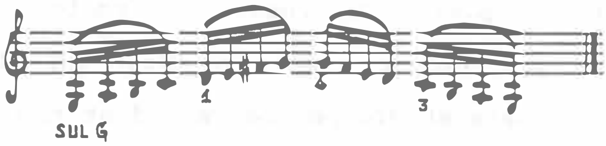
Hungarian-born Leopold Auer (1845-1930) can with good cause be considered to be, along with another great master, viz., Carl Flesch, among the leading violin pedagogues of the beginning of the 20th century. Pupils of Auer's who gained world-wide recognition include Zimbalist, Totenberg, Heifetz, Milstein and others. There can be no doubt that Auer mastered completely all areas of violin technique. However, his book *Violin Playing As I Teach It* (London, 1921) is for the most part a collection of entertaining anecdotes about famous artists and general comments about violin playing technique.

In his book Auer oversimplifies complex problems, confuses cause and effect, and is often inconsistent. (He apologizes for these weaknesses in his Preface.)

From the point of view of our investigation, of great importance is the emphasis that Auer places on rhythm. "... rhythm may well be called the underlying soul itself of movement....Rhythm is a principle underlying all life, and all the arts, not that of music alone." "Accent.. is really a rhythmic sensation. And rhythm and accent must be free, they must, in a certain measure, be instinctive and individual. A violinist without a sense of rhythm is no violinist", thunders Auer, "he is as helpless as a painter who is colour-blind" (Auer,1921,p.65).

Auer recommends that the pupil learn to make use of "rhythmic fingerings". He gives examples (op.cit.,p. 41):

Good fingering



Poor fingering

In rhythmic fingerings the changes in position take place on strong beats in the measure and this helps the player give proper shape to a musical phrase.

Auer has a very simple conception of the performance of scales in thirds: the shift is to be made quickly and inaudibly. A slow glide from one third to another is strictly forbidden (ibid.,p.46). At this point Auer oversimplifies a complex matter and gives the reader the impression that he doesn't want to bother treating the whole problem of shifting techique seriously. The problem of coordination in shifts can by no means be solved by merely maintaining that the shift is to be performed quickly. In this respect Auer has done a great disservice to violin pedagogy.

Auer suggests that the student of the violin practice scales in fourths in order to improve intonation and to make the eventual playing of flageolets easier:

(ibid.,p.47)

Auer recommendes that scales in fourths be practiced also descending and in different keys. He notes that it is much more difficult to play scales in fourths in tune than scales in thirds, sixths, etc (ibid.,p.47). In regard to scales in sixths, Auer recommends that one finger always be kept in place as long as possible. Both fingers should not be raised at the same time, since it is then impossible to play a passage in sixths legato. In regard to octaves, Auer once again emphasizes that "the movement of the two fingers should be carried out rapidly (even in slow tempo), in order to avoid the horrible caterwaul of the glissando from one note to the other" (ibid.,p.49).

He adds:"In general, when it is a question of changing positions, the shift should sound, in the case either of single or double stops, exactly as though it had been made on the piano keyboard."

Auer takes up the question of the coordination of the action of the two hands (ibid.,p. 59), and emphasizes that the finger of the left hand should be in position on the fingerboard before the bowing stroke is begun. He admits that this is not easy, but that the real virtuoso must master it.

Auer claims that violin students do not pay enough attention to factors of nuance. He lists these factors as dynamics, timbre ("quality and colour of tone "), and tempo (ibid.,pp. 64-65). In addition to not observing the grosser tempo distinctions adequately, the "average student", in Auer’s opinion, is not able to distinquish between the "hundred and one" smaller differences included in one and the same tempo marking. To correct this lack of ability to recognize "the infinite variety and meaning of tempo indications," Auer recommends learning the three basic classes of tempi (ibid.,p. 65):

1. The first class includes steady tempi from molto lento - which in Auer's opinion is the slowest possible - to prestissimo.
2. The second class includes all the accelerating tempi: accelerando, stringendo, etc.
3. The third class (" from rallentando to smorzando") includes all "the tempi of slackening speed."

Auer maintains: "There are no finer studies for nuance existing than (the) Bach Sonatas". Playing them with the proper attention to nuance is, in his opinion, extremely difficult. "If you can play the Bach Sonatas with the right shading then Lalo and Tchaikovsky need not worry you" (ibid.,p.69). He admonishes the student: "Study nuance on the violin ! Listen to yourself play !" (ibid.,p. 70).

Auer continues: "Correct phrasing is one of the hall-marks of true artistry, and only that violinist who has a fine and true conception of phrasing displays the quality of his talent in the most favourable light and takes rank among the artists.

All really beautiful phrasing depends, of course, in the last analysis, on technical perfection. For no matter how fine the student's musical instinct may be, faulty bowing - and faulty fingering as well - will inevitably destroy the continuity which is the very essence of smooth and convincing phrasing, and result in misrepresentation of the composer's ideas and intentions. Without technical competence even the most gifted interpretative instinct must fail of practical application" (ibid.,p.72)..."Furthermore, the violinist is characteristically so dependent on the mood of the moment, the accidental influence of temper and disposition, that the same musician seldom plays the same phrase twice in exactly the same manner" (ibid.,p. 73) (and cf. Garbusov's intonation hypothesis p.216 below.).

Carl Flesch.

Carl Flesch, who was born in Hungary in 1873 and died in 1944, was considered along with Auer to be the most outstanding violin pedagogue of the first half of the 20th century. Just a glance at a list of the names of his pupils reveals much: Rostal, Temianka, Goldberg, A.Ignatius, Gimpel, Totenberg, Odnoposoff, Szeryng, Neveu, Varga, Brainin, Neaman, Haendel, etc. Flesch delved into the problems of violin playing with the precision and thoroughness of a scientist. His books provide powerful documentation of an approach to teaching the violin that first searches and investigates and only then expounds. Flesch's inquisitive mind followed leads in all directions and untiringly sought out causes and effects. His books show the teacher of the violin (and why not also the pupil if he has sufficient stamina to read Flesch's works) how inexhaustible and rich the wonderland of violin playing is.

Flesch's *The Art of Violin Playing*, I (1924) and II (1930) initiated a new era in violin pedagogy. All noteworthy violin pedagogues after him have either unintentionally or intentionally had to quote him. Flesch has understood correctly the complexities of the coordination of movements:"The impeccable execution of technical difficulties in public performance demands a high degree of self-control in watching the degree of rapidity of the various movements" (Book One, p. 159) (Galamian also speaks about how the different parts of the arm move at different speeds: in Applebaum, 1972, Book One, p.346).

In his treatment of shifting Flesch brings up nothing essential from the standpoint of the present investigation. He prefers to confine his discussion of rhythm, tempo and coordination problems to the area of string crossing. In this discussion, however, there are sufficient references to the mechanics and timing of shifting, as also in Steinhausen's writings, and in those of Rolland, as we will see later.

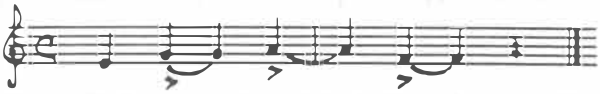
Flesch points out that string players tend to speed up in passages employing the "springing" bow. On the other hand, there is a tendency to slow down in beautiful cantilenas. Rushing in rapid legato passages is caused by the left hand. Flesch recommends the use of accents as a means of keeping the left hand under control in rapid legato passages (Flesch,op.cit.,Book Two,p.55). He offers the same corrective means in detaché passages where the left hand rushes. (It would seem, however, that in rapid detaché passages it is the right hand that rushes, not the left. Of course, the use of accents is helpful in such cases, both to keep the bowing hand under control and to speed up the left hand.)

Complex bowing patterns, in which accents against the beat are employed, make it difficult to keep the music flowing. Flesch gives the following example:

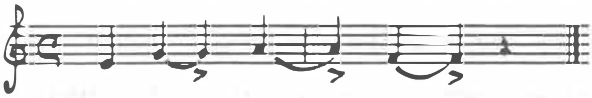
Playing such a passage calls for both exellent bowing technique and a great measure of rhythmic adaptability. In this case the accents make evenness of playing difficult (op.cit.,Book Two,p.18).

Syncopation as a Measure of Rhythmic Awareness and Culture.

In Flesch's opinion, syncopation is a "disintegrating element in the rhytmic texture, since it destroys the latter's legitimacy. It imperiously demands the accentuation of the weak beat on which it begins:"



Faulty acentuatution, however,is often heard - on the strong beat:



(op.cit.,Book Two,p.20)

Flesch is of the opinion that accentuating the weak beat in syncopation is a sign of great rhythmic culture on the part of the player. He believes that no experienced conductor would accept a musician for his orhestra who did otherwise, since placing the accent on the strong beat indicates that the musician’s education has been inadequate (loc.cit.)

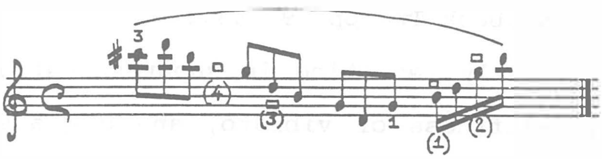
Another matter that demonstrates a high level of rhythmic culture on the part of a musician is giving rests their full value (op.cit.,p. 21) (Seashore states in one of his studies that 80 % of violin students fail to hold notes for their correct value) (Seashore,1967, p. 125).

Flesch takes under careful consideration the mechanics of changes of string and explains precisely the principles according to which slow or rapid changes of string should be carried out. He emphasizes that it is a mistake to carry out slow string changes with the wrist because the wrist is then either higher or lower than the fingers and this impairs good tone production (Flesch,op.cit.,Book One, p. 61). He believes that in all changes of string, both slow and fast, the movements should be as curved as possible. This is made possible by approaching beforehand the string being changed to (op.cit.,Book One p. 61-62). This involves the coordination of movements and Flesch emphasizes the preparatory stages.

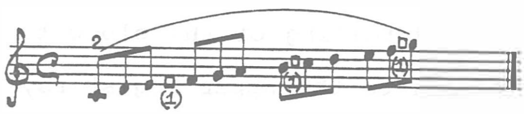
The Timing of Changes of Strings .

Flesch gives two reasons for why, as he says, "a smooth change of string is so rarely noticeable" (op.cit.,Book One, p. 25). The first is the angular movements of the right hand. I.e., these movements have the wrong shape. The second reason is the lack of coordination between the right and left hands: the movements of both hands must take place exactly at the same time, but - as Flesch quite correctly points out - the left hand often lags behind the right. To correct this Flesch recommends that the finger involved in the change of string be put into position a shade early during practice (though not while performing in public.) In the example he provides, the finger in question is marked by a small square:

Bruch,G minor Concerto, 3rd movement (loc. cit.)

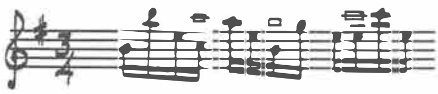


Flesch also reminds us that it is important to adapt this principle to the playing of scales:



In the playing of rapid two-note intervals divided between two strings the fingers should be placed on the strings simultaneously. (Otherwise coordination and intonation may suffer. LG)

Pugnani-Kreisler: Allegro



(op.cit.,Book One,p.126)

"Brake" Accents.

Rushing on the part of the bowing hand may also be prevented by adding accents during practice (but once again not during performances. LG):

at first

then

Flesch calls these accents "brake" accents (op.cit., Book One,p.161).

Unnatural Mannerisms.

Flesch lists a dozen "technical systems" that fetter the artistic imagination and spirit (cf.op.cit.,Book Two,pp. 97-98):

"Exaggerated finger pressure (usually resulting in superexcitation of the nerves of the fingers, stiffness of vibrato, and a glassy quality of tone). Exaggeratedly flat application of the fingers (endangering security of intonation). Exaggerated rolling of the elbow to the right (danger of sliding off the E-string). Exaggerated rolling of the elbow to the left (clumsiness in change of position to the upper registers, too flat an application of the fingers.) Leaning the upper arm against the chest (too low a position of the violin). An over-"hollowed" position of the hand (touching the strings with the nails). Exaggerated or totally lacking vibrato (the former causes intonation problems, the latter dead expression. LG) On the right: exaggerated wrist movements (that cause excessive movement in changes of strings. LG); exaggerated finger-stroke in bow shift (that causes uneveness in bowing and poor tone. LG); an exaggerated high arm (that prevents that natural application of the weight of the bow on the string.LG); an exaggerated expenditure of bow; insufficient expenditure of bow; clinging to a rigid point of contact (that all prevent the production of a first-class tone. LG)... Rejection of a violin support... as a matter of principle (even for players with long necks)(because this can cause loss of balance and discomfort in playing. LG).

In conclusion Flesch points out that although these "techical systems" may sometimes be necessary for certain players, if carried too far they can become pathological.

The Middle of the 20th Century

Ivan Galamian.

The legendary Russian-born violin pedagogue Ivan Galamian (1903-1981) transferred the French-Russian violin tradition, inherited from his teachers Mostrass and Capet, to the United States, transformed it and created his own world-famous method which has as one of its central features the use of countless rhythmical and bowing variations for the development of technical versatility. A clear exposition of this method can be found in his book, *Principles of Violin Playing and Teaching* (1962; Second edition, 1965).

Galamian was of the opinion that the youthful years should be primarily devoted to polishing the techical aspects of violin playing; the artistic aspects could be taken up later. By this he did not mean, however, that violin playing should be degraded to pure acrobatics. On the contrary, he emphasized that what he called virtuoso technique, "however spectacular, is not always a fully reliable tool in the service of the interpretive ideas formed by the artists", but that interpretive technique (which includes virtuoso technique) is a goal worth striving for (Galamian,1965, p.5). Among Galamian's pupils we find many of the leading violinists of the younger generation, such as Itzak Perlman, Pinchas Zukerman, Kyung-Wha Chung, Eugen Sarbu, Miriam Fried, and many more.

Galamian uses, for the first time in the history of violin pedagogy, the term "timing". The restricted extent to which this concept has been studied is indicated by the fact that in his thorough, wide-ranging book he devotes only a half page or so to it (op.cit.,pp.22-23).

Galamian defines the factors that are indispensable in the production of accurate intonation (ibid.,pp. 19-22):

1. The feeling in the fingers for correct placement on the fingerboard,
2. The guidance and control of the ear,
3. The setting of the frame of the hand, i.e., the awareness of the distance relationship between the first and fourth fingers in any position,
4. The ability to make rapid determinations of pitch as demanded by the musical demands of the moment. This last factor is extremely important when one wishes to play in tune (cf. Flesch, Book One p. 20).

In employing the term "timing", Galamian - inconsistently - connects it with the development of only the left hand. He explains that he means by this that one often has to prepare the movement of the fingers of the left hand before the production of the sound by the bow. Galamian is thus talking about synchronization. Later on, however, Galamian defines his views more clearly and states that it is often necessary to prepare the action of the bow in the same way, e.g., in playing martelé or staccato the pressure must be applied to the string before sound is started.

Galamian wishes to make a clear distinction between "musical" and "technical" timing even though he states (without precise explanation) that sometimes both appear united. Usually, however, first-class technical timing is, in Galamian's opinion, the prerequisite for succesful musical timing. The deciding factor, however, is musical timing. "If it is to be perfect, it presupposes correct technical timing of each hand by itself and a correct coordination between the two for any rhythm, any speed, or any required change of speed" (Galamian, op.cit.,p. 23).

Galamian points out further that it is often more difficult to produce correct technical timing in slow passages than in rapid figures. He emphasizes that it is a serious fault to slow down or speed up regardless of musical considerations because of deficiencies in the control of technical timing. Galamian maintains that "The mastery of the entire timing complex... is entirely a question of correlation", by which he means "the immediate and accurate response of the muscles to the directives of the mind" (ibid.,p.23). He defines what he means by "correlation" more precisely later in his book: "For all types of technical practice, the principle of mental preparation is of paramount importance. It means that the mind always has to anticipate the physical action that is to be taken and then to send the command for its execution. This, it will be remembered, is what I have called "correlation" (ibid.,p.95). Thus mental awareness of movements is in Galamian's opinion necessary for the achievement of first-class results. (The priestess of modern dance, Carolyn Carlson has said in a television interview that the most important things in dance are awarness and courage. In the same program the Finnish dance pedagogue Jorma Uotinen expressed it in these words: "The most important thing in dance is intelligence.")

The performance of any movement involves problems of technical timing and coordination related to different rhythms, bowings, accents and stresses, as well as combinations of all these. This must all be clear in the mind before orders are sent from the brain to the muscles. If there is a clear picture of the process in the mind, the coordination of movements functions smoothly. For there to be such a clear picture, it is necessary that there is an awareness in advance of the role of the different factors in the chain of movements; otherwise a precise command cannot be given to the muscles, resulting in imperfect correlation.

Galamian also suggests ways to improve correlation and coordination: a scale should be practiced every day with a great variety of rhythms, bowings, accents and tempos in many combinations. He provides many examples by means of which different combinations can be constructed (ibid.,pp. 96-98).

Galamian recommends that whenever technical problems appear, "they must be analyzed to determine the nature of the difficulty: intonation, shifting, rhythm, speed, a particular bowing, the coordination of the hands, and so on, or a combination of several of these. Each difficulty should be isolated and reduced to its simplest terms so that it will be easier to devise and to apply a practice procedure for it. The mind, which has to be able to anticipate the action, must have a clear picture of the motion involved, of the technical timing, and of the anticipated sound in order to give its commands with clarity and precision" (ibid.,p.99).

Concerning the timing of shifts, Galamian states:"The speed of execution of the shifting motion should be proportional to the general tempo of the passage. In slow tempos the shift is made slower; in fast tempos, more rapidly. The execution of the shift is largely a matter of timing, not only as far as the speed is concerned, but also with regard to the exact moments at which the shift is to start and to end. One of the commonest faults found in shifting is that of shortening the note preceding the move. The reason behind this fault is always a psychological one. The player worries about the shift to the point that he loses rhythmic control and nervously anticipates the correct moment for the move. This gives a feeling of insecurity and great uneveness to the passage. Conscious attention to the rhythmic value and sound of the note preceding the shift is imperative until correct habits are formed" (ibid.,pp. 26-27).

The 1960's

Alfred von Horn.

The extremely rigorous work *The Technique of Playing the Violin (Die Technik des Violinspiels)* by the German violin pedagogue Alfred von Horn appeared in Berlin in 1964. In his introduction von Horn states that the violin is difficult to play because the elements of the central nervous system which completely independently guide the functioning of the right and left hands must be made to work together with extreme precision (von Horn,1964, p. 7). This is a clear reference to problems of coordination in violin playing, and von Horn's book contains many references to the nature and coordination of movements. However, with few exeptions, there are no new insights to be found in the book.

von Horn has studied in great detail the moment when the bow first touches the string. At that moment the pressure on the string is zero, regardless of what part of the bow is involved or the dynamics. At the moment the bow sets the string in motion, it is still being held off the string for a split second. As soon as the string starts to vibrate any amount of pressure can be applied to it as long as the bow is drawn at the appropriate point on the string and at the proper speed. Since the moment at which the string is set in motion lasts only a fraction of a section, the listener gets the impression that the necessary pressure has been applied to the string immediately (op.cit.,p.32).

Concerning questions of balance and muscular tension, von Horn writes that it is through an alternation between tension and relaxation that a state of balance is achieved, and that this represents the basic law of movement in playing the violin (ibid.,p.33).

von Horn returns to the question of muscular tension in his discussion of precise finger placement: "Precise placement of the fingers can only be achieved in violin playing through the combination of a favorable playing position and living contact between the instrument and the player. Natural freedom of movement of the arm, hand and fingers must be achieved by means of an almost consciously felt alternation between an elastic tension-relaxation relationship in muscular activity. Cramped muscles do not allow for the development in the joints of the player of the precise feeling of depth perception that is necessary for the formation of a sensitivity to distance. Under such cramped and unnatural conditions the muscles function imprecisely and unreliably" (ibid.,p. 34).

In his discussion of shifting (ibid.,pp. 38-44), von Horn emphasizes that shifts must be made with the entire arm, the fingers must be in position above the string, and the thumb must be relaxed. He adds:"The location of the hand in different positions is "natural" when we experience the same relaxed feeling in the muscles in every position" (ibid.,p. 38).

von Horn takes up the question of timing in shifts in his discussion of the role of the thumb: he emphasizes that in downward shifts the thumb begins to move first in the direction of the new position, and also makes a preparatory movement backwards along the neck of the violin in upward shifts in high positions and in long jumps upwards. von Horn also mentions shifts with initial and final glissando and states, after a rather superficial description, that nowadays both are "allowed", i.e., in good taste (ibid.,p.40). In von Horn's opinion there are three causes of insecurity in shifting:

1) a weak ear

2) neglect of "intermediate notes"

3) lack of ability to visualize the location of notes on the fingerboard (he does not mention problems of coordination). von Horn emphasizes the role of the eye in learning to play the violin and claims to have taught, with the aid of eye control, deaf and dumb children to play the violin as quickly as children with normal hearing and with at least as good intonation (ibid.,p.41). He maintains that in teaching the violin one should make use of a "grip table" that shows the location of whole and half tone intervals on the fingerboard.

In his discussion of intonation (ibid.,pp.53-57), von Horn concentrates on explaining various possible tuning systems and their application in playing the violin. After a very factual exposition of the matter, he makes the unfortunate announcement that when playing the violin with piano accompaniment one should play "for the most part" tempered intonation. He seems here to have jumped to a bit too hasty conclusion: Pablo Casals, for example, was of the opinion that - except in unison passages - a string player should never play tempered intonation (cf.David Blum, Casals and the Art of Interpretation. London, 1977. p.109). von Horn considers lightning-quick corrections of intonation to be necessary, and refers to Flesch in this connection (von Horn, op.cit.,p.55).

von Horn ephasizes the importance of the use of the imagination in hearing the music in advance. He describes the "reading method" of practicing in which the pupil reads the music without playing it and sings it in his mind (ibid.,p.81).

As mentioned earlier, von Horn's rigorous book contains nothing new of interest concerning the nature and coordination of movements. There are to be found, however, certain points of interest in his book: the concept of the bow being held off the string at the moment it sets the string in vibration, and the contribution of the sense of sight to the production of good intonation.

Kato Havas.

The Hungarian-born violin pedagogue Kato Havas (1920 -) has written many outstanding works, including *The New Approach to Violin Playing* (Bosworth and co., London 1961). Havas has concentrated on the analysis of the fundamental balances in violin playing and has come to the conclusion that the most efficient movements are produced only when the fundamental balances have been established. In all her books and in private instruction she has emphasized the importance of pulse, explaining that a rhythmical pulse in playing the violin produces movements of the body and at the same time good balances in the playing position. Excess tension in the arm is dead weight that prevents the flow of movement and suffocates the natural vibration of the string. The violinist must learn to distinquish between dead and living weight. When the arm applies living weight an "air-borne feeling" is experienced (Havas,1961,pp.21-22).

Concerning intonation, Havas maintains that "Intonation is not a mechanical process of putting the fingers on an exact spot. It is mental process" (op.cit.,p.31). She distinguishes between hearing in advance ("inner ear",cf. Havas,1973, pp.75-77) and listening afterwards. The violinist must develop the ability to combine hearing in advance with a sensitivity in the muscles so that he hears the coming sound in his mind and feels it in his muscles simultaneously in advance. The quality and accuracy of the sound is checked by listening afterwards and correcting it quickly if necessary. Havas writes: ".. the sound should be a living conception long before the fingers even feel the string. This pre-conception is not a question of talent - it is merely a matter of training. It may seem difficult in the beginning, but with systematic and patient training it will develop surprisingly well" (Havas,1964,p.34). Thus the combination of two things is involved: both hearing the sound and feeling it in the fingers in advance.

Havas notes that it is wrong to think that playing the violin is easy, and continues : "However, it is most important to understand that the real difficulties are seldom caused by technique as the word is usually understood. The difficulties lie in the false notion that violin playing depends on the use of some sort of superimposed pressure or force. This mistaken idea inevitably results in faulty movements which in turn create an overall state of anxiety... and all artistic expression becomes nothing but a monumental struggle. So the first and most important object for each beginner is to eradicate this faulty idea of having to use any force. Instead, good violin playing... depends on the co-ordination of a host of delicate balances which in turn demand a high degree of mental discipline" (op.cit.,p.2). She comes back to this later: "Much struggle and useless work could be avoided if the silent "thinking" practice were more developed. For no physical action can take place without and order from the mind. This is why mental discipline plays such a tremendously important role in good violin playing" (ibid.p.5).

Havas emphasizes (ibid.p.10) that although it is easy to see the movement of the fore-arm, it is not that which controls the bow-stroke. It is rather the muscles of the shoulder blade that initiate the stroke. If the fore-arm begins to control the bow-stroke, its muscles stiffen and the grip on the bow becomes rigid. No amount of wrist and finger exercises are then of any use. Concerning the role of the thumb, Havas comments: "It is important to remember that the thumb is never used as a prop. It is a mobile point of balance in continuous movement; its position depending on which finger and string the player is using. (NB: Havas forgets to mention that the position of the thumb is also influenced by which position is being played. LG). If the violin-hold is secure, if the hand is straight with a loose wrist and a forward finger action, the thumb will always find its natural position" (Havas,1964,p.38).

Concerning the playing of scales, Havas comments:"... each interval has its own individual colouring within the scale... This keen awarness of the delicate interval colouring is of course closely connected with ear training, the preparation of each note, and the continous shift of balances in the left hand finger-action" (op.cit.,p.63). "One of the most important aspects of this approach is that all technical problems are tackled through the medium of tone production, so it is essential practice to make scales and arpeggios into music. Practice them slowly first with intense tone production (as if they were part of the 2nd movement of a Concerto) trying only three notes to a bow -then six - then twelve etc. It is important not to play them suddenly fast but increase the speed very gradually" (ibid.p. 67).

On bowing technique: "To many a poor student, 'Bowing Technique' seems nothing less than a veritable labyrinth through which he hopefully tries to find a road... However,... it is most important to realize that in the long run, there are no such things as 'bowing technique',' left hand technique' etc., but that good violin playing depends on the co-ordination of all the balances into a final 'whole'" ... (ibid.,p. 68).

She discusses the roles of both the left and right hand in the playing of double stops:"Unless the violin-hold is correct, the left arm cannot be free, and if the left arm is twisted, the left finger action is cramped, or, if the finger action is twisted, the wrist gets stiff, and if the control of finger-action is not from the base joints, the thumb gets disabled, etc.,etc...One of the most important points is, always concentrate on the lower finger first, not necessarily the lower sounding one, but the lower in position" (ibid.,p. 73). "As for the bowing arm, do not try to place the bow on two strings at the same time, for the right hand will (out of sheer anxiety) immediately want to press into the stick. Place the bow, with the upper-arm at the correct level for the lower sounding string only... because the curve of the bridge slopes toward the right anyhow, so nothing could be easier than to touch the higher sounding string with the curve of the stroke" (ibid.,p.74).

Havas sums up: "PLEASE NEVER FORGET... That the core of all violin playing is in a beautiful tone: because only through a quality of tone, which has the power to move, can one find a true artistic outlet. And this entirely depends on the correct use of the fundamental balances" (ibid.,p. 76).

The 1970's

Yehudi Menuhin.

Sir Yehudi Menuhin, who was born in 1916 and has become a living legend, has in his extremely original book *Violin: Six Lessons* (New York, 1971) thrown himself with abandon into the task of analyzing the fundamental essence of the movements employed in playing the violin. This book is exceptional in the history of violin pedagogy for several reasons: in the first place, Menuhin bases many of the exercises he recommends on yoga exercises, yoga being for him a way of life. In his Acknowledgements he jokingly calls his yoga guru, B.K.S. Iyengar, his best violin teacher.

In the second place, before he arrives at a synthesis he divides up the totality of movements into extremely small pieces: even the "sublest movements" (Menuhin.1971,p. 15) do not escape his attention. In the third place, he describes the sensations in the muscles of the trunk, arms, fingers and even the legs with a precision that is unprecedented in the history of violin playing. The reader may often have difficulty in experiencing those sensations in his own body, and thus the long descriptions of the details of movements have a tendency to fall "on barren ground". The self-analysis to which Menuhin subjects himself is, however, to be greatly admired.

In the fourth place, he consistently follows his principle that movement in violin playing (whether large or barely noticeable) is based on a "wave or pulse action" (p. 16). The very personal pre-exercises (without violin) presented in the book are based on fundamental natural circular or elliptical movements of the various parts of the body.

Menuhin's most important contribution to violin pedagogy is his precise mapping out of the fundamental body balances, the detailed analyses of the shape of movements, the identification of muscular sensations, and the short but precise observations about the importance of one's daily habits of living for the delicate overall entity that is violin playing. The reader is left with a clear picture of how all the elements of violin playing fit together into a complex, interdependent whole.

In his Introduction Menuhin writes: "He (the violinist) alone is master and servant, and as soon as his bow touches the instrument the marvellous battle has begun, the challenge and the response are joined and the achievement is wholly his" (ibid.,p.12).

Menuhin emphasizes the crucial role of the shape of the movements and of the fundamental balances right at the start in his Introduction: "There is no fixed or immovable point of support for the instrument, nor is there any - exept for those parts of the feet touching and balancing on the floor - for the violinist himself. The violin must become one with the fluid movement of the whole person, responding visibly to the undulant flow, to the swing, pendulum or circle, never blocking this flow at any of the joints of the body or at any of the points of contact with the violin and bow, and directing it into the very last muscle and finger joint, which must be trained to move in all directions and to control while in motion... The accuracy and precision, the lighting-like adjustment of pitch, sound and stroke, the switch from the minutest, invisible "inside" motion to the broad sweep of a golfer's swing, require a degree of mastery allowing of almost no margin whatsoever.. To prepare onself properly for this task, I think it is necessary not only to concentrate on the playing of the violin, but to cultivate an attitude of mind and heart, as well as certain habits of hygiene and general physical condition, so as to burden the playing itself as little as humanly possible with impediments of any kind " (ibid.,pp. 13-14) (cf. also Musashi's thoughts about correct attitude, above, p.17).

Toward the end of his Inroduction Menuhin discusses his method of analyzing "those minute movements, those inner feelings of parts of the fingers, which become, as it were, antennae. My purpose is to develop the utmost sensitivity to the sublest movements" (Menuhin, op.cit.,p.15).

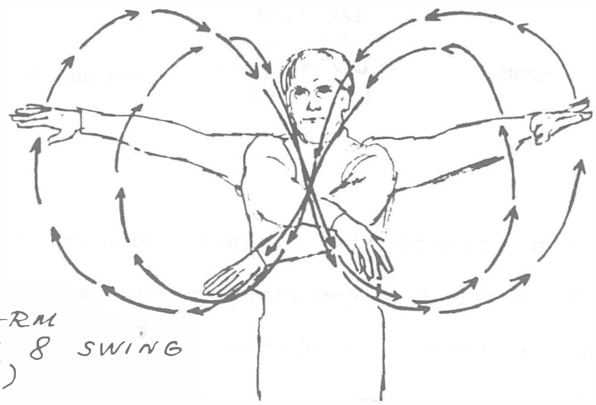
The first lesson in the book takes up breathing, stretching, balancing and swinging exercises by means of which an attempt is made to duplicate the natural movements employed in violin playing, i.e., to gain a perception of the delicate muscular sensations present throughout the body when movement conforms to natural laws. These breathing, balancing and streching exercises are - as Menuhin himself points out - adapted from yoga positions.

Most important for our discussion are the circular and wave motion exercises that Menuhin sets forth. In connection with them he explains the concepts of "thrust" and "momentum". He writes: "Try to feel the different speeds of these unforced natural swings of the arms according to the longer or shorter distance from the hand to the shoulder. You will notice that if each of the swings described is completely relaxed, it has its own natural speed. Until you become aware of this, there will be some residual tension in the arm and shoulder, or you will be deliberately moving them" (ibid.,p. 25). Here Menuhin brings up an important fact: the degree of tension in the arms affects the speed of movement. For the speed of movement to be "natural", the arm must be completely relaxed.

Menuhin explains thrust and momentum in the following way:"In ellipses of every description and circular swings having a vertical component, there is always one point of maximum speed - the moment of greatest thrust. This occurs naturally at the approach to the lowest point, but can be artificially applied at any point along the path. In playing the violin we must aware of that instant of maximum thrust in each repeated movement - it may precede the moment of maximum speed if deliberately applied. After that moment the remainder of the movement continues in passive relaxation, using the momentum gathered" (ibid.,p.26).

The forces described above are according to Menuhin to be found in basic movements that are set forth in his book in schematic drawings, from which we take a few examples:

Diagram 19



FULL ARM
FIGURE 8 SWING
(p. 27)

Diagram 14 FOREARM SWING (p. 25)

Diagram 15

Diagram 12

UPPER BODY ROTATION (p. 24)

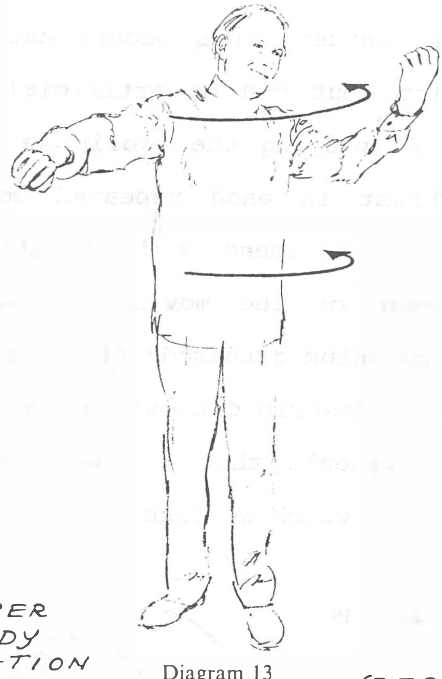


Diagram 13

(DESCRIPTIVE TITLES : LG)

The second lesson treats the contact between the fingers and the bow, as well as various preparatory bowing exercises. We will pick out a few details from this chapter. Menuhin philosophizes: "Thus every movement is to a certain extent affected, <u>and sometimes even</u>

contradicted, by associated movements" (ibid.,p.34;italics LG). Menuhin reminds us that the violinist must always return to that "floating state of minimum effort" that requires the least possible amount of exertion, the point of departure for the bowing stroke, the " 'zero'state, in which the bow is supported by the right hand alone" (ibid.,p.51) (and cf. Garam,1972, pp.23 and 26).

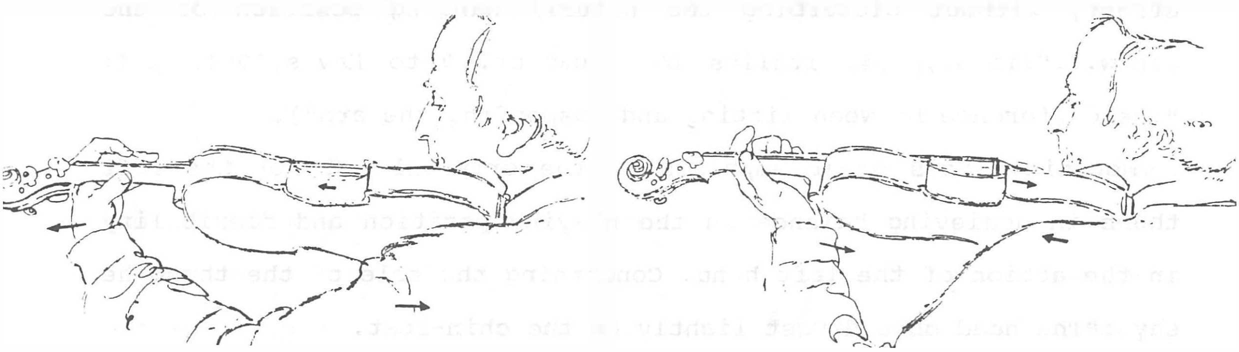
The third lesson discusses questions related to holding the violin, the use of the left thumb and exercises for the horizontal, vertical and sidewise movement of the fingers. Menuhin says that "the development of a sense of balance and flexibility" is a healthy point of departure for holding the violin. The violinist must assume an erect posture, and Menuhin recommends an upward stretching to counteract the force of gravity (Menuhin,op.cit.,p.18).

He advises against the use of a shoulder-pad or shoulder-rest since he is of the opinion that it restricts the freedom of movement of the shoulder: "if actively 'clamped', the shoulder is 'frozen'" (ibid.,p.53). "Now raise the violin to a position approximately parallel to the floor (if anything, a little higher) adjusting the head to the violin's new angle by lifting the head momentarily above the chin-rest and replacing it afresh... Now gradually allow the left hand to support itself with the minimum of effort, without disturbing the natural hanging position of the elbow..."(ibid.,p.54; italics LG) (and cf. Kato Havas,1964 ,p.4: "the difference between lifting and suspending the arm").

Menuhin places great emphasis on the critical role of the left thumb in achieving balance in the playing position and flexibility in the action of the left hand. Concerning the role of the thumb he says:"The head should rest lightly on the chin-rest.

Very gradually allow the external support of the violin to be replaced by your own left thumb, the weight of the violin making its own supporting cushion on the thumb's pad... Once this rather delicate balance has been caught, you will find that any downward pressure on the fingerboard, far from making the violin slip, will only serve to increase its security, based as it is on friction." (Menuhin,op.cit.,pp.55,57). Menuhin emphasizes the importance of the left thumb: "Until we learn to relax and develop the thumb, we will not do our best with violin playing" (ibid.,p.52).

He provides four different exercises to improve the flexibility of the thumb. The next two are important for our purpose since they are needed in shifting (as Menuhin points out): in the first, the top phalange of the thumb is bent back and forth, moving the violin from side to side; in the third exercise the elbow is swung like a pendulum to right and left with the thumb remaining still. It is essential, in Menuhin's opinion, that this movement becomes an unconscious habit for the violinist (ibid.,p.59). Menuhin distinguishes between vertical, horizontal and lateral movement of the fingers and arm. He emphasizes that it is important, when carrying out horizontal movement, to feel how the shoulder muscles are moving to the right or left. The shoulder and arms move in opposite directions:



Menuhin points out an interesting detail in the performance of downward shifts : "This raising of the knuckles is fundamental in downward shifts, and should become a habit" (ibid.,p. 67).

Menuhin recommends using left-hand pizzicato to practice lateral finger movement (ibid.,p.69). In his discussion of vertical movement of the fingers he reminds us that the fingers must not be pressed down on the fingerboard and that it is as important "to concentrate on the lift of the fingers as on their fall" (ibid.,p.63).

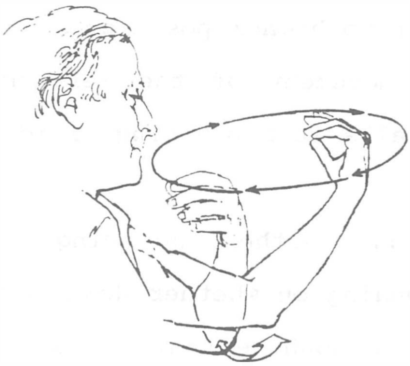
At the end of the third lesson Menuhin returns once again to the question of circular movement:"These three directions, each involving a pair of extremes (vertical pair - up and down; horizontal pair - away from and towards you; lateral pair - right and left), should now be co-ordinated on the violin so as to produce <u>a circle traced by the knuckles,</u> which involves the flexible movement of all the finger and thumb joints. The knuckles either rise from the far side of the circle and come towards you over the top, or rise on the near side of the circle and go away from you over the top. The object of all our efforts is to avoid head-on collisions between movements and to ensure their harmonious integration" (ibid.,p. 67).

The fourth lesson does, however, contain various points of interest to us. In his discussion of the sympathetic movement of the body Menuhin explains how the horizontal swing of the body "originates in the ball of that foot which is resisting the impetus of the stroke. Thus, the down-bow is hurled, as it were, against the right foot where it meets growing resistance. In a vigorous stroke using the whole bow one should feel that the up-bow begins in the right foot; it is at that point where the foot pushes the floor away that the opposite swing begins, which, as we have seen, takes place at the end of the down-bow in anticipation of the up-bow. The reverse occurs at the end of a vigorous up-bow when the impetus of the body is thrown against the left foot" (ibid.,p. 81).

Menuhin makes a noteworthy observation that, just as the violin itself is supported, so too is the bowing arm 'carried' (ibid.,p.78). This can be seen in connection with the concept of horizontal playing (Kato Havas, London, 1978: private lessons). Another important observation made by Menuhin is the desirability of preserving the "middle position", which allows for "a margin of movement and adjustment on either side" (ibid.,p. 81). He returns to this later in the fourth lesson: "In actual playing, however, we must never go to the extreme of any particular movement, but <u>always be conscious of its centre</u> so as not to lose sight of its essential function. This is an important principle that applies to all aspects of violin technique" (ibid.,p. 106; italics LG). At the end of the fourth lesson he states an obvious principle that is good to bear in mind: "As we have discovered, no one position or movement is correct in each and every similar circumstance" (ibid.,p. 106).

At the beginning of the fifth lesson Menuhin states that the same technical principles can be applied to the left hand as to the right. He is of the opinion that "The three main functions of fingerfall, shifting and vibrato will be seen to be not only related, but to proceed from a waving action... The fingers, of course, have special tasks for which they must be highly trained. This training consists in developing elasticity of stretch and spring - as of rubber band and a coil spring" (ibid.,p. 108).

In this lesson Menuhin returns to the three directions of movement: vertical, horizontal and lateral, and once more throws light on the circular component of horizontal movements. The pictures in the book present the matter best (ibid.,p. 110):



The wrist and fingers are completely relaxed . The circular movement is produced by a lateral movement of the elbow (text LG)

Small extra swings are carried out at each end of the ellipse (text LG)

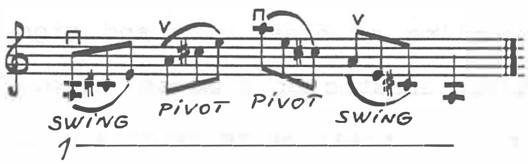
If the circle is looked down on from above, the movement of the hand should be in a clockwise direction, according to Menuhin.

The purpose of the circular movements pictured above is to produce the correct configuration of movement in shifts of position and to develop that feeling of elasticity and vigour that is, in Menuhin's opinion, characteristic of good shifting. The shift is a sort of catapulting from one position to another (ibid.,p. 114).

In the fifth lesson Menuhin also discusses two types of movement that arise from different sources: swing and pivot. What is involved is the influence of the swinging of the body on the lateral movement of the elbow supporting the violin. The swing of the body is dependent upon whether the arms move in the same or opposite directions (i.e., in the direction of the bowing stroke). When the arms move in the same direction (down-bow and shift from lower to higher position, or up-bow and shift from higher to lower position), the body swings more than in the opposite situation, i.e., when the arms move in opposite directions, either toward or away from each other (down-bow and shift from higher to lower position or up-bow and shift from lower to higher position). In the former situation Menuhin calls the movement of the left arm a swinging, in the latter situation he calls it a pivoting (ibid.,pp. 119,120,123).

In the sixth lesson Menuhin sums up:.. "either the swing or the pivot predominates for each shift depending on whether down- or up-bow is used" (ibid.,p. 135). He mentions nowhere that it is easier to perform a shift with a swinging movement than with a pivoting movement. He only states that "The body.. describes less of a swing when the hands move towards each other or away from each other (i.e., from opposite directions) than when they move in the same direction" (ibid.,p. 133). It would seem at any rate to be a known fact that shifts in which the arms move in the same direction feel more natural than those in which the arms move in opposition to each other.

Here is one of Menuhin's examples of swing and pivot movements:



(ibid.,p.135)

The sixth lesson contains many interesting exercises designed to improve the coordination of the hands. Menuhin describes the following exercise, in which repeated shifts between positions are combined with repeated string crossings, as "pleasant", because it corresponds to "the swinging of both arms in the same circle or ellipse" (ibid.,p.130):

He continues:..."both shoulders move slightly forward on the down-bow accented notes. The resulting body oscillation (backwards and forwards) reacts to the combined sympathetic action of the two limbs... The opposite simultaneous series of events occurs on the up-bow accented notes.

Basically this whole body co-ordination occurs on every note we draw and play and must therefore be practised on the basic movements of vibrato and shifting as on the various bow styles" (ibid.,p. 130).

"Scales require such absolute eveness and such perfect co-ordination between vibrato and fingerfall. The well played scale is a test of all the co-ordinating exercises we have done until now. This is particularly evident in a downward scale when the new note is heard through the lifting of the higher finger. Unless the vibrato in the hand and the lifting are absolutely co-ordinated, this downward scale will never have the clarity and definition of the percussive upward scale" (ibid.,p.136; italics LG). At this point Menuhin brings up a matter that he feels is decisive for good intonation in the playing of downward moving scales.

Menuhin appends to his book a set of practice hints and exercises "which aim to prepare the more advanced player within a short space of time for the succesful performance of the main types of movement involved in violin playing" (ibid.,p. 139; italics LG). The most important principle to be observed in practicing is in Menuhin's opinion "the precision and control of the maximum number of concurrent details. The mind must be continually active, checking detail after detail" (ibid.,p. 139). In the exercises he provides, Menuhin returns once more to the question of the control of muscular sensations. After the performance of whole-bow strokes, one should turn to practicing different types of attacks, from soft attacks to sharply accented attacks, "produced (a) from out of the air, and (b) by pre-stroke pressure as in martelé. It is particularly important to be conscious of the muscular tone necessary for each type of attack <u>before</u> beginning the stroke" (ibid.,p.141).

Another of Menuhin's exercises demands extreme sensitivity: "Cultivate a bow hold that allows the hand to feel the actual vibration of the string so that you can distinguish differences in pitch by means of their speed and magnitude" (ibid.,p.142). That is, by sensitivity of finger rather than ear.

Menuhin's book is an important document in the history of violin pedagogy. He has no equal among performing violin artists as student and describer of the shape of movements, the fundamental balances of the body and the sensations in the muscles of the arms. Granted that his book tends to run on and is often difficult to follow; it offers the persistent reader a wealth of useful information.

Werner Hauck.

Werner Hauck's book *Vibrato on the Violin* (London, 1975) is the most thorough study of vibrato in the history of violin pedagogy to date. It contains a broad, detailed survey of the history of vibrato, a critical analysis of earlier works treating vibrato, an exposition of the physiological aspects of the technique of vibrato, and exercises for the development of vibrato. It is not possible to ignore Hauck's work in a study of shifting technique for the simple reason that the movement employed in shifting is extremely closely related to the vibrato movement, and the points of departure for both movements have much in common.

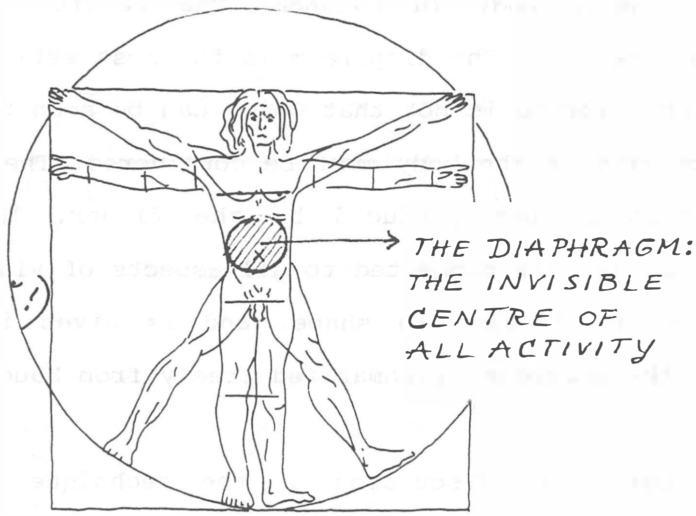
Hauck - in contrast to most people who have written about vibrato - goes beneath the surface in his approach. He is not satisfied with merely observing the movements that can be seen, but looks for invisible points of departure. The following (very free) summaries of his basic principles will give an idea of how he tries to get to the heart of things: The vibrato emanates from breathing, which is invisible, and a body in balance. The result is the visible movement of the hand. The diaphragm is the most efficient source of all movement. Vibrato is not that which can be seen by the eye. The overall activity of the body must be considered. The finger has no soul; vibrato is not produced by the finger. The control of breathing is directly connected to all aspects of violin technique. The vibrato is circular in shape, and is given impetus by the muscles of the shoulder, (summarized freely from Hauck,1975,pp. 52-57).

Hauck begins his discussion of the technique of vibrato by looking at the basic physiological activity of the human body. He points out that it is necessary to consider the movements of different parts of the body as a whole, and states that vibrato is "an expression of general body vibration" (op.cit.,p.55).

The real movement carried out by muscles is not, in Hauck's opinion, that movement that we can see taking place in some part of the body, but rather that which takes place in the upper limbs: the wrist is bent by the muscles of the arm, the arm is moved by the muscles of the shoulder, etc.(ibid.,p.66). The vibrato is not to be seen by staring at the fingers - nor does a singer imagine that the sound proceeds solely from his mouth.

Hauck philosophizes: "We have to proceed from the invisible to the visible" (ibid.,p.52). And later: "the diaphragm is the invisible center of the vibration which, so to speak, culminates in the visible vibrato of the finger" (ibid.,p.55). Technique can be organic only "when calibration, balance and the élan of the whole body enable a true integration of the violin with the body to be achieved" (ibid.,p.52).

Hauck makes use in his book of an adaptation of Leonardo da Vinci's representation of the centre of the body (ibid.,p.53):



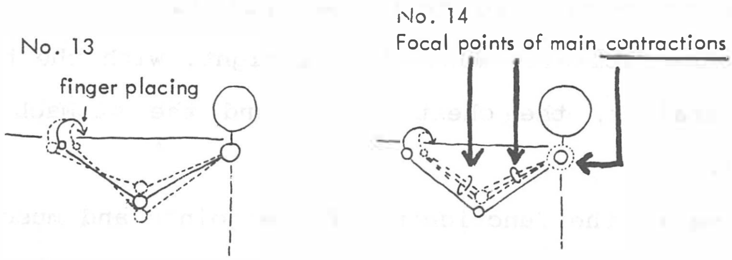
No. 1 Representation of the centre of the body (after Leonardo da Vinci)

According to Hauck all natural movements of the arms - lifting, stretching, bending, swinging, shaking - are circular movements proceeding from the central area of the body (ibid.,p.53). Raising and lowering the voice and the length of the sentence, can produce irregularities of breath in speaking. Similarly, musical expression is a problem of breath control, and the diaphragm occupies a central position in this process (ibid.,p.54).He sums up: "...the muscular apparatus concerned with breathing has a natural connection in the shoulder and upper arm muscles, hence those muscles which play a motivating role in violin playing. We can regard this as a functional motor unit comprising the breathing apparatus and the muscles visibly active in violin playing, and their correct activation is of decisive importance for the entire technique of movement in violin playing, hence also for vibrato" (ibid.,pp.57,58). Hauck emphasizes the importance of the organs of breathing being relaxed so that they can function properly. For this reason the violinist must stand upright, with the head up and the spine straight, the chest lifted and the stomach tucked in (ibid.,p.58).

Hauck discusses the functioning of the joints and muscles of the arm in great detail. He agrees with Steinhausen that the muscles of the shoulder and some of the large muscles of the chest are able to move the upper arm with great precision (ibid.,p.64). He continues by quoting Steinhausen (actually without giving him credit) to the effect that the movement of the arm originates in the shoulder and continues its progress through the upper arm, the forearm and hand to the fingers. The greatest mobility is to be found in the shoulder joint and the least in the finger joints. One can thus agree with Hauck's conclusion: " it is justifiable to state that a technical process will always require the use of the whole arm even if it does not become visible as a movement of the whole arm" (ibid.,p.66). Hauck explains in detail the roles of the upper arm, the forearm, the wrist and fingers in the production of vibrato. He stresses " the two functions which are of great importance for the process of vibrato:

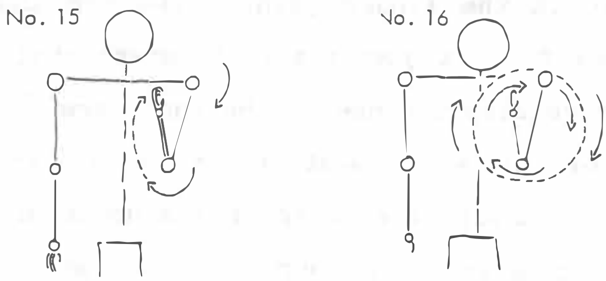
1. The shift movement as the basic form of arm-vibrato;
2. Contraction of shoulder and upper arm muscles as the impulse for the vibrato - "thrust" from the shoulder and upper arm" (ibid.,p.67,68).

These functions are followed by relaxation of the muscles. "Tensing contracts and relaxing stretches the muscles" (ibid.,p.68). The contracting of the muscles of the shoulder pulls the forearm toward the body. The movement of the forearm is more noticeable than that of the upper arm. The overall movements of the arm, when looked at from the side, appear thus:



Shoulder joint (ibid.,p.69,fig. 13 and 14)

In Hauck's opinion the vibrato is a circular movement. It starts from the shoulder and returns to it. If it has proper " élan", there is no cramping of the muscles of the arm (ibid.,p.71). Looked at from the front, the situation appears thus:

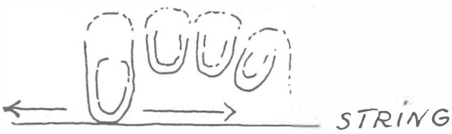


(ibid.,p.72)

Hauck sums up the entire process: " The total rolling action (slight rolling of the upper arm and extensive rolling of the forearm) transmits the impulse of the strong shoulder muscles by way of upper arm and forearm in a rotating movement... to the finger action of the left hand which thereby obtains more power than is inherent in the hand alone" (ibid.,p.70).

Hauck details two pairs of directions in which the wrist moves during vibrato: toward ← → away from the player; sidewise toward the thumb ← → toward the little finger (ibid.,p.74). Similarly, the finger joints move in two pairs of directions: depending upon the length of the fingers, the joints move either sidewise (ibid.,p.75,fig.20) or back and forth in the direction of the string (ibid.,p.75,fig.21).

The fingers of a small hand must be placed more parallel to the neck of the violin than the fingers of a large hand. For this reason the finger joints of a small hand have to move in a more sidewise direction during vibrato than those of a large hand:



(p.75,fig.20)

It is not necessary to turn (supinate) a large hand very much in order to place the fingers on the string. For this reason the fingers of a large hand are able to produce vibrato in a "more natural" position on the string, i.e., along the direction of the string:

(ibid.,p.75, fig.21)

However, the direction of movement of the joints of the fingers is never strictly in the direction of the string. All forms of vibrato require maximum flexibility on the part of the finger joints.

In the last chapter of his book Hauck provides a number of interesting vibrato exercises combined with controlled breathing. He concludes by observing that the violinist should master all types of vibrato (arm, wrist, and finger vibrato; technical and artistic vibrato), as well be able to play without vibrato (ibid.,pp.87-88).

From the standpoint of our investigation, the most interesting aspects of Hauck's views are the following:

- the shifting movement is the basis of the arm vibrato
- the invisible central locus of vibrato is the diaphragm
- natural breathing, good balance (posture) and the "élan" of body movement are prerequisites for supple vibrato
- the organic form of the vibrato movement is circular
- the essential movement does not take place where the eye can see it
- the investigation of movement must start from the invisible and proceed to the visible.

William Starr.

William Starr's book, *The Suzuki Violinist* (1976) is based on the methods of Shinichi Suzuki. Starr is one of the leading Suzuki experts in the United States of America, and has studied several times with Suzuki in Japan. His book and the video material related to it resulted from a study trip to Japan in 1968-69.

Starr describes how, while the tiny pupil (often only 3 or 4 years old) is learning separately to hold the violin and the bow, he is already beginning to learn rhythmic games as preparation for the bow strokes he will use in his first playing assigment (the Twinkle variations). Pupil and teacher both clap and sing different rhythms together (Starr,1976, p. 49). Starr quotes Suzuki as saying that if there were a subtitle to the first part of his Violin School, it should be "Preparation". Suzuki makes a wise observation: "Preparation is the most important habit of practice... the violin student must prepare every motion...If the student becomes accustomed from the very beginning to stopping and preparing when he practices, he will learn rapidly" (op.cit.,p. 58).

Starr explains clearly with the use of photographs (ibid.,pp. 60-64). Suzuki's approach to teaching the different string levels (E,A,D,G). It is important to pay careful attention to both arm position and timing of the change from one string to another. Suzuki discusses three different types of string level changes:

1. Changes in which the whole right arm as a unit is used;
2. Changes made using initially only the hand and forearm, with the elbow following after if playing on the new string is continued;
3. Changes made using only hand or finger motion.

Suzuki favors the second of these alternatives, and recommends that the pupil learn to change string levels by stopping the bow motion before each change and carefully moving the arm to the next level (ibid.,p. 60).

By means of this type of systematic practicing Suzuki solves the basic problem of timing of the different movements involved in string changes: the change of string level <u>must always take place before the new bow stroke.</u> In order to play legato string changes smoothly, Suzuki suggests that the notes should first be practiced "slurred staccato", i.e., with a slight pause between them (ibid.,p. 122).

Starr brings up the question of the elliptical shape of the bow stroke in his discussion of the playing of repeated down bows: "the hand, bow and elbow should all move in a small round motion as the bow is lifted... and then placed back on the string" (ibid.,p. 82). He points out that Suzuki emphasizes (ibid.,p. 86) that the fingers of the left hand should always be on the string before the bow stroke is started.

Starr gives a detailed summary (ibid.,p. 104) of the extremely systematic instructions given to a student by the Suzuki-method teacher Kyoko Kawamoto for the beginning of the Bourreé from Bach's C major Cello Suite. The purpose is to teach a) proper timing and coordination, and b) correct application and release of bow weight. The notes are to be played quite rapidly, but with pauses between groups of them:

1. "Put the bow on the A string slightly below the middle.
2. Play the 1st 3 notes without stopping, with a clear strong tone. Short strokes. Stop the bow and release the weight, leaving the bow resting lightly on the A string.
3. Move the bow hand and 3rd finger to D string.
4. Play the next three notes quickly, without stopping, with a strong, clear tone. Stop the bow. Release the weight.
5. Drop the bow silently to the E string level. Prepare finger. Put the bow "into the string".
6. Play G on E string with elbow and hand moving up together as bow moves to frog. Stop the bow. Release the weight.
7. Move bow hand to D - A level. Put bow back "into the string" but do not apply much weight.
8. Draw quick down bow for chord as practiced in Suzuki's exercise. Stop bow. Release weight.
9. Play next 3 notes lightly, with bow strokes of decreasing length. Stop bow. Release weight.
10. Put bow back "into the string".
11. Play next 3 notes without stopping. Short strokes. Clear strong tone.

The directions continue in the manner as indicated above."

Shifts of Position: Shifts must be practiced carefully. It is not enough that the initial sound in the new position is in tune, but the shift movement must also be performed correctly. Shifts between the 1st and 4th positions are performed with a movement of the forearm, with the wrist and fingers remaining in the same position. Suzuki first practices shifts with glissando (no more precise description is provided). Later the shifts are performed silently (ibid.,p. 105).

The following six rules should be born in mind when shifting:

1." Be sure to articulate clearly the first note of the shift (note of departure).
2. Anticipate in the mind the distance to be covered with the shifting finger.
3. Release the weight on the shifting finger so that it will slide on the surface of the string during the shifting motion.
4. Shift forearm as a unit. Move slowly and evenly. Don't jump for the next note... Don't change the angle of the shifting finger. Don't bend wrist or thumb. (That the forearm is moved by the muscles of the upper arm is not explained. LG).
5. Stop at the 2nd note of the shift. Return the proper weight to the fingertip so that the note of arrival is clearly articulated...
6. Do not move the finger, even if the top note of the shift is obviously out of tune. First, reflect on the motion made. Try to remember how the shift felt. If the shift was correct, after reflection on the motion, proceed with the notes in the new position. If the shift was incorrect, return to the 1st note, and try again" (ibid.,pp.105-106).

Suzuki emphasizes:"It is very important to have mental pictures of the shifting motion before and after the motion itself." (He does not explain why. LG)... Each shift should be preceded by a pause of sufficient length for the student to conjure up in advance a mental picture of the motion. Students who have observed fine players at golf or archery have seen them pause for mental placement" (ibid.,p. 106).

Suzuki explains that quick correction of incorrect pitch in the new position should be practiced only when a performance is approaching. There should be frequent performances (e.g., concerts) in which pieces ready for performance should be played through without stopping and notes out of tune after shifts should be corrected if possible (ibid.,pp. 126, 131).

Starr categorizes shifts as follows:

"A.The shift from a finger to the same finger in a new position.

B.The shift from a finger to another finger in a new position, with the first finger used as a guide finger.

C.The shift executed as an open string is played...

D.The shift from a finger on one string to another finger on another string...

E.The shift to the same pitch,with a different finger replacing the first one...

F.The half-shift, so-called because the thumb remains in the same position as the finger moves back and forth..

G.The glissando melodic shift...

H.The delayed shift. The player stretches a finger into a new position. The hand follows later..." (ibid.,p. 126).

Passage-work:

When learning new passage-work the student should put the fingers down onto the fingerboard quickly and also lift them quickly, although this does not mean that the passage should be played rapidly. It should be played slowly and each finger moved quickly, followed by a pause. After the pause the next finger movement should be concentrated on and carried out as quickly as possible. This requires great self-control, but Suzuki ensures that it produces quick results, according to Starr (ibid.,p.107).

In his treatment of intonation, Starr takes up the role of the ear in a general fashion, discusses tuning systems somewhat, touches on the role of the kinesthetic sense and the importance of mental placement. He does not mention details of timing even in passing (ibid.,pp. 128-131).

VII SCIENTIFIC STUDIES OF VIOLIN TECHNIQUE.

Paul Rolland.

Paul Rolland (1911-1978) was an American violin teacher who was, like Joachim, Auer, Flesch, Havas and Szende, Hungarian born. He developed a method for teaching school age children (cf.Suzuki, who developed a method for teaching pre-school age children) that is used quite widely, especially in the United States and England. In 1967 Rolland initiated a reseach project at the University of Illinois at Urbana-Champaign that had as its purpose to investigate all those phenomena that make their appearance when human beings move in one way or another. An attempt was made to adapt the results to the teaching of violin playing. The research project was terminated in 1974 and the book *The Teaching of Action in String Playing* and 16 films related to it were published.

Rolland quotes the cardinal principal of the well-known British speech teacher, F. Matthias Alexander:"The unity of the human organism is indivisible...The parts of the human organism are knit so closely into a unity that any attempt to make a fundamental change in the working of a part is bound to alter the use and adjustment of the whole" (Rolland,1974, p.30). Rolland emphasizes that when a beginner plays a demanding piece, he tends to become tense and his playing is characterized by fumbling and poor timing. In Rolland's opinion this is because he makes use of unnecessary muscles and is not able to control the forces he is applying (op.cit.,p.31).

The Importance of Balance in the Performance of Movements.

Rolland demonstrates (ibid.,pp.32-33) that objects in balance can be set in motion with a minimum of effort. This same matter has also been treated very thoroughly by Kato Havas (Havas,1961, pp.13-16). A state of balance in the body and arms greatly facilitates the functioning of the fingers. An absolute prerequisite for good violin playing is the adoption of the so-called fundamental balances of the body, from a relaxed stance to the balanced natural-feeling support of the violin against the body. Rolland quotes Josephine Rathbone's book, *Corrective Physical Education*:"...when the units of weight of the body are in perfect alignment, there is the maximum freedom of action with the least possible muscular effort."..."Any departure from the balance described above will mean strain of muscles and ligaments and friction in joints and, if one segment is out of line, all others will be affected" (Rolland,op.cit.,pp.204-05). Rolland sums up these observations:"It is fallacious to overemphasize the work of the fingers and hand. While they are important, they are never used independently but are coordinated with the larger motions of the entire arm and even the body" (op.cit.,p. 32).

Rolland analyzes the characteristics of the movements used in violin playing more precisely than anyone else in the history of violin pedagogy. For the most part he discusses bowing technique, and although this present study is mainly concerned with left hand technique, we have good cause to take Rolland's excellent description of the nature of movement into consideration. As has been mentioned in various connections already, the same factors that affect bowing also affect the action of the left hand.

Rolland also discusses the various repetitious movements used in violin playing: detaché , spiccato, sautillé , tremolo, vibrato and trills. Perfect balance of the arm is needed for the carrying out of repetitious movements. The arms must also be relaxed, so that they can quite passively follow the movements of the bow. The Hungarian scholars O. Szende and M. Nemessuri have pointed out, in their book *The Physiology of Violin Playing*, that repetitious movements resemble circular motion in that they "have no definite beginning, exept the first one, and have no definite end-point exept the last one" (Szende and Nemessuri,1971,p.16). Every repetitious movement must have its counter-movement (a reflex movement: cf. the up and down motion of a yo-yo). When performing such repetitious movements it is important to avoid providing too frequent muscular impulses, which only causes "freezing". To achieve this, one needs to keep in mind the broader musical pattern and to play extended rhythmic units with a single muscular impulse. In conclusion Rolland (Rolland,op.cit.,p. 36) points out that in repetitious movements the upper arm, the elbow and the hand move in opposite directions to each other at any given moment.

Types of Bowing Movements.

Rolland divides bowing movements into

1. Free "Ballistic" Movements
2. Slow Controlled Movements (op.cit.,p. 37)

The first group includes martelé , spiccato, sautillé, and the fast detaché. They are fast, light, curved, free wheeling movements that, once started, continue until they are stopped. They resemble the trajectories of flying objects, although they never can achieve the lightness and speed of such objects. Rolland thinks it is appropriate to call such movements "ballistic" movements. The thrust used to initiate them is followed by a passive, relaxed movement of the arm. The hand, fingers and bow all move in the same direction. When such a movement is performed correctly, the muscles that are soon to reverse the direction of the bow are already starting to come into play as the opposing muscles are still finishing their movement (cf. follow-through, preparation). The arm, hand and fingers are relaxed and passively follow the movement of the bow.

Rolland once more quotes Rathbone: "For proper movement, as far as the muscular systems is involved, several conditions are necessary; the possibility of complete motion in all joints, the ability to relax any muscle while its antagonist contracts, and the ability of certain muscles to hold the right degree of tension to make certain joints stable so that others may be free for movement" (ibid.,p.204). There must be a certain amount of tension in slow controlled movements, otherwise they become weak and wavering. The amount of tension applied, however, is critical, because too much tension makes the movement uneven, stiff and even painful.

Rolland quotes M. Gladys Scott's study *Analysis of Human Motion: A Textbook in Kinesiology* (New York, 1942):" When a certain muscle or group of muscles is stimulated, the antagonists of those muscles are ordinarily allowed to relax. This process of maintaining relationship between two sets of stimuli is referred to as reciprocal innervation" (loc.cit.,p.204).Good muscular coordination produces beautiful, relaxed, graceful and economical movement. Stiff, clumsy, uneven movements are characterized by excessive muscle power. Such movements are both uneconomical and ineffective.

Beginning and Ending of Movements.

Rolland applies the principles of movement in sport skills to bowing movements. He quotes Gene A. Logan and Wayne C. McKinney: *Kinesiology* (Dubuque, Iowa: William C. Brown Co., 1970, pp. 168-69) on the importance of the three phases of movement: "1) the preparation phase, 2) the movement phase, and 3) the follow-through and/or recovery phase.... The preparation phase is important because the quality of movement leading into the preparation portion of the skill will have either a beneficial or detrimental effect upon subsequent movement."

Rolland emphasizes that movements must not be begun suddenly in any of these phases and that the player must strive for a smooth transition from the preparation phase to the movement phase. The nature and speed of the bowing stroke determines what sort of preparatory movement is made: "calm in gentle music and brisk for vigorous entrances" (Rolland,op.cit.,p.38). He stresses that the stroke should continue after the sound has ceased. In bow changes the hand must not stop suddenly, but rather continue even after the antagonist muscles are preparing to start the following movement in the opposite direction. The former movement must still be going on as the new movement is already beginning: the two movements melt partially into each other.

Sequentical Movements.

Rolland stresses that jerky, angular bowing can be avoided by the use of curving, sequential movements and cities Steinhausen (Die

Physiologie der Bogenführung) as his source for his description of movements in slow bowing strokes:"... the large members of the body lead and the small ones follow... Thus, in bow changes or string crossings, the change first occurs in the slight transfer of body weight... The chain of motion passes through the upper arm, forearm, hand and fingers, and bow" (op.cit.,p.39). It could be imagined that there are 5 or 6 phases involved. The movement of the bow thus takes place just a shade later than the corresponding movement has taken place in the arm. All this takes place in an extremely short time, so it is quite difficult to stop it with the naked eye. It is, however, very easy to see in slow-motion film.

Rolland (op.cit.,p.206) quotes L.E. Morehouse and M.M.Cooper's book *Kinesiology* (St. Louis, 1950, p.324) for a precise description of what happens: "When momentum is transferred from a heavy to a light object, the speed of movement of the light object will be greater than the speed of the movement of the heavy object.. The speed of movement is continually increased as the momentum passes along these body segments (trunk, shoulder girdle, upper arm, forearm, wrist-palm, fingers) from the trunk to the fingers."

Change of Direction of Movement.

Rolland points out that changing the direction of a movement requires less strength if an object is kept moving than if it is stopped before it moves in a new direction. The turn of a swimmer at the end of a pool is an excellent example: the movement forms a loop, and the new movement is not the opposite of the former. There is no complete stop, and the former movement melts completely into the latter. It is Rolland's opinion that in slow movements which involve a change in the direction of movement, carefully timed, sequential, curving movements must be used. Slow bow changes and string changes are such movements.

Bow Changes.

Just as Carl Flesch, in the first edition of his *The Art of Violin Playing*, explained in 1924, Rolland states that the technique involved in bow changes depends upon the speed of the bow stroke, i.e., what type of bowing is involved at any given moment. In rapid bowing, the movement of the change is like that of a pendulum (detaché , spiccato, rapid string crossings). The balanced pendulum movement of the forearm and upper arm involve slight supination and pronation of both. The wrist and fingers must passively follow the arm movements.

The sequential movements employed in slow bow strokes ensure that also the bow changes are smooth. Rolland compares these movements with those of the engine and following cars in a turning train (op.cit.,p.39). The bow change (in connection with a slow bow stroke) must be carried out slowly. The slight looping movement of the arm makes possible a smooth bow change in which the bow never completely stops (ibid.,p.40).

Controlled bow changes produce a smooth legato. We can thus sum up the main points involved in the production of effective bow changes made with slow bow strokes:

1) The bow change is a sequential event: the movement begins from the shoulder and proceeds to the arm, the hand, the fingers and the bow.
2) The bow must not be held too firmly: the hand and fingers take part in the bow change.

3) The bow change is not sudden, but rather continuous, and there is no sudden change of direction. The bow change resembles a slight loop in form.
4) The arm changes direction slightly before the bow does. This is made possible by a relaxed grip on the bow.

String Crossings.
Rolland provides two quotations from L.E.Morehouse and A.T.Miller’s book *Physiology of Exercise* (1959, pp.67,80): "Work is accomplished at a faster rate if component movements are in a continous curved motion than if movements involve abrupt changes of direction...Continous curved motions require less effort than straight-line motions involving sudden and sharp changes in direction" (Rolland,op.cit.,p.40).

The movement should thus remain unbroken as its direction changes. Slow string crossing should be made by using sequential movements, originating in the upper arm and progressing to the fingers. Many violin pedagogues have taught that string crossing should follow as much as possible the curvature of the bridge. The direction of change in string crossing movements should be delayed a tiny bit, so that the lowering or raising of the arm is not angular. This is especially important at the tip of the bow where a much larger movement is needed to make the string crossing than at the frog.

In rapid string crossings, the movement starts in the arm or hand (cf. Flesch,1924,Book One, p.61 : rapid changes of string are made at the frog by a rolling of the lower arm in the elbow-joint and at the upper half by vertical movement of the wrist). If a rapid string crossing movement is continuous, it is best to accomplish it with a balanced arm movement, in which case the principal is the same as in repititious movements in general. String crossing movements, however, take place in a more vertical direction, and also involve continuous rotary movements of the arm. For this reason they are suitable for the development of soft, relaxed and even bowing strokes (cf. the many bowing exercises in Yehudi Menuhin's book *Six Lessons* (New York, 1971).

Shifts.

Rolland does not treat questions of movement and timing in shifts in any great detail, but sets forth nevertheless a number of essential points. The preparatory stage is of great importance in shifting. The shift must be sufficiently anticipated. In slow shifts the entire left arm starts to lean well in advance in the direction of the shift. In quick shifts the advance leaning of the arm must be more energetic (cf. taking a step when walking). A light anticipatory leaning eliminates the inertia of the arm that can easily cause delayed shifts. In the preparatory stage, the arm moves slightly to the right in ascending shifts and in the opposite direction in descending shifts (Rolland,op.cit.,p.38).

The Importance of Rhythmic Control.

Rolland states that a player's movements will become uneven unless he has a very clear concept of rhythm and pulses. When he understands the elements of rhythm, rhythm will produce no difficulties in performance and his playing movements will become organized: the coordination of movements will function. Rolland explains that the foundation of a "reliable rhythmic performance" ia an overall pulse which contains the rhythm of the piece of music. Thus (ibid.,p.45):

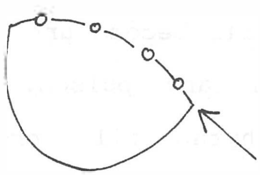
Many chancing rhythms can be fitted within the framework of an even pulse

Rolland fills 12 pages (ibid.,pp.48-59) with various rhythmic forms and also provides rhythm game exercises for the development of a sense of pulse.

The Elevation of the Left Hand in Relation to the Fingerboard.
The position of the left hand can be changed in three ways: by moving the elbow to the right or left(changing the angle at which the fingers fall onto string), by raising the hand higher or lower in relation to the fingerboard (again changing the angle at which the fingers strike the string), or by moving the hand toward the saddle or away from it.

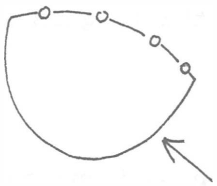
Rolland distinguishes three different elevations of the hand in relation to the fingerboard: high, normal and low.

The advantage of the high position is that the percussive power of the fingers increases. The disadvantage is that the extension of the fingers is limited (since they are more curved).

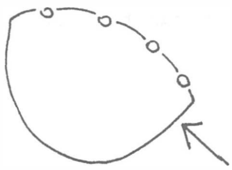


Lower inner crease of the first finger is positioned here in high position.

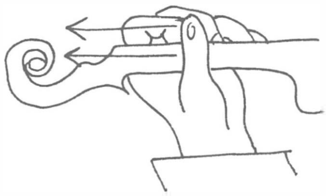
In addition, intonation problems may appear (ibid.,p. 107).
In low position, the fingers are straighter and lie flatter on the strings than in high position. The muscles that lift the fingers are not as relaxed as in the high position. On the other hand, the extension of the fingers is greater than in high position.



Position of lowest inner crease of first finger in low position



- and in normal position



In the normal position the middle phalanx of the first finger is parallel to the fingerboard when F # is played on the E-string.

In general, a broad hand with short fingers is most comfortable in low position, a narrow hand with long fingers in high position, according to Rolland (loc.cit.). He warns against what the author of this study calls the "gorilla grip": "it is important that the player refrain from wasting his strength in squeezing the wood of the neck horizontally between the thumb and the first finger. This disastrous fault hampers good intonation, shifting, and vibrato, and can cause left hand tension and cramping" (op.cit.,p.112).

We can sum up briefly Rolland's recommendations for left hand position so that it is comfortable to play and the conditions for good intonation are present:

1. The position of the hand must be balanced (all four fingers fall easily onto the strings).
2. The hand must be at a suitable elevation in relation to the fingerboard.

3. The elbow must be in such a position that the fingers strike the string at a natural angle.
4. The thumb must be relaxed.

To these points mentioned by Rolland we can add one more: in the first position the distance of the first finger from the saddle should be sufficiently great.

The Basic Movements of the Fingers.

Rolland distinguishes (op.cit.,p.124) three basic movements of the fingers:

1. Vertical movement
2. Horizontal movement
3. Movement across the strings.

Rolland maintains (ibid.,p.127) that intonation is spoiled if the player, in a situation that requires only the horizontal movement of a finger, instead moves the entire hand, i.e., does unnecessary work (e.g., when moving the first finger on the A-string in the first position from B to B-flat and back). Practicing horizontal finger movements improves intonation and limbers up the fingers, according to Rolland (ibid.,p. 129). Vertical finger movement (hammering) should be practiced carefully: the fingers must learn to strike the fingerboard and rise quickly from it (ibid.,p.125). Rolland explains that this produces a better sound (ibid.,p.129).

The Automatization of Movement.

Rolland (op.cit.,p.205) quotes Morehouse and Cooper again: "The highest level of skill is achieved only after conscious effort has been eliminated" (Morehouse and Cooper,op.cit.,p.210). "The speed at which a skill is first practiced should be approximately that of the speed at which it is to be used later" (ibid.p.214). Rolland points out that slow movements and fast movements are basically different, and that although practicing fast passages slowly can improve intonation, it does not produce final technical form. He quotes Morehouse and A.T.Miller's book *Physiology of Exercise* (St. Louis, 1959) on the same subject:"In the execution of a skilled movement, thoughts about it during the action are intolerable. Concentration is gathered on the wholeness of the act, not upon the parts nor upon the consequence of the outcome" (Rolland,op.cit.,p.206).

Rolland (op.cit.,p.207) makes use of Morehouse and Miller's summation of the principles of how best to perform a movement:

"1.Momentum should be used to overcome resistance.
2.Momentum should be reduced to a minimum if it must be overcome by muscular effort.
3.Continued curved motions require less effort than straight-line motions involving sudden and sharp changes in direction.
4.Movements in which the muscles initiating movement are unopposed, allowing free and smooth motion, are faster, easier, and more accurate then restricted or controlled movements.
5.Work arranged to permit an easy and natural rhythm is conducive to smooth and automatic performance.
6.Hesitation, or the temporary and often minute cessation from motion, should be eliminated from the performance" (Morehouse and Miller,1959,p.80).

Ottó Szende.

No one before Rolland in the 400-year history of violin playing has elucidated as thoroughly as he the complex nature of the movements involved. He has been followed by Otto Szende, also a Hungarian, who has also brought to light many interesting things. Szende's work is based on Rolland's views, which he has tried to enrich in various respects and then apply to shifting technique. Together with Mihály Nemessuri he published *The Physiology of Violin Playing* (Budapest,1971), and has used the results of the research described in it to a great extent as the basis of his second book *Handbuch des Geigenunterrichts* (Düsseldorf,1977).

In the Introduction to this last named book Szende states:"...the violinist makes music not only with the visibly moving parts of his body, but with his entire being, with body and soul" (Szende,1977, p.5). Naturally, the whole consists of the parts, but the whole is greater than the sum of the parts. The characteristics of the whole can only be very imperfectly explained by joining together its structural components. This sensible point of view is the foundation of Szende's research. He has investigated the function of the movements used in playing the violin, as well as the breathing and heart activity involved. In their research Szende and Nemessuri made use of a 3-channel DISA electromyograph, which measures muscle activity in microvolts (μ V/mm).

Szende and Nemessuri divide human movements into four groups according to their functional purpose (Szende and Nemessuri, 1971,p.15):

1. Vegetative movements (e.g., swallowing, coughing, blood circulation)
2. Instinctive movements (defensive and orientative reflexes)
3. Expressive movements (mimics,gestures)
4. Operative movements (various movements to produce practical effects)

Human movements can also be classified according to their principle of function into four groups:

a) motor reflexes

b) reflex chains, instinctive movements

c) automated motor performance (dynamic stereotype)

d) voluntary movements.

Movements cannot be classified into clearly separate groups. E.g., both swallowing and coughing are reflex movements, but we can also swallow or cough voluntarily. The movements in all the groups listed above are to a great degree neurophysiologically identical in respect to their mechanisms.

The playing of a musical instrument belongs basically to the expressive movements, but it can also be classified among the operative or working movements. The movements involved can also be looked upon as adaptive movements, since they must be performed in accordance with the structural and tonal characteristics of the instrument. The complexity of this phenomenon of adaption is precisely the source of so many of the difficulties met in playing the violin. The source of tonal problems and technical blocks can be found primarily in this area (ibid.,p.15).

Szende, in his *Handbuch des Geigenunterrichts* , writes: "It is well known that learning to play the violin is a long and difficult process. Each stage of this process - from basic problems of stance and holding the violin to the development of the most advanced technique - can be the source of new errors. These errors must, however, be systematically corrected if we want to ensure the steady development of our pupils. And what teacher does not want to achieve that ? However, we have to confess that we do not always find the simplest and most expedient solution. This is hardly surpirising, since the number of possible smaller and larger errors or blocks is so enormous. In addition, each pupil produces these errors with such individual variety that constantly parrying them costs the teacher a great deal of effort, reflection and concern"

(Szende,1977,pp.5-6).He adds that the range of subjects involved in playing and teaching the violin stretches from acoustics to aesthetics, so that not even an encyclopedia could contain it all.

The proper playing position is a factor that both fosters efficient playing movements and prevents faulty movements. A balanced stance is important for the following reasons:

1. "Physiological comfort" improves performance. If some part of the body is in an uncomfortable position while playing, the muscles must perform a great deal of (static) work to re-establish a balanced body position.
2. Tension in the skeletal-supporting muscles inhibits the free swinging of the shoulders that is necessary when playing the violin (op.cit.,p.9).

In Szende's opinion the best playing stance is one in which the smallest expenditure of muscular effort is required to maintain it (ibid.,p.14)(cf.p.34 above).

Szende investigated, with the aid of the electromyograph, muscular activity in the following aspects of violin playing:

- the playing stance
- the raising of the left hand into playing position
- hammering action of the fingers
- the playing of various intervals
- the function of the thumb
- the playing of flageolets
- shifting
- vibrato (with every finger)
- double stops
- the right arm and its fingers

a) the basic bowing stroke b) detaché c) bow changes and string crossings d) martelé e) staccato and various staccato combinations

- the bilateral coordination of both hands

In addition to being able to grip something firmly with his hands, man can also perform sensitive operations with them, such as repairing watches, writing and playing musical instruments. Szende explains (ibid.,p.45,48) that this is made possible by the fact that there are a total of 36 muscles in the five fingers: most in the outer fingers, viz., 9 in the little finger and 8 in the thumb, while there are 7 in the index finger and 6 in the ring finger and middle finger. The mobility of the ring finger is restricted because it is attached to both the middle finger and the little finger by means of tendons. The little finger is problematical because, although it is very mobile, it is much weaker than the other fingers (ibid.,p. 49).

Szende brings up an interesting matter on p.75 of the Handbuch: the speed of impulses along motor fibres is 80-120 m/s. The regulating of our movements is carried out by an extremely sensitive feedback system that functions on a time scale of milliseconds. It is this that makes it possible to perform movements that produce precise intonation.

Szende has investigated the minimum necessary finger pressure on the string with true scientific thoroughness. As is well known, it is necessary to employ increasincly greater pressure in the action of the fingers of the left hand as one plays closer to the bridge. If only the length of the vibrating part of the string is taken into consideration, least pressure is needed in the third and fourth positions. Consideration must also be taken, however, of the distance of the string from the fingerboard, since the further the string is from the fingerboard, the greater pressure is needed to hold it down. When the combined effect of these factors is measured the following graph can be plotted:

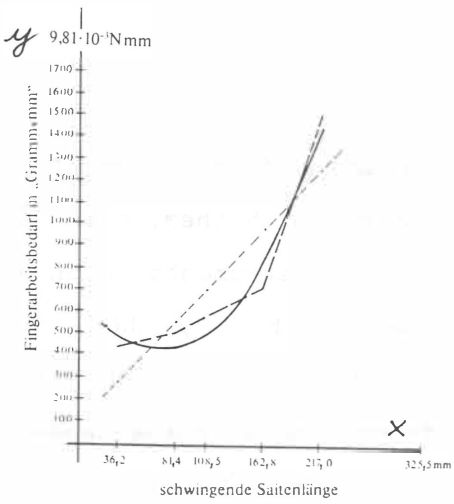
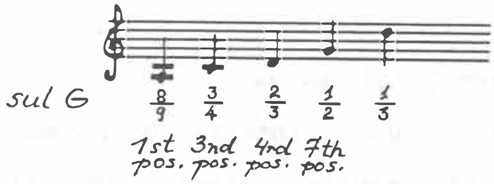


Bild 38. Der Fingerarbeitsbedarf über die schwingende Saitenlänge.

Figure 38: Work Performed by Fingers at Different Stop Lengths. y = Work Performed by Fingers in Grams x mm .x=Lenght of Vibrating Part of String.

Vibrating Portion of String and Corresponding Tone Heights of the G-String:



The same in tabular form:

	8/9	3/4	2/3	1/2	1/3
G	397.47	464.43	564.26	700.80	1.554.38
D	441.76	548.25	666.08	856.08	1.675.55
A	467.25	576.30	603.84	740.80	1.517.31
E	374.67	424.00	470.08	565.06	1.254.86
Average	423.52	506.35	579.02	717.22	1.500.76

Thus from the 7th position and upwards (upper third of the string), the average force needed is on the order of 1.5 kilograms (op.cit., pp.79-80).

Szende draws the conclusion from these data that they support the basic principle that one should learn to play on the entire extent of the fingerboard as early as possible. In this way the fingers learn to apply the varying amounts of pressure required in different positions. This is important because the pressure perception of the fingers has a great influence on the overall movement of the hand through the feedback system (ibid.,p.80).

Shifting (according to Szende).

I **Dimensional Relationships that Influence Shifting.**

1. The distance between fingers when playing different intervals
2. The distance of a fourth between first and fourth fingers
3. The decreasing distance between tones in higher positions

Szende stresses the importance of these relationships for the development of shifting technique. He agrees with Carl Flesch's comment in his *The Art of Violin Playing* that the dimensional relationships of the tones on the fingerboard play a decisive role in the solution of fingering problems (Szende,1977,p. 123).

The interval of the fourth is taken as the basis for the definition of the positions for two reasons:1) it is common to both just and Pythagorean tuning systems, and 2) it also forms the interval of the octave (with the two fingers on different strings.) Szende reminds us of something that few violinists think about: the separation of the fingers in the playing of a pure fourth is different in the three levels of the same position (op.cit.,p.124). There are three levels in each position:

Low Normal High

As in violin playing in general, the least possible amount of energy should be used in shifting. This can be achieved by employing the shortest possible distance (ibid.,p.128).

II **The Biodynamics of Shifting (Structure and Stages).**

In Szende's research shifting is set forth as a "periodic" operation. Szende does not explain what he means by periodic in this sense, but it is at any rate not of a cyclical nature, such as is the vibrato. He explains that shifting is brought about by a complex rotary movement of the elbow that brings the hand into the proper position in both up and down shifts. The thumb provides only intermittent support. In order to perform a shift successfully, it is necessary to master both the rotary movement of the arm and the proper coordination of the action of the thumb and fingers (ibid.,pp.129-131) (Szende does not say a word about changes in finger pressure, glissando and the placement and timing of bow changes).

III **Error Mechanics of Bow Changes.**

Szende mentions the following errors in shifting technique (ibid.,p.131):

1) No shift actually takes place. The stopping finger just stretches itself into the next position as a result of a too rigid hand position. (This bears no relationship to the modern so-called "retarded shift.")
2) Once more no real shift occurs, but a jump into the new position. This is due either to the fear of not finding the first note in the new position or to a rigid hand position.
3) Incomplete or faltering shift. Various errors are involved:

a) the movement of the hand stops too quickly
b) the movement of the hand falters
c) in upward shifts, the hand strikes the body of the violin.

Szende fails to mention:

4) the reduction of finger pressure and its reapplication is not observed

5) the shift is poorly timed

6) the left arm is not properly balanced.

The result of all these errors mentioned is poor intonation in playing the first note in the new position. Szende lists poor intonation as a fourth error in shifting, thus confusing cause and effect. He maintains that the correction of all these errors involves checking all aspects of the playing mechanism, starting with the stance (ibid.,p.132).

The Mechanics of Bow Changes.

Szende's investigation of the movements of the bowing arm shows what is involved is a very finely regulated form of muscular activity starting from the shoulder and moving downward through the entire arm to the fingers. This implies that the player must be conscious of the action of the entire arm even when using only part of the bow rather than full bow strokes. When he, e.g., plays detaché at the point of the bow, it is not enough that he limits himself to merely opening and closing the elbow joint (ibid.,p. 191).

Szende refers to the theory set forth by Jahn and Trendelenburg (Jahn,A., *Die Grundlagen der natürlichen Bogenführung auf der Violine* (Leipzig,1913);Trendelenburg,W., *Die natürlichen Grundlagen der Kunst des Streichinstrumentenspiels* (Berlin, 1925) that the pressure of the bow on the string approaches zero at the moment of direction change. He feels that this is plausible since it is unavoidable that the bow releases the string momentarily when the direction of vibration of the string is reversed, if the bow change is to be free of noise. This can be accomplished by supporting the bow either with thumb and little finger or with thumb, little finger and ring finger (ibid.,p. 194). Szende feels that the latter is to be preferred. The ring finger can even take over the role of supporting the bow completely. In Szende's opinion, all mechanical and tonal errors in connection with detaché playing are connected with errors in bow changing (ibid.,p. 199).

The Bilateral Coordination of the Hands (according to Szende).
Our movements tend to be symmetrical, which can have a positive or negative effect on performance. This tendency toward symmetry, bilateral coordination, is one of the most important sources of error in violin playing. Many violin pedagogical authorities, such as Koeckert, Klingler, Trendelenburg, Eberhardt and Mostrass, have investigated this problem (ibid.,p.213). They have come to the following conclusions regarding the phenomenon of bilateral coordination:

1. When bow pressure is increased, the pressure of the fingers on the strings also increases, and vice versa (e.g., when shifting into higher positions).
2. If shifts are made quickly with the left hand, the movement of the right hand is disturbed. (But cf. Auer's principle: shifts must be made quickly: Auer,1960, pp. 46 and 49).
3. Muscular activity in the left hand increases during the playing of rapid passages, causing stiffening of the joints and muscles of the right arm.

Szende has investigated the bioelectric activity of the muscles in the bowing arm in playing martelé strokes, and has registered what the left hand finger flexors are doing at the same time. In a clearly articulate martelé stroke the finger flexors of the left hand always act before the muscles of the right arm act to perform the bow stroke. (cf.graphs). This demonstrates how indispensible bilateral isolation is in playing the violin. The sequence of movements is (measured in hundredths of seconds):

1. left hand movement 2. right hand movement.

Szende explains that the non-observance of bilateral isolation is a major source of error in violin playing. It introduces tonal errors during bow changes, string changes and shifts, primarily because the finger of the left hand is not properly settled on the string by the time the bow begins to move in the opposite direction.

The Bilateral Isolation of the Hands:

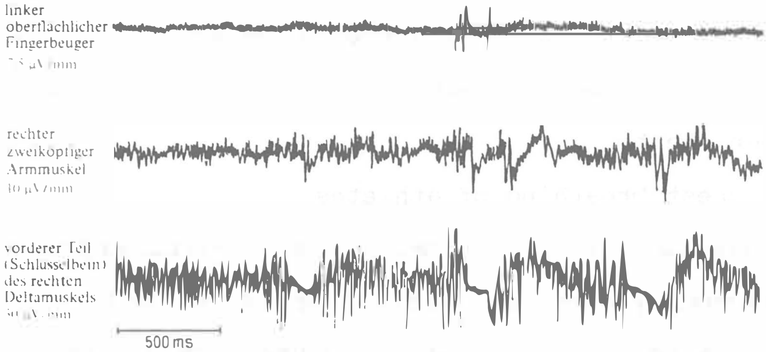


Bild 151. EMG-Befund des Martelèstriches mit dem rechten zweiköpfigen Armmuskel (auf ²/₃ verkleinert).

Figure 151. Upbow: finger flexor of the left hand acts before the biceps of the right arm.

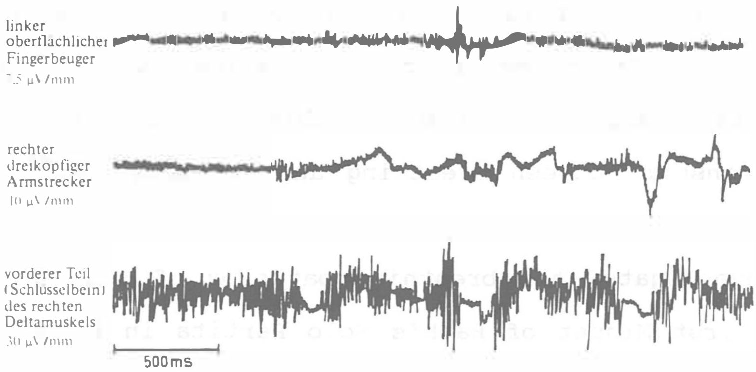


Bild 152. EMG-Befund des Martelèstriches mit dem rechten dreiköpfigen Armstrecker (auf ²/₃ verkleinert).

Figure 152. Downbow: finger flexor of the left hand acts before the triceps of the right arm (p. 214. Handbuch des Geigenunterrichts.)

Breathing and Violin Playing.

Szende has surveyed the technical literature in physiology and provides (Szende,1977,p.223) a summary of his findings: we breath on the average 16 times a minute and in the process inhale 8 liters of air. Under normal conditions breathing is automatic, but it is also possible to control breathing consciously (by means of yoga training , etc.).

Breathing is, as a motor function, a rhythmic, symmetrical and cyclical activity, but is imbued with certain types of physiological rhythmic irregularities. Three different kinds of uneconomical breathing can be distinguished:

1) The paradoxical breathing of asthenic persons
2) The breathing of pyknic persons, which resides predominantly in the upper chest
3) The full chest breathing of athletes.

In certain sports, such as swimming, weight-lifting, boxing, shot-putting, rowing, gymnastics, etc., inspiration and expiration are strictly regulated. It is necessary to use very different breathing techniques in singing, wind instrument playing, recitation and violin playing. In singing and wind instrument playing, the sound is produced by expired air, and the sound continues as long as expiration lasts. In string instrument playing, sound production is not immediately dependent upon breathing. There is, however, a close relationship between breathing and movements of the arms in string playing.

Szende investigated the breathing patterns of 10 violinists who played the First Minuet of Bach's Solo Partita in E major a total of 31 times. He tabulated the results and calculated that 80.6 % of inspirations occured during upbows and 78.6 % near the nut or point of the bow. This indicates that there is a strong tendency in violin playing to inhale while lifting the bow arm and exhale when lowering it.

Naturally, it is not possible to influence breathing directly all the time one is playing, because respiration is conditioned by the nature of the movements used in playing (and the need for oxygen they cause), the opportunities for breathing provided by these movements, and by physiological factors, viz., when a favorable moment for breathing presents itself (ibid.,p. 227). In any event, breathing must be coordinated with the demands of musical expression. If a breath is taken at the wrong time, the result may be an incorrect musical accent. It is important to avoid inspiration during a downbow because this can cause the right shoulder to rise, preventing a smooth bow stroke.

Szende also investigated pulse rate during violin playing and found out that it increased parallel with an increase in respiratory rate during the playing of what the player considered to be a difficult passage. While rest pulse varied from 70 to 90 beats per minute, it rose to between 100 and 110 beats per minute during normal playing, but approached 120 beats per minute during the playing of difficult chords in the Bach Menuet mentioned above.

Since the same piece can be difficult in different ways to different players, oxygen requirements and pulse rate were not mechanically dependent upon any "absolute" grade of difficulty, but the degree of difficulty depended on many different personal factors, e.e.,

1. general technical ability on the instrument and playing ability at the given moment
2. degree of familiarity of the piece
3. physical and psychological tension during performance and the individual ability to control it.

Unexpected errors during a performance can suddenly increase oxygen requirements. This showed up in Szende's experiments during performances of Paganini's Caprice No. 17 (ibid.,p.228).

Juri Jankelevits.

Juri Jankelevits (1909-1973) was one of the most influential violin pedagogues in the history of Russian music: all of 17 of his pupils have taken prizes in international violin competitions. Jankelevits travelled widely throughout the Soviet Union lecturing on music theory and violin pedagogy, and also lectured abroad. From the standpoint of the topic under consideration here, he is an extremely important figure, since he wrote his doctoral dissertation on the subject of shifting as a means of artistic expression (J.Jankelevits,*Pedagogical Heritage*. Editions "Musica". Moscow, 1983).

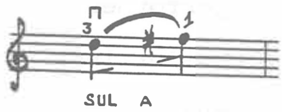
At the beginning of his dissertation Jankelevits categorizes the various types of shifts and then illuminates the characteristics of each type.

TYPE I: Shift on the same finger

TYPE II: Upward shift from lower to higher finger with slide on lower finger (no intermediate note).

TYPE III: Upward shift from lower to higher finger with slide on higher finger (no intermediate note)(Jankelevits,1983,pp.139-140).

TYPE IV: Upward shift from higher to lower finger with slides on both fingers (no intermediate note)



In addition, Jankelevits treats separately shifts with vibrating open string and the so-called Paganini shift with thumb in place.

Jankelevits maintains that each of these types of shifts displays its own special character. In order to determine precisely and objectively the special characteristics of these different types of shifts, he carried out a series of oscillographic recordings of all four types as performed by three leading Russian violinists - D.F.Oistrakh, J.I.Rabinovits and D.M. Tsiganov. Jankelevits presented the results in his dissertation in graphic form. The y-axis on the graphs shows pitch (in half tones), and the x-axis shows time measured in fractions of a second (different on different graphs). In addition, each graph gives the total time of the execution phase required for the shift in question. Jankelevits considers this to be a factor of great importance in the determination of the character of the shift.

Type I Shifts.

To begin with, Jankelevits analyzed the shift $e^1 - g^1$ divorced from any musical context. This is a Type I shift, i.e., a shift on the same finger. From the graph it can be seen clearly that this shift as performed by Tsiganov began slowly and ended with rapid acceleration of the slide.

Graph 1 (Tsiganov)
1 division = 0.03 sec.
Duration of shift = 0.09 sec.

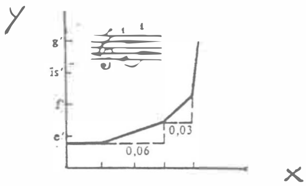


Схема 1
1 деление=0,03 сек.
Время выполнения перехода=0,09 сек.

The same phenomenon makes its appearance in corresponding downward shifts. Shifts performed by Tsiganov and Oistrakh begin slowly, followed by a more or less marked acceleration (op.cit.,p.141).

Graph 2 (Oistrakh)

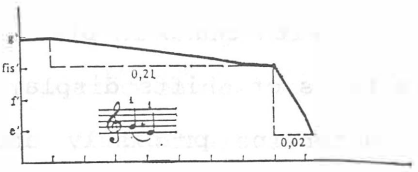


Схема 2
1 деление=0.01 сек.
Время выполнения перехода=0,23 сек.

1 division = 0.01 sec.
Duration of shift = 0.23 sec.

Graph 3 (Tsiganov)

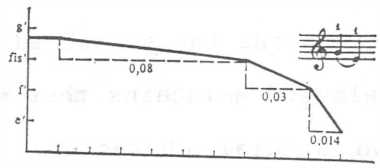


Схема 3
1 деление=0.014 сек.
Время выполнения перехода=
0,124 сек.

1 division = 0.014 sec.
Duration of shift = 0.124 sec.

Jankelevits now turns to analyzing Type I shifts occuring in a musical context. The passage he chose to investigate is from the introductory section of the Tschaikovsky concerto. "In spite of individual treatment by the players, the execution of the shift is basically the same in each case: the finger slide begins slowly and then accelerates. The individual differences appear in the overall duration of the entire process, in the point of time at which the acceleration is started, and its intensity" (ibid.,p. 142). These differences appear clearly on the graphs:

Graph 4 (Oistrakh)

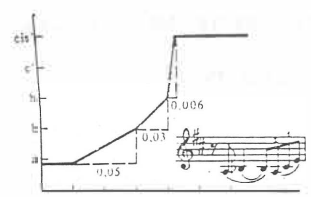


Схема 4
1 деление=0.03 сек.
Время выполнения перехода=
0,086 сек.

1 division = 0.03 sec.
Duration of shift =0.086 sec.

Graph 5 (Rabinovits)

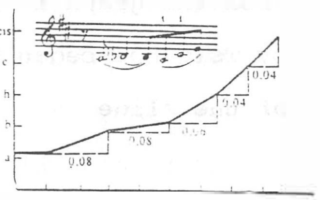


Схема 5
1 деление — 0,04 сек.
Время выполнения перехода=0.3 сек.

1 division = 0.04 sec.
Duration of shift =0.3 sec.

Graph 6 (Tsiganov)

1 division = 0.04 sec

Duration of shift = 0.37 sec.

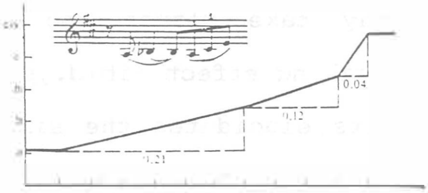


Схема 6

1 деление — 0.04 сек.
Время выполнения перехода=0,37 сек.

Jankelevits continued investigating Type I shifts (e.g., in Tchaikovsky's Serenade and the second movement (Canzonetta) from his violin concerto) and received affirmation of his conclusions concerning the timing of the shifts: they start slowly and accelerate toward the end. For Jankelevits, there is a close connection between precise intonation and the fulfilment of aesthetic requirements. He makes this clear in the following passage:"As we have already seen, Type I shifts are characterized by the acceleration of the sliding finger toward the end of the shift. This acceleration contributes to a great degree to the aesthetic requirements of sound production. This can easily be shown: one has only to prevent the acceleration from beginning, and the shift loses its definition, becomes diffuse - a glissando - and the connecting sound becomes dominant" (ibid.,p. 144).

Jankelevits points out that Type I shifts performed by students lack either a smooth beginning or the acceleration toward the end. In the first instance, the shift is characterized by a marked jerkiness, producing a "slack and unpleasant sound" (ibid.,p. 145). In Jankelevits' opinion, ease of performance of Type I shifts is dependent upon the regulation of the pressure of the finger on the string. The pressure must be released slightly at the moment the shift is performed. Slightness of pressure is especially important in longer shifts and also in rapid shifts. If the player has insufficient mastery of this regulation of finger pressure, the opposite may take place: too extreme release of pressure can produce a braking effect (ibid.,p. 145).

Jankelevits elucidates the significance of Type I shifts in the following manner:"The special tonal expressiveness and melodiousness of shifts carried out on the same finger is explained by their resemblance to a cantabile portamento (which should as far as possible be striven after in the execution of other types of shifts as well). This indeed explains the extensive use of Type I shifts for the purpose of imparting special expressiveness to the tone" (ibid.,p. 147).

Type II Shifts.

Before Jankelevits begins to analyze Type II shifts he points out that most textbooks dealing with violin technique recommend the performance of this type of shift with the aid of an intermediate note (the intermediate note corresponding to the position of the initial finger in the new position). Jankelevits mentions books by Alar, Voldan, Voiku, Jokish, Koekkert, Mihalovski, Radmall and Flesch. Later he adds the names David, Spohr and Joachim.

Graph 12 shows the shift e' - b' as executed by Oistrakh. As the lower line shows, the initial finger slides only as far as f', whereas the corresponding intermediate note should be g'. That is, the finger initiating the shift does not travel as far as the intermediate note.

Graph 12 (Oistrakh)

1 division = 0.013 sec.

Duration of shift = 0.142 sec.

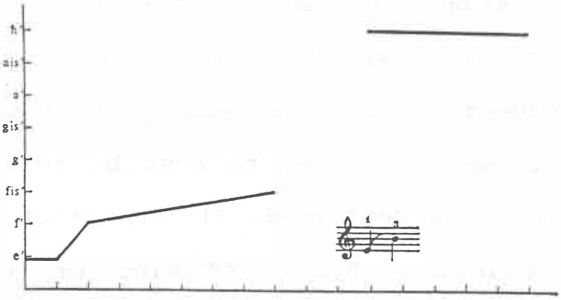


Схема 12

1 деленне=0,013 сек.

Время выполнення перехода=0,142 сек.

Tsiganov executes the same shift with a slightly larger tonal jump: Graph 13 (Tsiganov)
1 division = 0.02 sec.
Duration of shift = 0.089 sec.

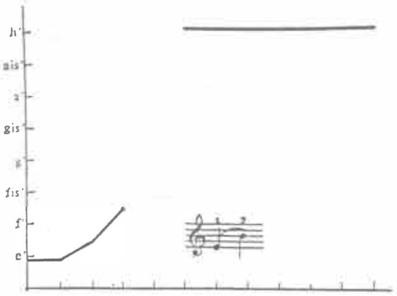


Схема 13
1 деление=0,02 сек.
Время выполнения перехода=0,089 сек.

Jankelevits also points out in the course of his analysis cases in which one violinist makes use of an intermediate tone in the execution of a given shift, while another violinist does not. In the following examples from the Violin Concerto by Rakov, Oistrakh does not make use of an intermediate note in the execution of the shift $g\#^{1}$ - d^{2}, leaving rather an appreciable jump between the two notes (Graph 17), while Tsiganov does in effect make use of an intermediate note (Graph 18):

Graph 17 (Oistrakh)

Схема 17
1 деление=0,016 сек.
Время выполнения перехода=0,096 сек.

1 division = 0.016 sec.
Duration of shift = 0.096 sec.

Graph 18 (Tsiganov)

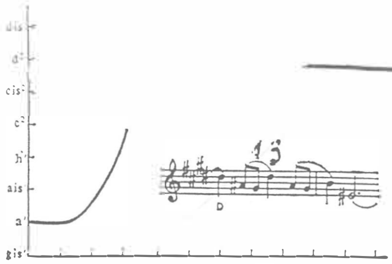


Схема 18
1 деление=0,026 сек.
Время выполнения перехода=0,133 сек.

1 division = 0.026 sec.
Duration of shift = 0.133 sec.

Jankelevits points out that the foregoing type of tonal jump between notes usually takes place in short shifts and may even at times be inaudible. On the other hand, the tonal jump is always clearly present in long shifts (ibid.,p. 152). E.g., in a shift extending over a septim, the tonal jump covers an entire tone or more, as can be seen from graphs 19,20 and 21.

Graph 19

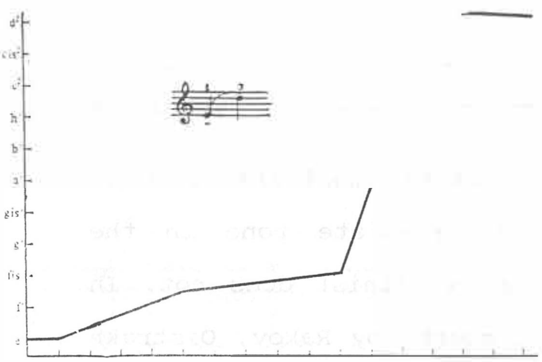


Схема 19
1 деление=0.013 сек.
Время выполнения перехода=0.173 сек.

1 division = 0.013 sec.
Duration of shift = 0.173 sec.

Graph 20

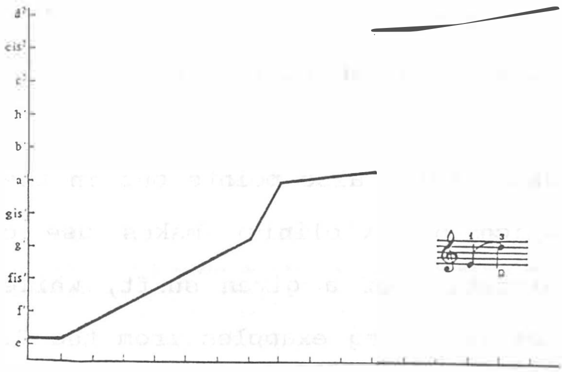


Схема 20
1 деление=0,025 сек.
Время выполнения перехода=0,3 сек.

1 division = 0.025 sec.
Duration of shift = 0.3 sec.

Graph 21

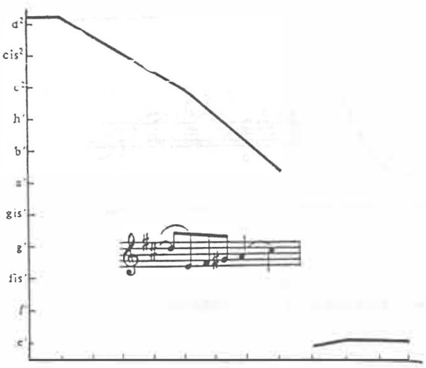


Схема 21
1 деление=0,013 сек.
Время выполнения перехода=0,106 сек.

1 division = 0.013 sec.
Duration of shift = 0.106 sec.

An even larger tonal jump can be observed in decim shifts extending to as much as four and half tones (Graph 24, p. 155):

Graph 24

1 division = 0.03 sec.

Duration of shift = 0.13 sec.

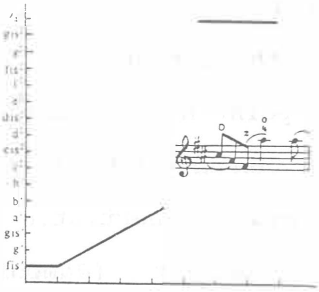


Схема 24
1 деление=0,03 сек.
Время выполнения перехода=
0,13 сек.

Jankelevits comes to the following conclusions on the basis of the preceding analyses:

1. The use of an intermediate note is not absolutely necessary in Type II shifts.
2. When an intermediate note is used, however, the initial finger must reach the intermediate note before the final finger is placed in position.
3. The start of Type II shifts appears to be slow, followed by an acceleration (as also in the case of Type I shifts). This is less noticeable than in Type I shifts, but is a necessary condition for a smooth, elastic execution of the shift (ibid.,p.155).

In a Type II shift, the pressure of the sliding (initial) finger gradually weakens, often to the extent that it releases the string at the instant the final finger makes contact with the string. Jankelevits stresses that the use of an intermediate note is based on the principle that it simplifies the execution of all types of shifts. He considers it very useful to see the similarities between Type I and Type II shifts, as long as attention is also paid to the differences between them (ibid.,p.156).

Type III Shifts.

In Type III shifts the slide is made on the final finger. Later on we will employ the concept "end glissando". Jankelevits begins his discussion by pointing out that its use was frowned upon by the classical 19th century school of Russian violin pedagogy and even considered harmful, "unartistic and a sign of bad taste", as I. Jampolski expressed it. (Jampolski (1905-1976) was one of the leading Russian specialists in musical source research and music lexicography, and was himself a prolific publisher). Neither Spohr, David or Alar condoned type III shifts exept under special circumstances, in long upward jumps.

Jankelevits conceived of the significance of type III shifts thus: "From our point of view, the Type III shift is one of the most distinctive means of expression. Its special characteristic is the diffuseness of sound at the beginning of the shift and, in contrast, its soft, gradual fulfillment. Type III shifts executed in different ways can impart different character to the sound: ingratiating intimacy, accentuated emotionality, passion, etc., so their use is often indispensable" (ibid.,p. 157).

Jankelevits comments that the use of Type III shifts as a means of artistic expression presumes that the player has a highly developed sense of artistic taste and great performing skill. The elementary student must not make use of them. Nor is this type of shift suitable for use in rapid passages since it is not possible to achieve the clarity of sound necessary in rapid shifts. Oscillographic analysis also shows that the final finger begins its slide in the vicinity of the new note and is - in Mostras' expression - a sort of "anticipatory sound" to the new note.

Oscillographic analysis thus shows that the use of an intermediate note is not involved in Type III shifts. This can be clearly seen from the graphs below. In Rabinovits' execution of such a shift in Glazunov's Violin Concerto the beginning of the slide does not occur at the interval of a major third, corresponding to an intermediate note, but only a half tone from the new note (Graph 25).

Graph 25 (Rabinovits)

1 division = 0.04 sec.

Duration of shift = 0.38 sec.

Схема 25

1 деление=0,04 сек.

Время выполнения перехода=0,38 сек.

If we look closely at this graph we can see an interesting thing (that Jankelevits does not mention): the shift exhibits slides on both the initial and final fingers. It is thus not really a Type III shift, as is the same shift as executed by Oistrakh (Graph 26), where the slide on the initial finger is for all practical purpose negligible.

Graph 26 (Oistrakh)

1 division = 0.02 sec.

Duration of shift = 0.15 sec.

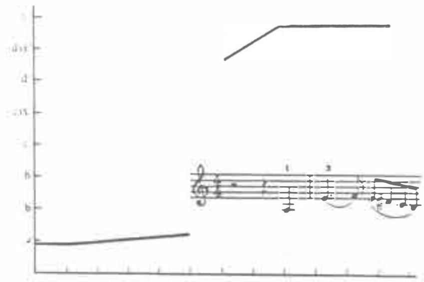


Схема 26

1 деление=0,02 сек.

Время выполнения перехода=0,15 сек.

In the third example of this same shift (Graph 27), Tsiganov also makes use of a (slight) slide on both the initial and final fingers:

Graph 27 (Tsiganov)

1 division = 0.034 sec.

Duration of shift = 0.25 sec.

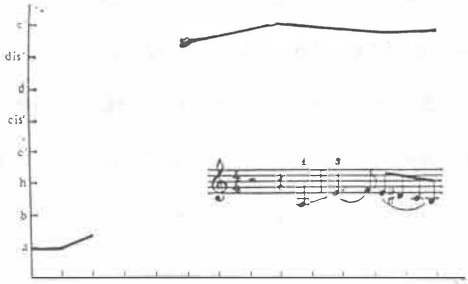


Схема 27
1 деление=0,034 сек.
Время выполнения перехода=0,25 сек.

When Jankelevits investigated the use of a Type III shift in the Fifth Violin Concerto by Vieuxtemps, he found that the slide on the final finger extended over either a minor third (Tsiganov) or a second (Oistrakh and Rabinovits), whereas if an intermediate note had been made use of, it should have extended over a fourth.

When Jankelevits compared final finger portamenti in the violin concertos of Glasunov and Vieuxtemps, he ascertained that they were much longer in the latter case. In Jankelevits' opinion this shows that the length of final finger slides in Type III shifts depends upon the nature of the musical material: in Glasunov it is "nobly severe" (a short slide), in Vieuxtemps "sensually sentimental" (a longer slide) (ibid.,p.162).

There is a change in pressure of the sliding finger on the string also in the case of Type III shifts, except that - in contrast to Type II shifts - it increases as the new note is approached.

Type IV Shifts.

Jankelevits discusses the appearance in the professional literature of two different approaches to Type IV shifts, both involving intermediate notes. In accordance with the first point of view (David, Joachim and others), the shift should be carried out with the help of a "higher" intermediate note: 

According to the other point of view a "lower" intermediate note should be used: 

In Jankelevits' opinion, neither of these approaches gives a tonally satisfying result. As a matter of fact, oscillographic analysis shows that Russian violinists employ neither a "higher" nor a "lower" intermediate note in this type shift. The slide in actual shifts of this type forms a more or less continuous curve (my italics, LG), corresponding in nature to Type I shifts. The change of finger in a Type IV shift takes place inconspicuously during the slide, i.e., in conjunction with the movement of the hand (Graph 31):

Graph 31

1 division = 0.023 sec.

Duration of shift = 0.25 sec.

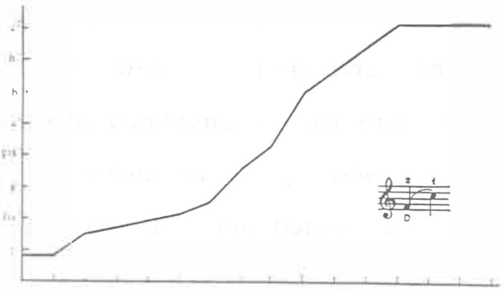


Схема 31
1 деление=0.023 сек.
Время выполнения перехода=0,25 сек.

If the movement of the hand is slowed down slightly for an instant, the final finger has to repeat the movement already carried out by the initial finger. The resulting graph is thus:

Graph 32

1 division = 0.019 sec.

Duration of shift = 0.228 sec.

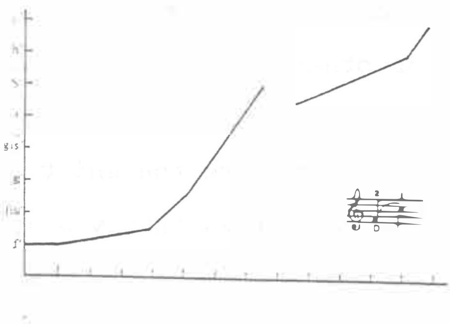


Схема 32
1 деление=0,019 сек.
Время выполнения перехода=0,228 сек.

The movement of the hand may also speed up for an instant. Then a small break will appear in the curve because the final finger does not have time to complete its slide (Graph 35).

Graph 35

1 division = 0.022 sec.

Duration of shift = 0.132 sec.

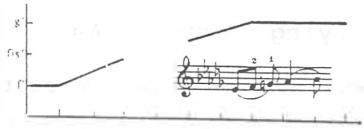


Схема 35

1 деление=0.022 сек.
Время выполнения перехода=
0,132 сек.

Jankelevits points out, however, that these last two mentioned cases are insignificant and transitory exceptions that cannot be observed without the use of a sensitive oscillograph.

Jankelevits says that one might assume that in difficult Type IV shifts, when the shift is made with the fingers farthest from each other, the use of an intermediate note would be unavoidable. This turns out, however, to be wrong: analysis shows that intermediate notes are not needed even in this case.

That which distinguishes Type IV shifts from other types is, according to Jankelevits, the replacing of one finger with another during the shifting movement. No part of the slide is outside of the interval of the shift. The use of an intermediate note to make the performance of this type of shift easier would distort the nature of the relationship between the sounds.

The learning of Type IV shifts is more difficult than the learning of other shifts. For this reason it is best to begin the study of Type IV shifts with shifts carried out on neighboring fingers. In cases where the shift is not carried out on neighboring fingers, the principles involved in performing the shift remain the same. The movement of the arm must just be speeded up: since the distance between the fingers is larger, the initial finger has to cover a greater distance in the same period of time.

As far as finger pressure is concerned, it must be remembered that the pressure of the initial finger on the fingerboard decreases while the pressure of the final finger gradually increases. Oscillographic analysis showed that not a single artist made use of intermediate notes in descending Type IV shifts. The slide on the initial finger covered in all cases approximately only one tone, when it should have covered (in the cases in the graphs below) a fifth if an intermediate note had been employed:

Схема 44
1 деление=0,025 сек.
Время выполнения перехода=0,1 сек.

Graph 44 (Oistrakh)
1 division = 0.025 sec.
Duration of shift = 0.1 sec.

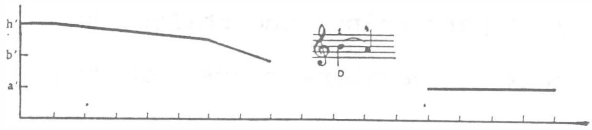


Схема 45
1 деление=0,016 сек.
Время выполнения перехода=0,16 сек.

Graph 45 (Rabinovits)
1 division = 0.016 sec.
Duration of shift = 0.16 sec

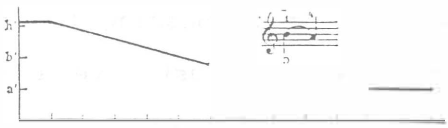


Схема 46
1 деление=0,025 сек.
Время выполнения перехода=0,3 сек.

Graph 46 (Tsiganov)
1 division = 0.025 sec.
Duration of shift = 0.3 sec.

There are a number of subdivisions of Type IV shifts in Jankelevits' analysis that we will not discuss in this context.

Jankelevits' emphasis on the avoidance of the use of intermediate notes seems extreme. He writes (ibid.,p. 178): "Sometimes, in order to avoid an unwanted glissando, a barely perceptible pause is

7 402983A

employed. Skilfully used, this can be considered to be an expedient measure."

Jankelevits treats as special cases leaps, i.e., shifts over long intervals, which cause, as he puts it, "well-known difficulties with accuracy of intonation" (ibid.,p.178). In Jankelevits' opinion the difficulties encountered in connection with such leaps are intensified by two factors: "First, the fear of making intonational errors that the pupil experiences while playing, leading to uncertainty of left hand movement resulting in playing the new note flat. Second, the fear of losing the rhythm, which often results in a rapid convulsive leap, which in turn leads to decreased accuracy" (ibid.,p. 179). Later, Jankelevits mentions a third factor pointed out by Mostrass, namely, the use of vibrato during the shift, which veils the player's awareness of the correct distance on the fingerboard (ibid.,p. 180). In our opinion, Jankelevits forgets the most important causes of uncertainty in performing long shifts: the balance of the arm and the lack of a preparatory phase for the movement.

Jankelevits offers the advice that leaps should be begun calmly and smoothly and then accelerated. Once again he warns against the use of intermediate notes. Later he mentions in passing (ibid.,p. 180) that Zeitlin emphasized that the violinist must have a clear picture of the shifting movement as a whole, which includes "a preparatory movement, a necessity dictated by the form of the violin." Zeitlin maintained that giving attention to the preparatory phase increases accuracy of intonation.

In regard to glissando in connection with leaps, Jankelevits states that there are differences of opinion in violin pedagogy: some teachers recommend sliding on the initial finger, others on the final finger (ibid.,p.181). Jankelevits concludes that the selection of the type of glissando to be used depends on the type of sound required by the musical material.

In conclusion he mentions several important things that must be kept in mind in connection with leaps: first, it is important to maintain contact with the fingerboard, which gives the feeling that the final note is connected to the initial note - even though a break between them may be indicated in the music. Second, the violinist must form in his mind "a strong image of the final note before shifting" (ibid.,p.181). He amplifies on this: "Before executing a leap,the final note must be clearly preconceived, "pre-heard": Thus, the movement of the hand realizes an already existing musical conception. Only by this means - and not through mechanical training - can be created the necessary auditory-motor responses that make possible the mastery of the fingerboard ("the knowledge of the fingerboard" as D. Oistrakh expressed it) in the professional sense of that term" (loc.cit.).

Jankelevits' dissertation is one of the most important documents in the history of violin pedagogy. From the broad range of problems associated with shifting between positions he chose the use of intermediate notes and glissando as the object for his investigations. The typology of shifts developed on this basis is, however, of a highly simplified nature: shifts can be classified on the basis of their fingering as well as their direction and range. In any event, the clarification of the harmful nature of intermediate notes and the "offical" approval of the use of end glissando (glissando on the final finger) are Jankelevits' great accomplishments. Oscillographic analysis is an extremely striking means of observing glissando and breaks between tones. We are justified in considering Jankelevits to be one of the most important pioneers in the field of scientific investigation of violin playing on the basis of his life work and of his dissertation in particular.

VIII INTONATION.

1. General Principles.

During the past two or three decades the demands related to questions of intonation in violin playing have increased tremendously. The cause of this has been primarily the continuously expanding production of records and casettes that has brought outstanding performances of most of the major works for violin into every home.

In connection with violin playing the term "intonation" is usually used to mean only accuracy of pitch. The concept of intonation can, however, also be looked upon in a broader context in violin playing, and can be divided into two parts: accuracy of pitch and the basic sound of the instrument without vibrato.

The Swiss scholar Christine Heman treats intonation in its narrowest meaning, i.e., strictly as accuracy of pitch, in her book *Intonation auf Streichinstrumenten* (Bärenreiter, 1964). She lists three main causes of faulty intonation in violin playing:

1) Aural inaccurancy (imprecise hearing)
2) Manual and technical deficiencies,
3) Deficiencies of the instrument or the strings (Heman,1964,p.7)

In her book Heman concentrates on a rigorous analysis of the role of the ear. She describes in detail the use in different situations of three separate intonation systems (the so-called Pythagorean, just and tempered systems), stressing the importance to players of string instruments of becoming familiar with different intonation systems. She sums up her views: "No strict "prescriptions" can be given for every case when dealing with such living material as the universe of sound, but a well-trained ear will by itself make the right choice in any given case" (loc.cit.,p.7).

2. The Pythagorean, Just and Even-Tempered Tuning Systems.

Systems of intonation based on the interval of the fifth, the oldest of which are known to have existed in the cultures of ancient China, Mesopotamia and Egypt, are generally referred to as PYTHAGOREAN INTONATION (or PYTHAGOREAN TUNING). Knowledge of this system came to western cultural circles in the 5th century B.C.. The mathematician and philosopher PYTHAGORAS is regarded as the inventor of the system. Pythagorean intonation performed a key role in the musical rudiments of ancient Greece and retained its significance throughout the Middle Ages until the system of JUST INTONATION, based on the proportional series 1:2:3:4:5:6, superceded it in the 16th century.

Just intonation led to problems when modulating from diatonic tonic keys to more remote keys and this gave rise to the development of various TEMPERAMENTS and finally to the division of the octave into twelve equally sized intervals, a system which is known as EQUAL TEMPERED TUNING or INTONATION (Otava's Large Music Encyclopedia, 1976-79,Vol.5,p.401).

2.1. Pythagorean Intonation.

The knowledge that the ratio of string lengths 1:2 gives rise to the relation of an octave, the ratio 2:3 correspondingly giving rise to a perfect fifth and 3:4 a perfect fourth, probably has its roots very far back in history. These three ratios are equivalent to the frequency ratios 2:1, 3:2 and 4:3. The three integer numbers

1, 2 and 3 form the basis of the Pythagorean intonational systems. It its earliest form it was based on rising intervals of a perfect fifth and falling intervals of a perfect fourth f c g d a e b. Subsequently this has usually been expressed as a cycle of fifths :

f c g d a e b

3:2 3:2 3:2 3:2 3:2 3:2

Under the Pythagorean system the complete diatonic scale corresponds to the following ratios :

c^1	d^1	e^1	f^1	g^1	a^1	b^1	c^2
1/1	9/8	81/64	4/3	3/2	27/16	243/128	2/1

9/8 9/8 256/243 9/8 9/8 9/8 256/243

A so-called comma discrepancy of size 531441/524288, known as the PYTHGOREAN COMMA,occurs between the twelve perfect fifths and the 7 perfect octaves. A difference of 81/80 occurs between the Pythagorean major third or DITONE 81/64 and the just major third, and this is referred to as the COMMA OF DIDYMUS or SYNTONIC COMMA (op.cit.,Vol.3,p.137).

2.2. Just Intonation.

JUST INTONATION refers to a system where the ratios are based on the proportional relationships 1:2:3:4:5:6. These correspond to the first six harmonics of the natural overtone series:

A just-intoned diatonic scale can be derived from these proportions as shown in the following table:

1		1		1		1		1		1		1		2
c		d		e		f		g		a		b		c
1/1		9/8		5/4		4/3		3/2		5/3		15/8		2/1
	9/8		10/9		16/15		9/8		10/9		9/8		16/15	

It is a characteristic of just intonation that it possesses two whole tone intervals of different proportion, the large (9/8) and the small (10/9). The difference between them - 9/8:10/9 - is the same as the difference which exist between the two thirds 81/64 and 5/4,i.e. the syntonic comma 81/80 (loc.cit.).

Just intonation can only be used in vocal music or with instruments where the frequency tuning of the degrees of the scale is freely adjustable, such as stringed instruments and the slide trombone (op.cit.,Vol.5, p.635).

2.3. Equal Temperament.

To a certain degree, the human ear is tolerant of intonational deviations. This has paved the way for the widespread adoption in western music of the equal tempered system of intonation, even though this system does not provide for even one single justly tuned interval with the exception of the octave (which itself can only be regarded as pure with certain qualifications) (loc.cit.). The tuning of keyboard instruments,amongst others, implies that all semitone intervals are of equal size.

In China in around 400 A.D, the theoretician HO TCHENG-TIEN proposed an excellent system of tuning based upon Pythagorean intonation. The earliest western references to tempering are accredited to RAMIS de PAREJA (1482)(op.cit.,Vol.5, p.446). During the last four hundred years a number of special keyboards have been constructed to enable the octave to be divided into 19, 31 or even 53 different steps (micro-intervals).For practical reasons,however, a system limited to 12 tones has been the norm.

Problems of tempering apply predominantly to the following three instances:

a) the twelve justly intoned fifths 3:2 of the Pythagorean system of intonation exceed the span of a justly intoned octave by the extent of one Pythagorean comma (23.43 cents). Equal temperament is arrived at when this discrepency is compensated for equally over the entire range of twelve fifths (each fifth becomes nearly 2 cents smaller).

b) the difference between the major third 81:64 of the Pythagorean system and the major third of just intonation 5:4 is 81:80, or the syntonic comma, compensation for which has been an important element in many systems of temperament.

c) The arithmetical divisions of the justly intoned major third 9:8 and 10:9 give rise to two whole tones of different size, equivalent to 203.91 and 182.40 cents. In the process of tempering, the difference between them (the syntonic comma) must be eliminated (loc.cit.).

3. Relationships Between Intonation Systems.

The relationships between the Pythagorean (linear), just and tempered intonation systems can be seen clearly in the table below (Heman,op.cit.,p. 15):

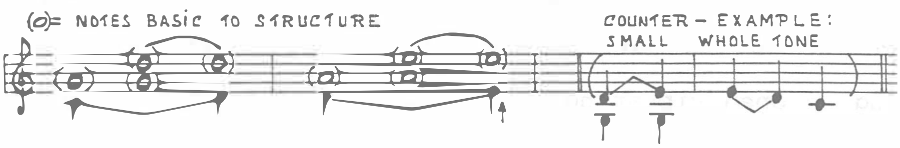
Interval	Pythagorean	Tempered	Just
minor second	90 (narrow)	100 (centered)	133 (broad)

major second	204(broad)	200 (centered)	182 + 204 small and large whole tones
minor third	294(narrow)	300(centered)	316(broad)
major third	408(broad)	400(centered)	386(narrow)
pure fourth	498(unchanged)	500(slightly broadend)	498(unchanged
pure fifth	702(unchanged)	700(slightly narrowed)	702(unchanged
minor sixth	792(narrow)	800(centered)	814(broad)
major sixth	906(broad)	900(centered)	884(narrow)
octave	1200(unchanged)	1200(unchanged)	1200 (unchanged)

The unit of measurement used in this table is the <u>cent,</u> which is arrived at by dividing a tempered semitone into one hundred equal parts,i.e., a tempered semitone = 100 cents. The octave thus has the value of 1200 cents.

4. The Acoustic Origin of the Scale Third.

A linear great third corresponds in structure to two great whole tones (cf. Table above) because IN CONNECTION WITH A RUN we regard only a GREAT whole tone as pure. A great whole tone is based on two pure unwavering fifths,e.g.



(Heman,op.cit., p.12: cf. Handschin: Der Toncharakter, p.113, 1st chapter.)

A fifth is unwavering when three vibrations of a higher note correspond exactly to two vibrations of a lower note, whereupon the following vibrational rhythm arises:

rhythm:

combination tone:

(cf.p.202 below).

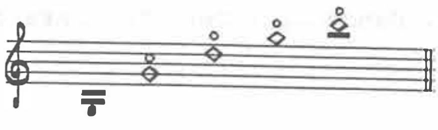
If we tune the violin and viola to successive PURE fifths, the extreme strings C and E form a third which in UNISON melody is pure:

(Heman,op.cit.,p.13; cf.Handschin,op.cit.,p.113)

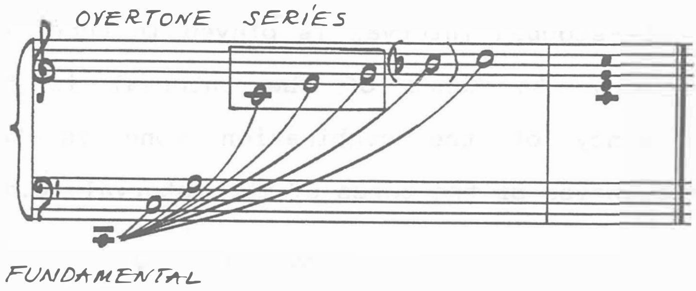
On the other hand E and C strings if played SIMULTANEOUSLY do not form a pure great third (+2 octaves).

5. The Acoustic Origin of Double-stopped Thirds.

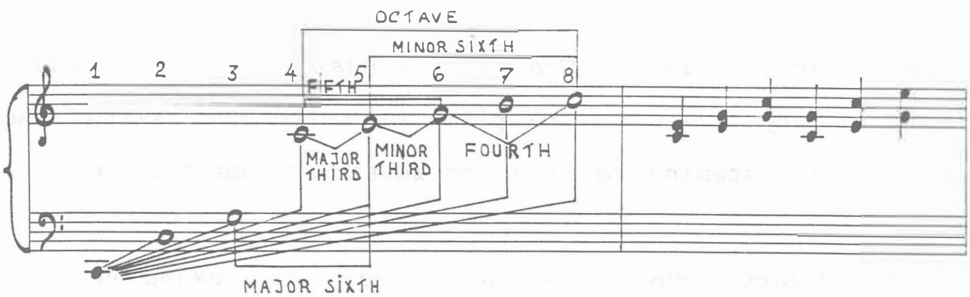
An overtone series is a succession of tones of which at least a part is to be found in the sound spectrum of any complex sound (e.g., a musical tone). This is due to the fact that the source of the sound does not vibrate only as a whole, but also in a decreasing series of its parts (i.e., it also vibrates in halves, thirds, fourths, fifths, etc.). String players are familiar with this series as the natural harmonics that are produced by lightly touching an open vibrating string at a point respectively one-half, one-third, one-fourth, one-fifth, etc. from either end of the string:



This series of overtones forms the basis for our traditional harmonic system. Basically, the triad is nothing more than a reinforcement of a group of tones in the overtone series (Heman,op.cit.,p.10):



Every triad is a component part of the overtone series of a fundamental tone. Thus every major or minor third, every major or minor sixth, every fourth, fifth and octave is a component of a given overtone series:

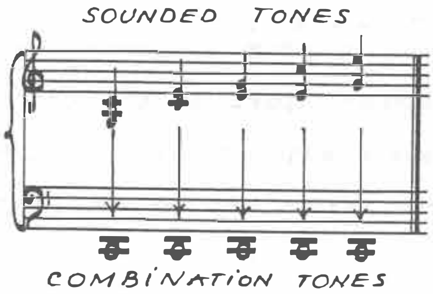


(ibid.,p.11)

When these intervals are played as double stops, a good ear hears them to be in tune only when they are played exactly as they are in the overtone series, i.e.,the frequency of the octave is exactly twice that of the fundamental, the frequency of the octave + fifth exactly three times, the frequency of two octaves exactly four times, that of two octaves + third exactly five times that of the fundamental, etc. If an interval is played otherwise than in exact accordance with these relationships, the ear hears beats (loc.cit.)

6. Combination Tones.

If an interval composed of two notes played simultaneously is played exactly in tune, not only do the beats disappear, but also a third tone can be heard, a so-called combination tone. When a double-stopped interval is played in tune, the fundamental related to both the tones of the interval is heard below them. The frequency of the combination tone is the difference of the frequencies of the tones of the interval, e.g.:



Giuseppe Tartini, in his *Trattato di musica* (Padua, 1754), put forth the theory that accurate pitch of thirds and sixths can be arrived at by listening for the combination tones that arise from them.

Leopold Mozart devoted several pages, with examples, to the subject in his famous *Versuch einer gründlichen Violinschule* (Augsburg,1756). He writes: "I have proved that on the violin, when playing two notes simultaneously, the third, now the fifth, now even the octave, and so on, make themselves heard of their own accord in addition thereto and on the same instrument. This serves then as undeniable proof, which everyone can test for himself, if he be able to play the notes in tune and correctly. For if two notes...be so to speak drawn well and rightly out of the violin, one will be able at the same moment to hear the lower voice quite clearly, but as a muffled and droning sound" (Mozart,1756, pp. 163-164).

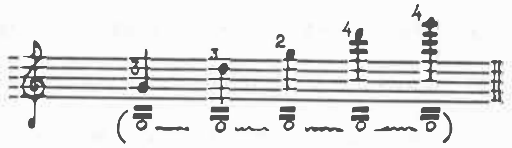
Many of the most famous violin methods of the 19th century (e.g., Bériot and Rode-Kreutzer-Baillot) do not mention combination tones. Nevertheless, the old tradition derived from Tartini and Mozart must have continued to exert a quiet influence, or it may have been rediscovered time and again. Especially musicians graduated from the conservatories of Bucharest and Prague bear witness to the fact that they work with combination tones there (Heman,op.cit.,p. 39).

Carl Flesch considered combination tones to be useful, though not necessary (loc.cit.). In Heman's opinion pupils devote more attention and time to listening to and perfecting double stops if they "have to wait for the combination tones to sound and thereby receive their reward. Otherwise, they often just continue playing thoughtlessly and uncritically, even young professional musicians with "good ears".This has been confirmed by tests in a conservatory class (loc.cit.).

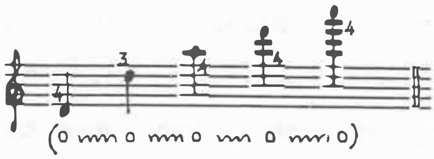
7. Resonance Tones.

So-called "resonance tones" also have a considerable influence on intonation. An open string vibrates not only as a whole, but also in halves, thirds, fourths, etc. (cf.p.201 above). It therefore vibrates sympathetically to tones played on the other strings at the frequencies of the overtones of the open string and adds a special beautiful resonance to those tones. Working with these resonance tones helps the violinist to develop a sense for sound coloration, leading to the development of sound color memory, which can be of good support in the achievement of pure intonation (Heman,op.cit., p. 21).

The sympathetic vibration of the G-string adds to the resonance of the tones shown below when they are played precisely in tune:



The sympathetic vibration of the open D-string adds resonance to these tones:



The corresponding tones for the A-string and E-string are:

(ibid.,p.20)

Thus the sympathetic vibrations of the open strings enrich the resonances of a total of 20 tones, which can be called "resonance tones". In the three-octave G-major scale (containing a total of 22 notes) there are in all 13 resonance tones (the black notes below):

(ibid.,p.21)

The scales of D♭-major, G♭-major and F♯-major have no resonance tones. For this reason it is more difficult to play them in tune than other scales:

(ibid.,p.25) 

8. The Use of the Pythagorean and Just Intonation Systems in Violin Playing.

Adapting the Pythagorean and just intonation systems for use in playing the violin involves playing semitones flatter or sharper depending on the musical context in which they occur. This affects major and minor seconds, thirds and sixths, but not fourths, fifths or octaves,which remain unchanged (cf.the table,pp.198-199), independent of which of the systems is being used. The most important difference in the use of semitones between the Pythagorean and just intonation systems is that in single-note passages , narrower semitones are used in the linear (Pythagorean) system than in the chordal(just) system. In the former case, in which the ear listens horizontally, the Pythagorean system is applied (narrow semitones, broad whole tones, broad major thirds),while in the latter case one listens vertically (to notes sounded together) and the chordal system is applied: semitones (i.e., minor seconds) are broader than in the Pythagorean (and also in the tempered) system.

This results in the following extremely important rule that applies to all minor and major thirds and sixths, as well as semitones and whole tones in all keys: In applying the chordal intonation system, minor thirds and sixths are broadened and major thirds and sixths are narrowed. Thus a double-stopped minor third or sixth is broader and a double-stopped major third or sixth is narrower when applying the chordal systems than when applying the linear system. Chordal intonation could thus also be called static intonation, and linear intonation could be called dynamic intonation.

Pablo Casals' terms for chordal and linear intonations were "simultaneous" and "successive" respectively (op.cit.,p.14). He had an interesting and important point of view concerning the influence of tempo on different intonation systems: the slower the melody, the more it is tied to the other voices in the ensemble and the more it loses its independent force. It then has to assume a more simultaneous (chordal) relationship to the other voices (Tobel,1941/45, p. 90).

Otherwise, in quartet playing, for example, the demands of the melody pull the harmonies down, i.e., if the theme is played linearly without taking the accompanying voices into consideration. Cf. the 1949 paper by J.F. Nickerson in which he studied the performances of six first-rate quartets (Heman,op.cit.,p.45; Journal of Acoustical Society of America,Vol.21, 1949): The first violinists (or other members of the groups) play rapid melodic passages in accordance with Pythagorean intonation while those playing accompanying parts employ chordal intonation. Quite often, however, the melodic voice is forced to switch from linear to chordal intonation. When the melody is strongly dependent on the other voices, all the members of the group switch to chordal intonation. In a professional quartet this takes place instinctively. The playing of a student group, however, may be irritatingly out of tune if all the members employ the same type of intonation that they are accustomed to using when playing solos.

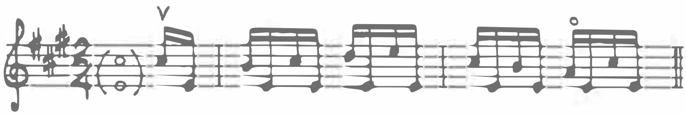
9. The Use of Tempered Intonation in Violin Playing.

Several situations need to be mentioned in which the violinist must employ tempered intonation:

1. In chromatic runs, in which the semitones are broader than in linear intonation, but still narrower than in chordal intonation.
2. When playing sustained notes with piano accompaniment when the piano is playing melodic material.
3. In unison passages, with piano accompaniment, which are especially frequent in, e.g., Mozart's sonatas for violin and piano.

10. Broken Thirds and Sixths.

In playing broken thirds and sixths there is such a strong feeling of a single-note scale that they must be played with Pythagorean intonation. If, however, because of a relatively large number of repetitions of notes, the intervals give a static, double-stopped, impression it is then necessary to play the scale with chordal intonation and practice it with the fingers in double-stop positions. The same applies to, e.g., the Mazas, *Etudes speciales* No. 21:



11. The History of Concepts of Intonation

It has become apparent in the course of the discussion so far that intonation has not always through the ages been conceived of as it is today. Concepts of intonation, as is also the case with styles of composition, violin making and violin technique, have passed through various stages of development.

In 532 B.C. the Greek mathematician-philosopher Pythagoras described a broad major third, which differed from the narrow major third used by the Greek-Egyptian astronomer and mathematician Ptolemy. In 1714 Giuseppe Tartini (1692-1770) made his own intonational discovery. He played a double-stopped major third and gradually moved his second finger until the interval was in tune and no beats were heard:

He also heard a weak bass note that he called **terzo suono** (= our combination tone). Tartini noticed quite correctly that the resulting major third was narrow - just as Ptolemy's third had been. His "error", however, was that he adopted his discovery in both chordal and linear playing. Many talented violinists from all over the world studied in Tartini's famous violin school. As a result of Tartini's method, most 18th-century violin virtuosos played "out of tune" when playing linearly.

This intonation method was in use for about 70 years, until the end of the 18th century when Bartolomeo Campagnoli (1751-1827) rejected the use of Tartini's narrow major third in linear playing in his Metodo per violino published in 1797 and supported the use of Pythagoras' broad major thirds. Campagnoli's drawing of the violin fingerboard, showing the location of the various notes, has been preserved: it shows Pythagoras' $f^{\#}$ as being higher than $g^{\flat}$, e higher than $f^{\flat}$, etc..

By the end of the century most violinists began to give up the 17th-century practice of playing augmented notes lower than the corresponding enharmonic diminished notes (i.e.,$f^{\#}$ was played lower than $g^{\flat}$, e lower than $f^{\flat}$, etc.).

Hungarian-born Joseph Joachim (1831-1907), the most distinguished violin pedagogue in the world in the last half of the 19th century, befriended the physicist Herman von Helmholtz, who acquainted Joachim with "scientific thirds" = narrow major thirds. Joachim made use of this information, but only in a limited fashion. Joachim's pupil Karl Courvoiser (1846- ?) published in 1873, under the "auspices" of Joachim, a work supporting the Pythagorean intonation system. We can draw the conclusion from this that Joachim himself used broad major thirds in linear playing.

Solo Ptolemy, Tartini
linear C D E F
playing E
Pythagoras, Joachim, Auer,
Heifetz, Kreisler

Leopold Auer did not accept narrow major thirds in linear playing. Their use in playing diatonic scales necessitates also using broad semitones, which Auer considered to be the root cause of bad intonation in melodic playing.

During the 1920's Auer's most famous pupils - primarily Jasha Heifetz and that great master of the Vienna school, Fritz Kreisler - firmly established the world-wide use of broad major thirds in linear melodic playing. That Heifetz and Kreisler actually did consistently make use of the Pythagorean intonation system is shown by a series of laboratory tests in which recordings of the playing of these masters are analyzed. Pablo Casals specified the use of narrow semitones in linear playing and emphasized that when playing rapid runs it is especially important to keep the semitones narrow (Blum,1977,p.107).

Campagnoli, Auer, Heifetz, Kreisler and other leading violinists shared the view that, when playing a major scale, not only the last, but both semitones must be played narrow: in this way the acoustic profile of the scale is clarified and sharpened.

Pythagorean intonation means that just as the leading tone is drawn up toward the tonic, the second whole tone in the major third is broadened. Thus both diatonic semitones become very narrow.

12. Factors Affecting Intonation.

Intonation in violin playing is extremely sensitive to many different kinds of both internal and external factors. If we ignore the role of the ear - the most important factor - for the time being, we can imagine that the determination of pitch in violin playing is primarily dependent upon the action of the left hand and that the quality of sound is for the most part dependent upon the action of the right hand. The action of the hands is, however, only the externally visible part of an invisible image born in the mind. The reason why there is such great variation in intonation is to be found in the mind of the violinist.

The factors affecting intonation in playing the violin can be pictured in the form of an "intonation pyramid". It is an extremely complex structure, composed of innumerable parts:

Intonation Pyramid

First rate intonation

Artistic pre- requisites. A sense of beauty and the ideal. A practiced, precise relative sense of pitch. Awareness of key signature. Concertrated listening in " the inner ear". Thinking in groups at fast tempos. Sensitivity of all the senses. Strong motivation. Powers of concentration. Comfortable position of the violin : compromise between the four directions. Relaxation of the arms, taking advantage of gravity. Mastery of the basic balances. Proper breathing. Mastery of shifting technique: its mechanics, glissando, timing, changes of pressure, balances, bowing changes. Minimal movements of the fingers. The movements of the fingers along the strings. The proper angle of fall of the fingers on strings. Good fingerings. Mastery of the even numbered positions.Use of reflexes.Control of vibrato.A comfortable hold on the bow, with supple fingers. Correct relationship between playing point , bow pressure and speed . Proper direction of movement at playing point . Mastery of types of bowing . Proper elbow movement . Mastery of string - changing technique.Manual syncronization.Sufficient practice . Good condition for playing. Good general physical condition. Excellent bow and violin.

The list includes the same factors that are a prerequisite for good violin playing in general. The reason is obvious: good violin playing (without artistic elements) = good intonation .

Naturally, the ear plays the most important - indeed, an indispensable - role in the production of good intonation. However, if intonation were dependent solely on the ear of the violinist, the eternal problem of accurate pitch in violin playing would not be the burning question that it constantly is. A good ear can be developed in the course of several years, if one goes about it determinedly enough. On the other hand, the refinement of a violinist's technique is a task for a lifetime. As we can see from the Intonation Pyramid, there are many factors that affect intonation in violin playing besides those connected with hearing. Flesch's list (cf,Flesch,1924,Book I , pp.19-35) includes only an outline of violin technique. When the psychological character of the violinist is, in addition, taken into consideration, one begins to get a glimpse of the myriad of problems involved. Every violinist should make an attempt to identify all possible factors - both instrumental and human - that affect intonation, and observe them carefully when practicing.

13. The Realities of Intonation.

In Carl Flesch's opinion, the secret of playing in tune lies in being able to correct quickly enough a note originally played out of tune: the ear and finger of the player must be quicker than the listener's reaction. In this way, according to Flesch, the impression is created that the note was originally in tune. Flesch writes: "Yet there are a number of violinists who create the impression of playing in tune. How are we to explain this apparent contradiction? By the simple fact that these violinists, though they do not strike the note exactly, do CORRECT it during the fraction of a second, either by shift of position or by means of a vibrato which approximates the TRUE note. All this, when the player is correspondingly skilful, takes place so rapidly that the listener feels as though the note had been TRUE from the very beginning, whereas it has only BECOME SO after a tiny lapse of time. HENCE WHAT WE CALL "PLAYING IN TUNE" IS NO MORE THAN AN EXTREMELY RAPID, SKILFULLY CARRIED OUT IMPROVEMENT OF THE

ORIGINALLY INEXACTLY LOCATED PITCH. WHEN PLAYING "OUT OF TUNE", ON THE OTHER HAND, THE TONE, AS LONG AS IT SOUNDS, REMAINS AS FALSE AS IT WAS AT THE MOMENT OF ITS PRODUCTION" (Flesch,1924,Book I, p.20).

Flesch adds that the "correction method" is valid only if notes of duration longer than 1/2 second are involved. The listener is not able to hear that notes shorter than this are out of tune, nor can the player correct them (op.cit., p.23). Pablo Casals was of a different opinion in this matter (cf.p.209 above). The listener receives a hazy impression of intonation if semitones are played too broadly in rapid linear passages.

14. Research into the Use of Intonation Systems.

According to experiments carried out in 1940 at the Moscow Conservatory by the Russian researcher L.V. Blagonadyozhina, the ability of highly talented child violinists to distinguish pitch was greater than that of equally talented child pianists (Szende, 1977,p.239). In 1937 O.C. Green published a study at the University of Iowa in which he investigated the playing of six professional violinists and came to the result that they employed neither the chordal nor the tempered intonation system, but rather the Pythagorean system (loc.cit.).

The research on the same subject carried out by Alexander Garbusow and published in 1948 in Moscow also documents the preference of violinists for Pythagorean intonation (loc.cit).

In 1970 Ottó Szende himself carried out a series of investigations of sensitivity to pitch under the auspices of the Acoustic Group of the Hungarian Academy of Science. He tested a total of 887 subjects, of which 789 were music students, 34 were teachers and 64 were orchestra musicians. There were 303 players of string instruments in the test group, of which 184 were violinists (loc.cit).

The base tone (fundamental) used was A prime (440 Hz), from which base 21 intervals were judged as to whether they were, in the opinion of the test subject, "flat, in tune or sharp." The intervals were heard in three series, each containing seven different intervals. The results showed that the ability to judge musical intervals was affected by three factors:

1) The direction and change in direction of the given interval.
2) The differences in cents of the intervals following each other and their change.
3) As an a priori factor, the preconceptions of the intervals to be heard (a psychological factor) (op.cit.,pp.240-241).

In Szende's opinion these tests clearly demonstrate the difficulties involved in investigating the perception of musical pitch. In the first place, the laboratory enviroment does not correspond to the conditions under which music is played and heard. Therefore, results obtained under these conditions must be applied with the greatest caution to the psychology and teaching of music (ibid.,p.241). Szende warns that all investigations that disregard the above-mentioned three factors should be looked upon extremely critically. Furthermore, one can arrive at greatly diverging results through the use of different investigative equipment. For this reason it is difficult to achieve a high degree of validity when testing pitch perception.

It is precisely the psychological factor that distinguishes musical pitch perception from ordinary hearing. Because of this, Szende maintains that we can draw the following conclusions concerning the methodology of experiments of a musical-psychological nature:

1. Pitch perception and interval perception are two different things. "Musical ear" cannot be investigated solely by measuring the ability to identify the pitch of a note.
2. Results concerning different intervals cannot be compared directly. One must determine to what degree the results are affected by the test subject's conception of the type of interval involved.
3. Amateurs and professionals should not be tested together, because the acuteness of musical perception of these two groups differs so greatly. It is characteristic of good pitch perception that it is a function of routine. The perception of an interval is the result of pedagogical-psychological discipline (ibid.,p.242).
4. Accurate perception of intervals is a function of musical backround, and also of the specific instrument. (In Szende's study violinists, woodwind and brass players heard Pythagorean intervals quite similarly, but chordal and tempered intervals differently). This gives one the right to employ the term "instrumental pitch perception", with which one can play quite suitably even though not in pitch in the traditional sense. There is thus no such thing as an unambiguously "good" or "bad" ear.
5. In order to develop his ear, the pupil should be advised on the different variations of a given interval. The listener should, e.g., hear in his mind the given interval according to which direction the melody is moving in, etc. (ibid.,pp.243-247).

15. Types of Intonation.

Different types of intonation can be divided into three groups:

1. "Pure" intonation refers to the orthodox use of an intonation system, e.g.,in connection with the playing of scales: thus, use of the Pythagorean system when playing linearly (when the ear hears horizontally), use of the chordal system in connection with chords (when the ear hears vertically), and use of the tempered system in the playing of chromatic scales and in certain situations when playing with the piano.
2. "Concrete" intonation, by which is meant intonation closely tied to musical expression deriving from the theoretical structures, harmonic tensions, modulations, etc., of the music. Different intonation systems are used flexibly.
3. "Artistic" intonation, in which intervals are "colored" according to the internal emotional state of the performer at the moment of performance. "Creative" intonation is thus based on the player's feelings and reflects his state of mind and being at the time of actual performance.

The Russian musicologist O. Abraham pointed out as early as the 1920's in his study treating absolute pitch, that a^1 has an "environment". In 1926 the Americans H. Moran and C. Pratt came to the conclusion that our ears do not perceive intervals mathematically, but rather psychologically. The Russian professor Alexander Garbusow has for his part come to the conclusion that the interval is by nature like a ring that expands and shrinks. Each ring is subjected to its own tension. There are 12 "basic rings" (the semitones that constitute the octave). The nature of the music and emotional state of the performer determines what sort of tension he imparts to the various intervals, i.e., how he "colors" them. Garbusow claimed that there are 15 "coloration possibilities", delicate adjustments of tension. The tensions selected by any given performer are unique and spontaneous. If the performances of Efrem Zimbalist and Mischa Elman of the "Air" by Johann Sebastian Bach (both in Wilhelmj's arrangement) are compared, one notices immediately that these two master violinists experience and play the various intervals quite differently.

Even the same performer is not able to repeat the same intonation pattern one hundred percent identically. Garbusov's research shows that intonation in its highest form, i.e., so-called "creative" intonation, is an extremely personal matter, which must, however, conform to certain melodic and harmonic laws.

IX EMPIRICAL SECTION.

A. Terminology.

A change of position (shift):	The fingerboard of the violin is divided into several positions.When the players's hand does not move horizontally, it is "anchored" in one position or other. A shift is the moving of the hand from one position to another.
Relatively short or long shifts:	Shifts may be either short or long. The differences between them can be measured in half-tones. A shift performed on the same string is called relatively short if it covers no more than an augmented fourth. A relatively long shift covers more than an augmented fourth. We make use of the concept "relatively" short or long shift because defining precisely what is a short or long shift is not generally possible.
Lower positions:	Position 1 through 4.
Higher positions:	Position 5 through 10.
Initial position:	The position from which the shift is initiated.
Final position:	The position in which the shift terminates.
Initial note:	The last note sounded in the initial position.
Final note:	The first note sounded in the final position.
Initial finger:	The finger that plays the last note sounded in the initial position.
Final finger:	The finger that plays the first note sounded in the final position.

Types of shifts:

Shifts are classified on the basis of the following characteristics:

- shifts from a lower to a higher position or vice versa.
- a shift made on the same finger, or from a lower to a higher finger (cf. explanation later) or vice versa.
- a shift is either relatively long or short.
- a shift is made either by sliding, extending or contracting the finger
- shifts may be made using the so-called Paganini-technique, in which the thumb remains in place during the shift.
- a shift may be made while an open string is sounding or during a pause.
- a shift may be made in connection with either a detaché or legato stroke (cf. explanation later) made by the bow.

Glissando:

A sliding of the finger playing a note.

Initial glissando:

The shift is performed by sliding on the initial finger, i.e., the glissando takes place at the beginning of the shift.

End glissando:

The glissando is made on the final finger,i.e., at the end of the shift.

Legato:

Two or more notes played with the same bow stroke.

Detaché:

The playing of only one note with each bow stroke.

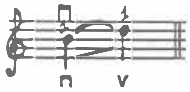
The extent of a shift:	The extent of a shift is the musical interval covered by the shift.
Contracted shift:	A shift with shorter than correct extent.
Expanded shift:	A shift with longer than correct extent.
The configuration of a shift:	If a movement is correctly carried out, its configuration is natural, and it proceeds exactly the right distance in the proper direction. The configuration of a movement can either be natural or unnatural independent of whether it is of the correct extent or not.
The timing of a shift:	A shifting movement must include all the elements of a harmonious movement: a strong image of the movement ("a movement of the mind"), a preparatory phase, the precise giving of an order, the execution phase and the follow-through phase. By "timing" is meant the proper coordination of all these elements.
Lower finger:	E.g., the first finger is lower than the third.
Higher finger:	The reverse of the above.
Fingertip pressure:	The pressure formed when the violinist presses his finger down on the string and fingerboard.
Vibrato:	The cyclical, back-and-forth motion of the hand in the direction of the string. It causes a slight rise and fall in the pitch of the note being played that is considered to be pleasing to the ear.

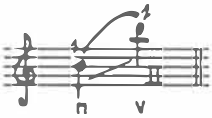
B. Typology of Shifting.

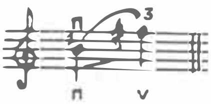
Traditionally, the typology of shifting has been made only on the basis of fingerings. When also the extent, configuration and timing of the shifting movement is taken into consideration, the typology of shifting assumes the following form:

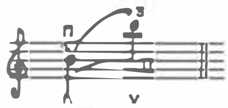
<u>I Shifts from lower to higher positions.</u>

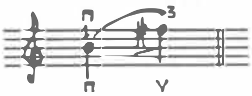
(by "short" shift is meant a relatively short shift and by a "long" shift is meant a relatively long shift; cf. definition in section A).

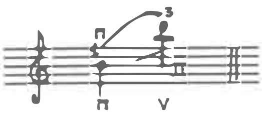
1.  Short shift on the same finger.

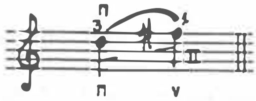
1a.  Long shift on the same finger.

2.  Short shift from a lower to a higher finger with initial glissando.

2a.  Long shift from a lower to a higher finger with initial glissando.

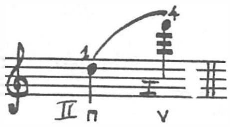
3.  Short shift from a lower to a higher finger with end glissando.

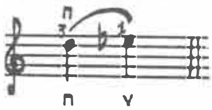
3a.  Long shift from a lower to a higher finger with end glissando.

4.  "Scissoring", i.e., a short shift from a higher to a lower finger with (short) initial and end glissando.In downward shifts end glissando is not used.

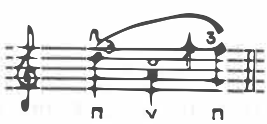
4a.  Long shift from a higher to a lower finger with (short) initial and end glissando. Downward shifts: as in 4.

5.  Short shift from a lower to a higher finger by extension, without glissando.

5a.  Long shift from a lower to a higher finger by extension, without glissando.

6.  Short shift from a higher to a lower finger by contraction, without glissando.

6a.  Short shift from a higher to a lower finger by contraction with (short) initial or end glissando or both.

7.  Short shift while an open string is sounding or during a pause, either on the same finger (as pictured) or on a different finger.

7a.  Long shift while an open string is sounding during a pause, either on the same or different finger (as pictured).

8.  Short shift employing the so-called Paganini-technique : the thumb remains in place during the shift. The example includes shifts both upward and downward.

There are thus 15 different types of shifts from lower to higher positions. The shift can take place either on the same string or to a new string. Types 1-7 also occur double-stopped.

<u>II Shifts from higher to lower positions.</u>

The types of shifts are the same as in group I with the exception that in shifts from higher to lower positions, end glissando is nowadays not used for aesthetic reasons.

C. Research Problems.

1. Is it possible to improve intonation in shifting by means of performance instructions ?
2. How are different aspects of the shifting movement related to improvement of intonation?

D. Hypotheses.

1. The Influence of the Extent of Movement on Intonation during Shifting.

   Long shifts are more difficult than short shifts when the arm of the player is not balanced. The shifts then tend to remain too short.

2. The Influence of the Configuration of Movement on Intonation during Shifting.

   Failure to perform properly the following aspects of the shifting movement causes disturbances in intonation in connection with shifting: integration of the shifting movement (moving the arm as a whole); moving the arm sideways; combined vertical and horizontal movement of the arm (resulting in a u-shaped motion); movement of the wrist; the angle of bending of the fingers when they strike the fingerboard; the role of the thumb.

3. The Influence of the Timing of Movement on Intonation during Shifting.

a) In order to produce good intonation, it is necessary for every phase of the shift to be of effective duration, and for the duration of each phase to stand in proper relationship to that of each other phase. The phases of the shift are: image formation (movement of the mind, invisible phase);the preparatory phase; the giving of an order at the precisely correct moment (invisible phase); the execution phase; the follow-through phase. If not enough time is given to the preparatory phase of a shift or if the overall timing of the shift is scant, intonation will suffer during the shift. (A precise definition of the "effective" duration of preparatory and execution phase will be provided below, pp.298-311, in connection with the analysis of the data).

b) Good intonation in shifts is best achieved at freely selected tempos.

E. The Experiment.

The investigation was conducted in the form of a control experiment (Karma, Kai,1983, pp.49-50). Two groups (a test group and a control group) of equal size (10 + 10) were chosen. All members of both groups were representatives of essentially the same generation (12 - 17 years old). There were 14 girls and 6 boys in the groups, both of which were composed of pupils from two different music schools. All members of both groups played a set of selections in an initial trial and a final trial. The members of the test group were given instruction in performing the shifts before the final trial.

A jury of 5 members was selected from among the lectures in violin of the Sibelius Academy. Their assignment was to judge the intonation of the participants in the experiment. All the members of the jury were highly qualified professionals who had received diplomas from higher schools of music in Helsinki, Stockholm, Leningrad, Budapest, Utrecht and New York. In addition, each of them had been, or still were, concert artists. Two of them had been winners of the national violin competition in Kuopio, and one of them had been a finalist in the Sibelius Violin Competition. Several of them had made recordings.

Transferring violin playing to the laboratory is a very questionable business and may lead to the banalization of research. Jankelevits and Szende brought to light valuable information about the mechanical and physiological aspects of violin playing in their laboratories. In my opinion, they succeeded in avoiding the dangers of artificiality.

When planning this experiment I was fully aware of the possibility of measuring precise, absolute differences in pitch and producing extensive and extremely accurate statistics about the intonation of the participants. However, because what is considered to be "good" intonation follows extremely complicated rules and the instruments of measurement would have to be calibrated in accordance with the conceptions of the members of the jury, it was decided to use as the instrument of measurement the members of the jury themselves, viz. the incorruptible ears of experienced performing and teaching violinists, i.e., precisely the same "instruments of measurement" by which the achievements of the participants are judged in music school examinations.

The tool employed was a HITACHI VM 500 E video camera. Through its use it was possible to investigate, in addition to intonation, the configuration of the shifting movement, the control of balance, the playing position, the regulation of muscular tension and also the overall coordination of the various elements of the shifting motion. The running-time indicator of the video camera was used to measure the duration of the various phases of the shifting movement, thus producing a measure of the timing of the movement.

1. The Elimination of the Contribution of the Ear to the Successful Production of Intonation.

It has been pointed out in an earlier context (cf.,p.194 above) that three factors influence intonation in string instruments: the ear, the physical movements and the proportions and condition of the instrument. It was not the purpose of this experiment to investigate the influence of the ears of the participants on the accuracy of intonation produced. It was necessary first to eliminate the influence of the other two factors so that the influence of the physical movements alone could be studied.

The condition and proportions of the instruments could be determined to be adequate before the beginning of the experiment. The contribution of the players' ears could be disregarded during the actual experiment following the determination that the "musical ear" of each participant was at least well-trained, and in some cases good or even excellent. It could thus be assumed that any faulty intonation that appeared in either the initial or final trials was not due to lack of training of the ears of the participants.

The degree of training of the ears of the participants was tested as follows. Each participant recorded two selections on video tape. These selections were chosen in such a way that the first contained no changes of position at all, and the second only a few simple shifts. Neither contained any technical problems that would have caused difficulties for any of the participants. It could thus be assumed that if faulty intonation did occur, it would be as a result of poor ear training rather than of technical difficulties.

After the recordings had been made, the jury evaluated the intonation of the performances according to the following scale: good = 11-15 points, excellent = 16-20 points, exceptional = 21-25 points. The jury members were accustomed to using this evaluation scale in their everyday work.

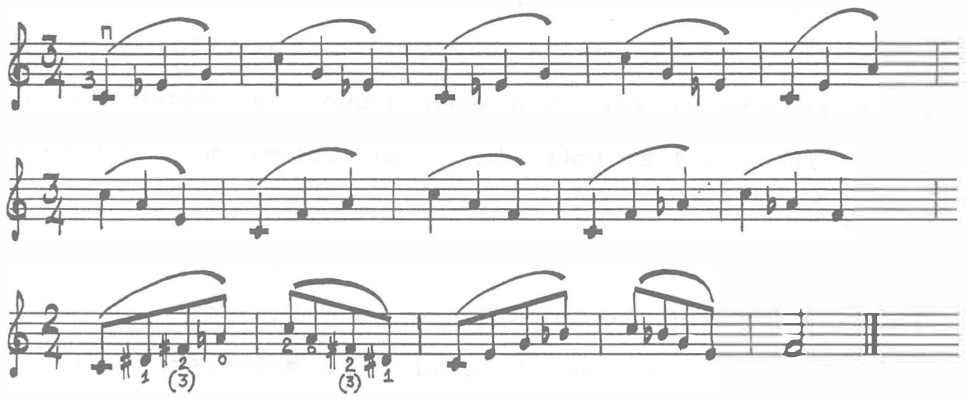
1.2. The Ear Test Selections.

The first selection chosen for the ear test was four measures (C major) from the beginning of Carl Flesch's Das Skalensystem. The tempo was halved (♪ → ♩ ; 𝅘𝅥𝅯 → ♪), so this piece was 15 measures in length. These arpeggios were all to be played in the same position, without any shifts , although they were originally intended to be played on the same string. The second selection chosen was the first 12 measures of the Schubert-Palaschko Ave Maria. This selection was fingered in such a way that there would be as few changes of position as possible, and even those few would be simple shifts. Thus, at this time no fingerings were employed that placed either technical or artistic demands on the players.

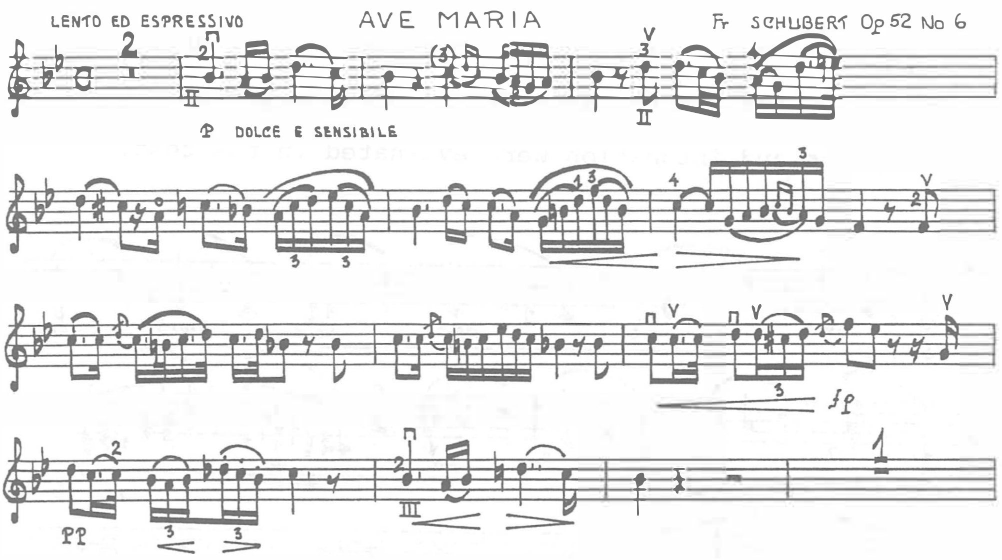
These selections were sent to the participants a week before the first recording session. The jury that had been asked to judge intonation was of the unanimous opinion that one week would be sufficient for the participants to learn material of this level of difficulty and that the selections involved in no way exceeded the technical skills of the participants. Later on, the jury was also unanimous in its opinion that the selections chosen for the initial and final trials were of a suitable technical-artistic level of difficulty for this experiment.

Each participant recorded both selections on video tape after various small technical filming details had been explained and learned as a group.

1. Carl Flesch: Das Skalensystem (C- major, in one position).



2. Schubert-Palaschko: Ave Maria.

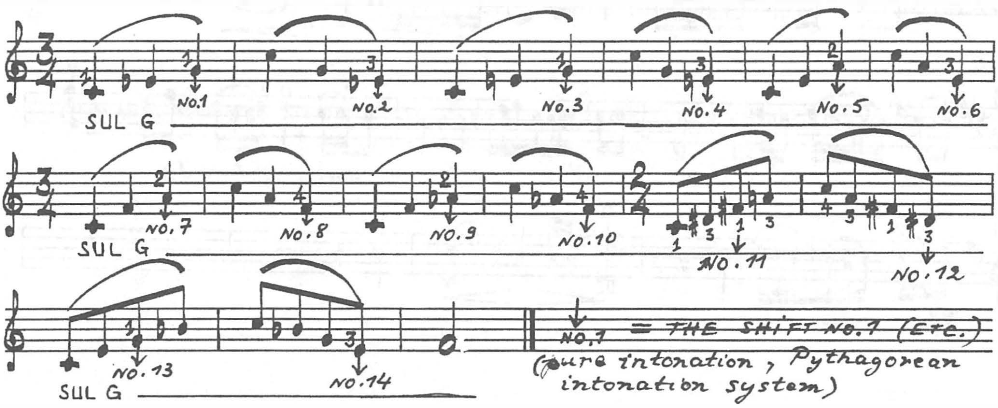


2. The Initial and Final Trials.

In both the initial and final trials all participants played 5 selections that included many changes of position. In this way it was possible to observe the influence of shifting on intonation. The selections played in the final trial were the same as those played in the initial trial. Comparing the video recordings provided a measure of how much each group had progressed in the final trial in regard to both their own performances and those of the other group.

2.1. The Selections of the Initial and Final Trials:

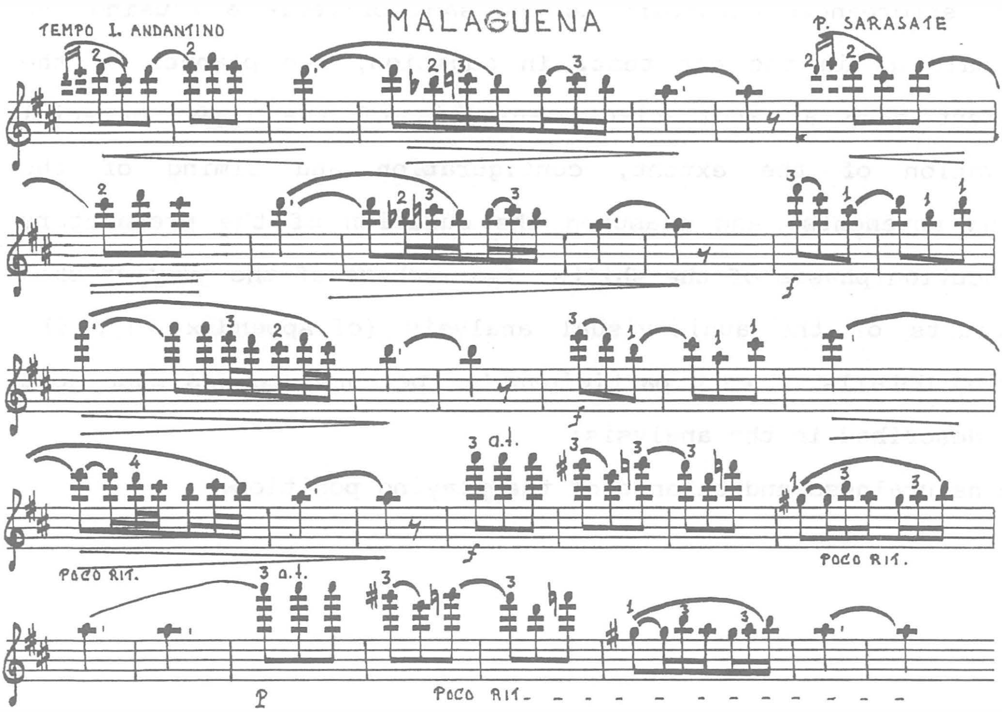
1. Flesch: Das Skalensystem (C major), 15 measures. This is the same selection that was used in the ear test, but in the initial and final trials it was played on the G-string with changes of position, of which there were a total of 14 (cf. below). It was played at three different tempos: ♩ = 54, optional tempo, and ♩ = 138. The selection was first played sitting. The 14 shifts involved are numbered on the example shown below. The preparatory phase, the execution phase and intonation were evaluated in the test.



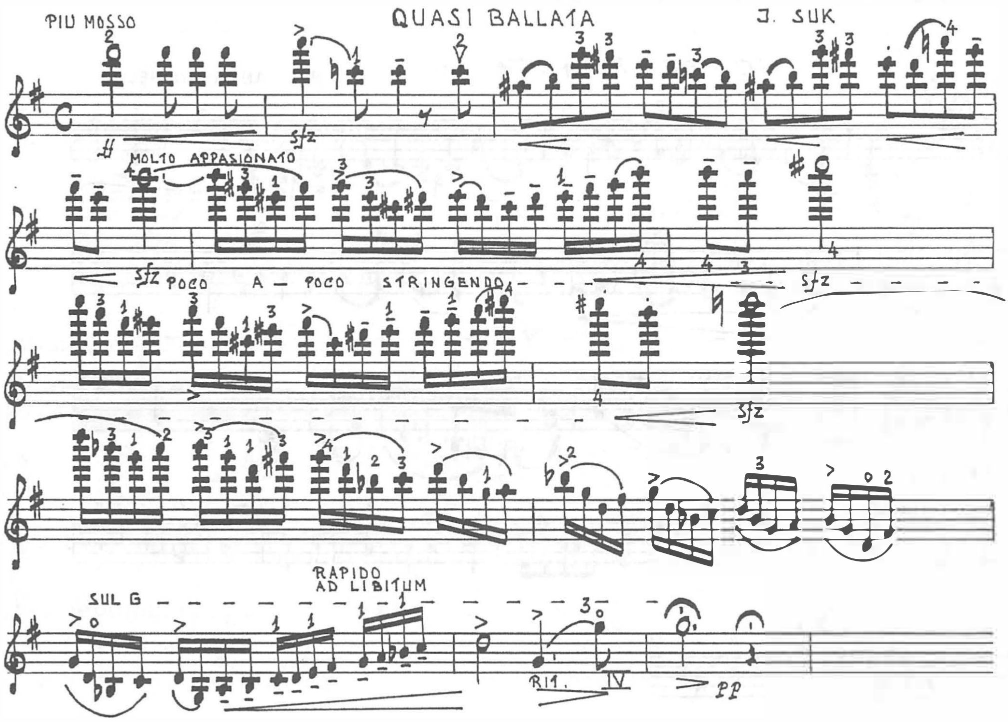
2. Flesch: the same selection as above, standing.

3. Paganini-Wilhelmj: Moses Phantasia

4. Sarasate: Malaguena



5. Suk: Quasi Ballata



After the initial and final trials the jury evaluated intonation in the performances according to the same criteria and using the same scale as in the ear test. In addition, the planner of the experiment made an audio-visual analysis of the taped material (observation of the extent, configuration and timing of the shifting movements) and measured the duration of the preparatory and execution phases of the shifts. Two members of the jury checked the results of the audio-visual analysis (cf.Appendix 22). The following details of each participant's performance was made note of and described in the analysis:

1. The naturalness and balance of the playing position.

2. The smoothness of the shifting movement: "a flowing movement", possible twitches and jerkiness.
3. The integrity of the shifting movement: balance during the shift.
4. The duration of the preparatory phase (running-time indicator, slow motion).
5. The use of glissando.
6. The elasticity of the wrist.
7. The action of the fingers in the preparatory phase.
8. The elasticity and activity of the thumb.
9. The angle at which the fingers strike the fingerboard.
10. The distance of the fingers above the string.
11. The facial expression of the player: The lines around the mouth (tension).
12. The type of vibrato and its use.
13. The power of the player’s imagination (evaluated with greatest reservations).
14. The attention devoted to the follow-through phase: the correction of out-of-tune notes.

3. The Instruction Given to the Test Group.

The final trial took place two weeks after the initial trial. In the interval between the trials the members of the control group were allowed to practice by themselves. All the members of the test group received instruction from the planner of the experiment three times for 20 minutes each time. Instruction in the production of good intonation was not given. The instruction concentrated on the principles related to shifting technique, which are listed here:

1. Relax your mind and arms: erroneus, extraneous tension blocks fluent movement. Concentrate on what type of shift is involved. Check your posture.
2. Check for a comfortable hand (and finger) position in both the initial and final positions. Keep the thumb relaxed. Before an upward shift the thumb moves under the neck of the violin (if the hand moves over the body of the instrument). Before a downward shift the thumb first releases the neck of the violin (positions 4.-1.).
3. Don't let your left hand hang down from the violin. Maintaining balance during the shift means that you support the arm (starting from the shoulder) and make the shift with a minimum of pressure between the initial finger and the fingerboard.
4. The movement must be integrated: the shift is to be made as much as possible with the entire arm. The upper arm moves freely to the side and up (or the opposite). Shifts in the higher positions require precise movement of the wrist.
5. Pay close attention to the preparatory phase of the shift. The entire arm begins to move ahead of time in the direction of the new position.
6. Decrease the pressure between the initial finger and the fingerboard just before the shift. Increase the pressure between the final finger and the fingerboard just before the final note is reached (if you are employing end glissando).

7. Don't make any jerky motions. Control the overall timing of the shift: the shift begins calmly and speeds up toward its conclusion. The final finger oscillates, as it were, into place at the conclusion of the shift.
8. Pay close attention to the use of initial glissando, which is made with light pressure on the initial finger. Delay the arrival of the final finger on the final note as much as possible.
9. Control the end of the shifting movement with the help of vibrato (i.e., correct any possible inaccuracy of intonation).
10. Upon arrival at the final note, regain a comfortable fingertip feeling, fingertip balance. The basic principle is once more that the upper arm supports the left hand and does not allow it to hang down from the violin.

4. The Types of Shifts Involved in the Performance of the Musical Selections in the Initial and Final Trials (cf. musical examples).

Sarasate: Malaguena: (Tempo I, Andantino, measures 1-35).

Short shift upward on the same finger: 1 (number refers to type of shift, cf. pp.221-23 above)

Short shift downward with initial glissando from lower finger to higher: 4

Short shift upward with initial glissando from lower finger to higher during a pause: 7

Long shift upward with initial glissando from lower finger to higher during a pause: 7a

Short shift downward by extension without glissando from a higher finger to a lower: 5

Short shift upward by extension from a lower finger to a higher: 5

Long shift downward with initial glissando from a higher finger to a lower: 2a

Paganini: Moses Phantasia (measures 1-23).

Short shift upward on the same finger: 1

Short shift upward on the same finger during a pause: 7

Short shift downward with initial glissando from a lower finger to a higher: 4

Short shift downward on the same finger: 1

Short shift upward with both initial and final glissando from a higher to a lower finger: 4

Short shift downward by contraction from a lower finger to a higher: 6

Long shift downward while an open string is sounding from a higher finger to a lower: 7a

Short shift downward by extension from a higher finger to a lower:5

Long shift upward on the same finger during a pause: 7a

Suk: Vier Stücke: Quasi Ballata: piu mosso (measures 1-13).

Long shift downward by extension from a higher finger to a lower:5a

Short shift downward by contraction from a lower finger to a higher: 6

Long shift upward with initial glissando from a lower finger to a higher: 2a

Short shift downward on the same finger: 1

Short shift downward with initial glissando from a lower finger to a higher: 4

Short shift upward by extension from a lower finger to a higher: 5

Short shift downward by extension from a higher finger to a lower:5

Short shift upward with both initial and final glissando from a higher finger to a lower: 4

Short shift upward on the same finger: 1

Short shift downward while an open string is sounding from a lower finger to a higher: 7

Long shift upward with short initial and final glissando from a lower finger to a higher: 4a

The participants played in arbitary order: thus the test group and the control group were mixed. The jury listened to the performances "blind", i.e., they did not know which group any given participant belonged to. The tests were short: the ear test lasted 5 minutes, the initial and final trials each barely 10 minutes. The participants had no chance of becoming fatigued during the taping sessions. (On the other hand, these sessions were very time-consuming for the planner of the experiment since each participant had to be taped separately).

The results of the experiment were not obtained by artificial means, even though the most natural venue for research dealing with musical compositions would have been the concert stage. Scales are not performed in concerts, so taping them was perfectly "natural". The video-taping of the musical compositions can be criticized on the following grounds:

1. accompanied pieces were played without accompaniment.
2. during taping there was no contact with an audience.
3. the test situation put extra pressure on the nerves of the participants.

The lack of accompaniment does indeed lay bare the solo voice, but precisely for that reason technical deficiencies are exposed. That is exactly the reason that try-outs for admission to the Sibelius Academy are conducted without accompaniment. In addition, the player is not able to fall back on the support of an experienced accompanist.

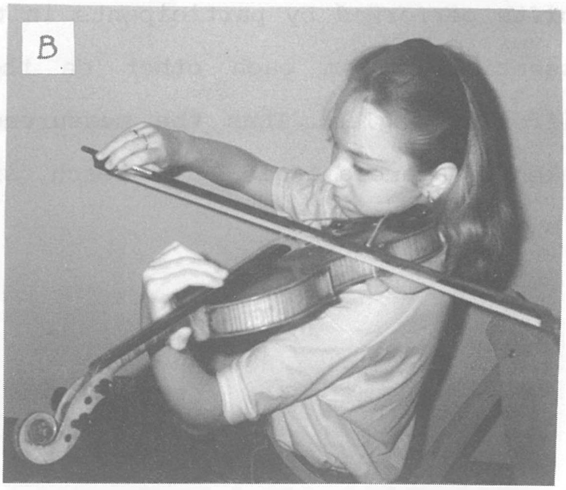
As far as contact with an audience is concerned, it can be noted that any musician has to learn to handle such situations, e.g., when making radio recordings. Including an audience under such circumstances has never been usual practice (unless the recording was made during a concert). Artists have never attempted to avoid recording sessions because of their unnaturalness. Quite to the contrary, the legendary pianist Glenn Gould, e.g., concentrated exclusively on recording during his final years and gave up concertizing, i.e., contact with the audience.

Extra nervousness could arise because of the unusualness of the test situation if a participant was not used to making recordings. The subjects involved in this particular experiment were, however, exceptionally experienced musicians who had performed on both radio and television. None of them was bothered by extreme stage-fright. Quite to the contrary, there were many artistically satisfying moments during the recording sessions.

An artist is also under extremely great psychological pressure during a real concert. It could even be maintained that many concert situations could seem "unnatural" for a performer. It is not "natural" to have to perform as a last-minute replacement, in a substandard environment, in poor condition or even sick, without having practiced sufficiently (for one reason or other), depressed by the death of a dear one, or on a violin that is temporarily in bad voice. No artist would consider appealing to "unnaturalness" under such circumstances.

All the participants and their parents, as well as the members of the evaluation jury, considered without exception that the experiment was both important and useful. The members of the test group (1) felt they were learning something new that would be of value to them in their future studies. Thus the experiment was looked upon as being closely related to study goals.

The performances of the Flesch Skalensystem were video-taped from two angles: A) from a point looking along the axis of the fingerboard and slightly above it, and B) from a point approximately 1 meter farther to the player's left (cf. photographs).



Both angles were advantageous, each in its own way, for the investigation of the configuration of the shifting movement. The former (A) provided an opportunity for observing the movements of the upper arm and wrist, the latter (B) for following the action of the fingers.

The two angles from which the video-taping was done involved both advantages and disadvantages from the standpoint of measuring the duration of the preparatory phase. The recording made from angle A showed clearly the beginning of the preparatory phase and its point in time could thus be determined accurately. On the other hand, the beginning of glissando starting the departure from the initial position (i.e., the beginning of the execution phase of the shift, at which point the preparatory phase ends) is not easy to observe. It is difficult to observe the precise beginning of the preparatory phase from angle B (because from that direction the sideways movement of the upper arm cannot easily be seen), but the departure of the initial finger from the initial position can be clearly observed.

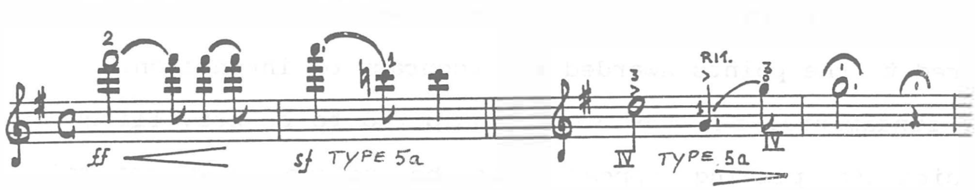
Several comparisons between measurements made from both camera angles showed that the durations of preparatory phases in the shifts performed by participants in the experiment did not diverge essentially from each other on the films taken from the two different angles. Thus the measurements were made from the tape taken by camera angle B (Flesch, sitting, ♩ =54).

5. The Relationship between the Length of the Shift and Intonation. Jankelevits mentions in passing in his study (Jankelevits,1983,p. 178) that long shifts generally cause "well-known difficulties" for violinists. He finds three reasons for this: the fear of making intonational errors, the fear of losing the rhythm and the detrimental effect of vibrato. Jankelevits does not investigate possible technical reasons for this. The real reasons for these "well-known difficulties" remain unclear in his study.

In the present study an attempt is made to determine whether or not long shifts are actually more difficult than short ones. Second, an attempt is made to explain why long shifts are difficult, if indeed difficulties do arise. Four relatively long shifts from the pieces played in the initial and final trials were selected for special study: two upward shifts (types 7a and 2a) and two downward shifts (both type 5a):

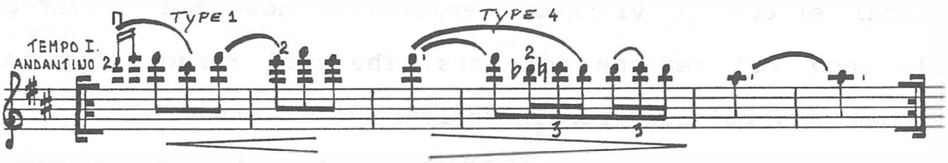
Malaquena: Tempo I, Andantino

Quasi Ballata: Molto appasionato



The planner of the experiment listened to the pertinent parts of the taped performances of both the initial and final trials (involving a total of 2 x 78 shifts) and evaluated the intonation of the final note in each case: if it was in tune, sharp or flat. Then two sections of the Malaguena that contained relatively short shifts (types 1 and 4) were chosen:

Malaguena: Tempo I, Andantino



Once again the intonation of the final notes (2 x 78 shifts) was evaluated. The results were compared to those obtained for the relatively long shifts.

6. The Relationship between the Configuration of the Shift and Intonation.

The configuration of the shifting movement was considered to include the following factors:

1. Playing position and the fundamental balances.
2. The paths of movement of the hand and muscular tension.

The configuration of the shifting movement was determined with the aid of audio-visual analysis. The observations made were compared to the points awarded for accuracy of intonation.

The fundamental balances were considered to be prevailing when a participant's playing appeared to be relaxed and natural and produced a free-sounding quality of tone. Good fundamental balances thus signified succesful execution of the "horizontal playing concept", "flowing" arm movements and the natural resonance of the violin. Signs of poor fundamental balances were considered to be excessive vertical movements of the arms, rigidity and heaviness of movement on the part of the arm or parts of the arm, in other words a stiff and strained style of playing, resulting in pinched tone.

A good playing position is the result of several factors. The most important are a good playing stance and a succesful compromise between four different dimensional factors when the violin is placed in contact with the body: 1) how high the violin is held in relationship to the shoulder-sternum axis, 2) how horizontally the violin is held, 3) how far to right or left the neck of the violin points, and 4) how far it points up or down (cf. pp.35-36 above).

Any exaggeration in one direction or another immediately alters the various relationships,i.e., the "conditions of playing" ,and may lead to the improvement of feeling in the muscles, or conversely its impairment. Every violinist has to seek, and find for himself, a playing position that provides for him the greatest possible freedom of movement.

It was not possible in the course of this study to investigate in detail all the factors affecting the playing position. Special attention was paid to only one of the four factors mentioned above, since it was that one of the dimensional factors that allowed of easiest observation, in addition to which its influence on the naturalness of performance and the quality of intonation is immediate: whether the participant appears to be letting his left hand hang down from the neck of the violin (in which case the neck of the violin points toward the floor) or whether he supports it with his left hand (in which case the neck of the violin is horizontal to the floor).

The participants were divided into two groups on the basis of whether the neck of the violin pointed toward the floor or was horizontal. The influence of the playing position on intonation was investigated by calculating the significance of the intonation point differentials. In the same way the influence of the fundamental balances on intonation was investigated.

7. The Influence of the Timing of Shifts on Intonation.

7.1. Glissando.

The use of glissando is one of the factors involved in shifting to which the timing of the movement is closely linked. Deficiencies in the timing of shifts usually go hand in hand with the uncertain use of glissando. A violinist must know how to make use of both initial and end glissando in both upward and downward shifts. In addition, he must have mastery over the use of glissando under both rehearsal and performance conditions and know the use of glissando in the music of different periods and different styles. (Taste changes with the passage of time: in our day, e.g., Fritz Kreisler's compositions cannot be played as slowly and with as much glissando as Kreisler himself played them in the 1920's.)

In this study the use of initial and end glissando was investigated by comparing the points received for intonational accuracy by two separate groups in the initial trial with the points they received in the final trial, and calculating the progress achieved. Participants who made use of initial and end glissando in both the initial and final trials were placed in the first group. Those players who used only end glissando in both the initial and final trials were placed in the second group.

8. The Significance of the Duration of the Preparatory and Execution Phases of Shifts for the Achievement of Intonational Accuracy.

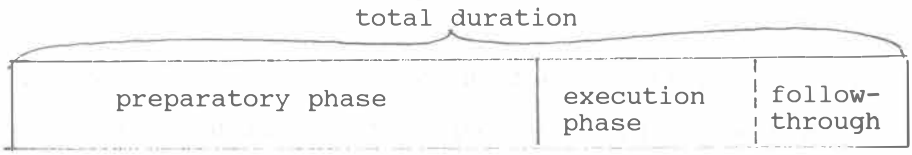
The relationship of the duration of the various phases of the shift to intonational accuracy was investigated with the aid of the (C-major) triad exercises of the Flesch *Skalensystem* since in the performance of these exercises the player has to move his left hand repeatedly over the edge of the violin and back again to the starting position. In these shifts the movement of the arm must be quite extensive in both horizontal and vertical directions. This makes it easy to observe the elements of the movement. The first 10 of the 14 shifts in the piece were investigated because in these the length of the notes remain the same since they are all triplets. On the other hand, during the last four shifts the length of each note is shorter (with accentuation on each fourth note). Therefore the duration of the various phases of these shifts is not as such comparable to the duration of the phases of the first ten shifts.

The duration of the last four shifts is, however, included in the raw data (provided in Appendices 1-4) for two reasons: in the first place, the evaluations of the jury were based on the intonation achieved in all 14 shifts. In the second place, the duration of the last four shifts could be compared to that of the first ten in the Appendix.

The duration of each shifts was measured (by observing the film in slow motion) in the first section of the Flesch exercises, which the participants played sitting, at the metronome setting ♩ = 54. The duration was obtained thus: when the hand of the participant gave an indication of preparation for the shift (e.g., by raising or lowering the arm, moving the elbow to the side, moving the thumb back or under the neck of the violin, bending the wrist, moving the final finger toward the initial finger, etc.) the tape was stopped and the number indicating the running time of the film noted. In this way the point in time at which the preparatory phase started was established.

Subsequently,the film was again observed in slow motion and note was made of when the participant's initial finger left the initial note and began the initial glissando. At this point the tape was once again stopped and the running time figure noted. This provided a measure of when the preparatory phase ended and the execution phase began. By calculating the difference between these two times, the duration of the preparatory phase was obtained.

The duration of the execution phase (and the follow-through included in it) was measured in the same way. The execution phase began - as noted above - at the moment when the initial finger moved away from the initial position toward the final position. The execution phase ended when the final finger stopped at the location of the final note on the fingerboard. By once again calculating the difference in time between these two moments, the duration of the execution phase (with follow-through) was obtained. The sum of the durations of the preparatory phase and the execution phase gave the total duration of the shift:



(In the diagram the preparatory phase is shown to be clearly longer than the execution phase. In the course of the study it became evident that the best intonation in shifts is produced when the preparatory phase is in fact longer than the execution phase).

The tape was stopped by the person making the measurements pushing the stop buttom on the video player. This method is not as exact as using an automatic electric switch. A delay of several hundreths of a second was observed between the pushing of the button and stopping of the tape. However, since the same delay appears each time the tape was stopped or started, the final result was not affected and could thus be disregarded as being an inconsequential factor.

All the figures obtained in this way were even numbers, because the running-time indicator of the video tape player run in slow motion advanced two one-hundredths of a second at a time. This is thus the greatest accuracy that can be achieved when taking measurements from the tape player run in slow motion. This is, however, sufficiently great accuracy under the conditions in which the investigation was carried out. The figures appear alternating between upward and downward shifts: numbers 1,3,5,7 and 9 represent upward shifts and numbers 2,4,6,8 and 10 downward shifts (cf. Appendix 12). o, + or - appears after the numbers expressing the duration of the preparatory and execution phases, indicating whether the final note of the shift was played in tune (= o), sharp (+) or flat (-).

The quality of pure intonation produced was evaluated by the planner of this study by listening to the tape several times one after the other. In addition, the comments made by two members of the jury about these evaluations were subsequently taken into consideration.The following abbreviations were used in Appendix 12: PREP = duration of the preparatory phase, EXEC = duration of the execution phase, PREP + EXEC = total duration of both phases, INT = intonation, $\overline{X}$ = average, IT = initial trial, FT = final trial.

9. The Reliability of the Evaluation of Intonation.

The reliability of the evaluation of intonation was established by comparing the points assigned by the members of the jury. Each performance was evaluated separately (cf.App.4), so that the total number of performances in the initial trial was 5 x 20 = 100 and in the final trial 5 x 20 - 5 = 95 (one participant did not play in the final trial). The average of the points assigned (cf.App.3) was thus not made use of in the establishment of reliability. The correlation matrices formed from the points assigned for each separate performance are calculated separately for the initial and final trials. In this way it can be established if the unanimity of the evaluators was strengthened or weakened during the experiment.

The correlations for the initial trial are on the average satisfactory. This shows that the reliability is fair, so that the assigned points can continue to be used as the basis of the investigation. It is true that one strikingly weak correlation appears in the matrix (.3352). The correlations for the final trial are considerably better. It would appear that the members of the jury had learned to evaluate intonation more unanimously than during the initial trial. It may also be that the improved intonation of the participants in the final trial was more unambiguous than in the initial trial, which caused a greater spread of points for the initial trial.

Initial Trial

Correlations	Judge 1	Judge 2	Judge 3	Judge 4
Judge 2	.5730			
Judge 3	.6249	.3352		
Judge 4	.5140	.4227	.6767	
Judge 5	.6346	.5635	.6113	.6206

N of cases = 100

Final Trial

Correlations	Judge 1	Judge 2	Judge 3	Judge 4
Judge 2	.7845			
Judge 3	.7118	.7779		
Judge 4	.6486	.7687	.7215	
Judge 5	.7098	.7166	.6340	.6487

N of cases = 95

10. The Validity of the Experiment.

There has long been a tendency to rely on a strict classification of different types of validity: e.g., predictive validity (if a correlation between a given ability and future achievement can be shown), content validity (if a given ability is tested directly) and associative validity (when there is correlation between the results of a test and some other measure of achievement (Sloboda 1985, p.235). Nowadays such rigid classifications are being abandoned. Cronbach is of the opinion that "construct validity" is at the basis of all types of validity. He writes: "The end goal of validation is explanation and understanding. Therefore, the profession is coming around to the view that ALL validation is construct validation" (Cronbach 1984, p. 126). Construct validation evaluates the truthfulness of a description (e.g. how do "introverts" act in special social situations).

A test is valid if it measures only that factor that it has been constructed to measure. It is often difficult to define the criteria used to establish the validity of a test. E.g., in tests of musicality, one cannot consider the statements of teachers concerning their pupil's musicality to be a criterion of validity: musicality explains only 50% of the variances among such statements (Lotti 1988, p.47). A test of musicality that also measures, e.g., intelligence, success in school, endurance, ability to concentrate, dexterity, etc., does not fulfill the conditions demanded of a test.

The validity of our experiment can be divided into two parts:

1. Was intonation actually measured in the experiment (the jury's part).
2. Was the influence of shifting factors actually measured in the experiment (the part related to the structure of the experiment).

The validity of the jury's contribution cannot be directly calculated. However, when consideration is taken of their many years of experience and their great expertise in evaluating intonation in violin playing, it can be considered probable that the jury was competent and that its members did evaluate intonation and not other aspects of violin playing.

A possible source of error is the fact that the members of the jury were all experienced in evaluating both "concrete" and "artistic" intonation in connection with performed works of music, in which situation the definition of pitch is relative and to some degree a matter of taste. This means that during an artistically impressive performance, some members of the jury might give relatively high points for intonation although the pitch differences involved might not always strictly speaking correspond to the demands of concrete intonation. Artistic sensitivity and interpretive intensity are exceedingly difficult to divorce from intonation, nor is it even desirable to do so in standard evaluations of musical performances. It can be assumed that the jury's easiest task was in evaluating the performances of the Flesch *Skalensystem* - involving so-called "pure" intonation. The jury was more unanimous in evaluating the final trial than the initial trial. This would indicate that the jury was able to make more efficient evaluations in the final trial than in the initial trial.

In this study the contribution of the ear in the determination of intonation was eliminated. The violins of the participants were in good condition and had suitable proportions. The strings were unflawed and pure in intonation. Thus it was possible to investigate the third factor influencing intonation: the physical movements involved in shifting. The pieces played represented two clearly distinct levels of difficulty: the pieces played in the ear test did not (with very few exceptions) contain changes in position. The relatively high points for intonation achieved showed that the pieces played in the ear test were easy for a person with a practiced violin ear. The situation changed completely, however, in the course of the initial trial: a great many shifts, in which the player often had to move his or her left hand over the edge of the violin and carry out repeated shifts in rapid succession in the high positions, made the playing of these pieces problematical precisely because of the shifts. The idea that playing the violin would be easy if it were not necessary to shift appeared for the most part to hold true: the number of points awarded for intonation decreased sharply compared to those given in the ear test. One can thus with good cause assume that what was investigated in the initial and final trials was indeed the influence of shifting on intonation in violin playing.

F. THE RESULTS.

1. The Points Received in the Ear Test.

The role of the ear was eliminated surprisingly easily, as will be seen from what follows. This was done by finding that participant (or participants) receiving the lowest points. If the average of the points this participant received was at least in the high range of "good" (cf.point scale,p.228 above) the matter was clear: a violinist with a "good" ear would qualify for participation in the main experiment, and so all those receiving more points would also qualify.

The matter was settled rather quickly, because 4 of the jury’s 5 members gave the lowest number of points to the same participant for the playing of the Flesch triad exercise: the points given by these 4 members were 16,12,14 and 16. This indicates that the jury’s principles of evaluation were to a great extent in agreement with each other. Since 12 points and 14 points still represent a "good" ear, 16 represents the lower range of "excellent" and the average of 15,6 (including 20 points awarded by the fifth member of the jury) was almost "excellent", it can be concluded that the ear of the participant receiving the fewest points could be depended on in the main experiment.

It is also worth noting that the average numbers of points received by all the other participants was at least "excellent". This means that any faulty intonation occurring in the main experiment was not due to any deficiencies in the ability of the participants’ ability to hear good intonation, i.e., lack of training or experience. The number of points received by the poorest performing participant could be treated even more objectively, viz., by leaving out the lowest and highest points received (12 and 20 respectively) in the calculation of the average. The average of the remainig points (16,16,14) would be 15,3, i.e., in the high range of "good".

In the evaluation of the intonation achieved in the Ave Maria, three members of the jury gave the same participant (a different person than in the Flesch) the lowest points (16,15,18). In addition, the remaining two members of the jury awarded this same participant the next to lowest number of points (19,19). Thus the average of the points given to the participant with the weakest intonation in the playing of the Ave Maria was 17,4,viz., a respectable "excellent". There was thus no cause for criticizing his ear.

Listed below are the averages of the points awarded by the jury for the ear test pieces. Since the participants knew in which order they had played, the averages were listed, for reasons of tact, in ascending order from poorest to best result in the Flesch exercise. Each participant's average point score in the Ave Maria is on the same line as his or her score in the Flesch exercise:

Flesch	Ave Maria
15.6	20.8
16.4	17.4
16.4	19.4
17.4	19.6
17.6	17.8
18.0	19.6
18.5	18.4
18.6	20.0
19.2	21.4
19.5	19.4
19.8	21.6
20.0	20.0
20.0	20.6
20.0	20.6
20.4	20.0
20.6	21.6
21.0	18.8
21.2	20.2
21.4	21.4
22.0	22.6

The correlation between the points received for the Flesch exercise and the Ave Maria is .74.

From this it can be seen that the "violinist's ear" of all the participants was sufficiently practiced to satisfy the demands of the production of good intonation on the violin. The contribution of the ear in determining intonation in shifting can thus be dispensed with in the main experiment.

2. Questionnaire in Connection with the Ear Test.

After the ear test each participant was given a questionnaire and asked to answer the following questions:

1. Which of these two ear test pieces did you play best? Or did you play them equally well ?
2. If you played one less well, what was the reason? Were there difficult parts or things in it ?
3. Which was more fun to play ?
4. Were you relaxed during the test or were you a) somewhat b) very nervous?
5. Were your hands cold and clammy, or were they warm ?
6. Was the atmosphere of the test situation the same as or different from. e.g., recording a concert ?
7. Do you practice scales a) regularly b) occasionally c) not at all?
8. Have you ever played the sort of etudes in which primarily changes of position are practiced (e.g, some violin tutor or Sevcik, Opus 8) ?
9. What do you think is the most important thing in shifting ?

More than half (12) of the participants experienced the test situation as being similar to that of recording a radio or TV performance. The remaining 8 experienced it as being slightly different. Most of the participants (15) were somewhat nervous and one of them was quite nervous. Four felt no nervousness at all. The fingers of 11 of them felt cold (and usually a bit clammy), but 9 had warm fingers. 13 of them thought the Ave Maria was most fun to play, 3 preferred Flesch, and the remaining 4 rated them equally. 17 of the participants claimed that they practiced scales regularly and 3 of them checked "occasionally".

3. Intonation in Relatively Long and Short Shifts.

The relatively long and relatively short shifts in **Malaguena** were made use of to investigate if good intonation is more difficult to achieve in performing shifts over long intervals than over short intervals. There were a total of 78 relatively long shifts upward (octave jumps) performed and the same number of relatively long shifts downward (major sixths and fifths). Two types of relatively short shifts were investigated:

1. Upward shift on the same finger (2-2) over a major second (total = 78).
2. Downward shift from lower to higher finger (1-2) over a major third (total = 78).

Of the total number of 78 shifts investigated, 40 were in the initial trial, 38 in the final trial, since one participant did not play in the final trial. The results were as follows (cf.Appendices 5, 6 and 7):

Relatively long shifts (octave jump upward):
Total 78 : In Tune 51, Sharp 13, Flat 14.

Relatively long shifts (major sixths and fifths downward):
Total 78 : In Tune 37, Sharp 33, Flat 8.

Relatively short shifts (major seconds upward):
Total 78 : In Tune 41, Sharp 8, Flat 29.

Relatively short shifts (major thirds downward):
Total 78 : In Tune 36, Sharp 41, Flat 1.

Of the 78 octave jumps performed 51 were successful and 27 failed. On the 40 attempts in the initial trial, 15 failed (i.e., more than 30%) and of the 38 attempts in the final trial, 12 failed (i.e., nearly 30%). Of the 78 relatively long shifts downward 37 were successful and 41 failed, i.e., over 50%. This supports the general opinion that balance problems are greatest in downward shifts. In relatively short shifts upward 41 of 78 were successful and 37 failed. Of 78 downward shifts 36 were successful and 42 failed. Both relatively long and short downward shifts often remain too short.

When interviewed, the participants were asked if they thought long jumps were more difficult than short shifts. It was expected that they would answer positively. But this was not the case: in the opinion of 12 participants short shifts were either more difficult (6 participants) or the degree of difficulty depended on the situation (6 participants), i.e., on the tempo, fingering, intervals or positions involved.

However, 8 participants had some sort of prejudice toward long shifts (e.g., "a long shift is more difficult because it takes longer to perform"). There is, of course, a realistic basis for this type of thinking: in a long jump the fingers have to release contact with the fingerboard for a longer period of time than in a short shift. It is precisely this release of contact with the fingerboard that causes a feeling of insecurity for some players. There are four reasons for this:

1. Lack of ability to hear the final note sufficiently precisely in advance.
2. Weak feeling of contact with the fingerboard ("sense of shifting").
3. There is no controlled balance of the arm before the shift is begun.
4. Too little time is used to perform the shift.

We will not go into the first two points here. The third means that a player who is used to letting his left arm hang down from the neck of the violin (in which case the arm is not balanced) loses all feeling of support and security when his fingers have to release contact with the fingerboard in order to perform the jump. The longer the shift lasts, the longer the player suffers from the feeling of insecurity. It is now no longer a question of prejudice, but of fact: for the player who does not master the fundamental balances in respect to the left arm, long jumps are actually more difficult than short shifts. In order to escape the feeling of insecurity as quickly as possible, he hurries the shift. This introduces an element of uncertainty into the shift and results in poor intonation.

The results of this study do not indicate, however, that long shifts are more difficult than short shifts. Quite to the contrary, greatest success was achieved in long shifts **upward.** The second best results were achieved in short shifts **upward.** The poorest results were achieved in both long and short shifts **downward** (respectively 37 and 36 shifts of 78 in tune). Insecurity due to lack of balance appeared to cause trouble for the participants in downward shifts especially (audiovisual analysis). Thus long shifts were not on the average less successful than short shifts. It would appear that it is not the **extent** of the shift that affects ease or difficulty of execution, but rather the degree of difficulty is determined by the **direction** of the shift.

The following conclusions can be drawn on the basis of all this: if shifting technique has been mastered, long jumps cause no special difficulties. There are many components of shifting technique that must be joined seamlessly together in performing both short and long shifts: the fundamental balances, the use of glissando, the correct configuration of the movement, the correct coordination of the various segments of the movement, and the proper timing of the movement as a whole. If a player has deficiencies in any component part of shifting technique, he will have difficulties with short as well as long shifts. Surprisingly many participants shared this view, as is seen by their responses reported earlier.

The fact that there were extremely many notes played out of tune in performing both relatively long and short shifts would seem to indicate that a) the mental images of the pieces were not clear and the pieces had not been practiced sufficiently and were thus not familiar enough and that b) familiarity in this case would mean the mastering of numerous shifts. Since the shifts were not mastered, the result was poor intonation.

4. Poor Intonation in Relatively Long and Short Shifts in Two Balance Groups.

It was impossible to check the balance or imbalance of the hand position of the participants for each single shift. However, it was possible to divide the participants into two balance groups (cf.,p.265 below) on the basis of audio-visual analysis. The final notes of shifts performed in the initial and final trials were treated separately. The number of notes out of tune (a maximum of 4 in each case) in each group was as follows (P = participant):

INITIAL TRIAL

P	balance		imbalance	
	long	short	long	short
1			2	2
2			3	3
3			2	3
4			2	2
5	2	1		
6	1	1		
7	1	2		
8	2	2		
9			2	3
10			1	4
11			2	4
12			1	2
13			2	4
14			1	3

FINAL TRIAL

P	balance		imbalance	
	long	short	long	short
1			1	2
2	1	1		
3	1	1		
4			3	2
5	1	1		
6			0	1
7	1	2		
8	2	1		
9			3	4
10	2	2		
11			3	1
12	1	2		
13	2	3		
14			1	3

P	balance long	balance short	imbalance long	imbalance short
15	3	2		
16			1	0
17			2	3
18			3	1
19	3	1		
20	0	1		
$\overline{X}$=	1.71	1.43	1.85	2.62

P	balance long	balance short	imbalance long	imbalance short
15	2	1		
16	2	0		
17			3	4
18			1	3
19	2	1		
$\overline{X}$=	1.55	1.36	1.88	2.50

It can be seen from the averages that those participants whose left hands appeared to be in balance on the basis of audio-visual analysis played appreciably fewer notes out of tune than the participants belonging to the other group. The former group played relatively long shifts more poorly than relatively short shifts. In the case of those whose hands were not in balance, the situation was the opposite: they played out of tune more often in relatively short shifts than in relatively long shifts. Even though this result is surprising, there is a natural explanation for it: participants whose left hands were not in balance probably concentrated better on relatively long shifts than on relatively short shifts, which were played carelessly.

The statistical significance of the average differences of the out-of-tune notes occurring in relatively long and short shifts in the playing of the two balance groups was investigated (cf. Appendices 8 and 9). A one-tail T-test showed that the difference in relatively long shifts was not statistically significant. On the other hand, the T-value for relatively short shifts was 3.78. Since the size of the groups was 20 and 18, and the degree of freedom arrived at 36, the level of risk is 0.05%.

5. The Preparatory Phase in Relatively Long Shifts (Sarasate).

Since it seems natural to assume that relatively long shifts require a long preparatory phase in order to be successful,the duration of the preparatory phase of octave jumps was investigated. (cf. Appendix 10). In the initial trial the participants used on the average 0.17 sec. on the preparatory phase of successful octave jumps, and on the average 0.19 sec. in the final trial. Even in successful shifts the preparatory phase was relatively short, with a few exceptions (e.g., participants 1,10,12,13,17). This is probably because it is necessary to save sufficient time for the execution phase of such a shift where the distance to be covered is so long. Part of this time must be taken from the preparatory phase. In any event, the preparatory phase flows so smoothly into the execution phase that they are not really consecutive, but rather interwoven, i.e., the former is still being carried out when the latter begins. When the total duration of the shift (slow beginning, acceleration toward the end) is as it should be and fingertip sensitivity is heightened to the point that it is possible to produce a soft end glissando on the final finger and stop precisely, a short preparatory phase need not result in poor intonation. Everything described above is good shifting strategy.

It was not possible to determine that the preparatory phase plays a decisive role in the production of good intonation in the preformance of long jumps. Factors involving balance, the use of glissando, the regulation of pressure, etc., seem to influence the successful performance of jumps at least as much as the duration of the preparatory phase. However, this last named was part of the picture as a contributory factor.

The following facts seem to support the usefulness of a relatively long preparatory phase: the greater part (7) of the participants who succeeded in performing two long jumps in a row (or all four of them) used a relatively long time on the preparatory phase of the shift (participants 2,5,6,7,8,10,12):

P	sec.	sec.		
2:	0.20	0.18		
5:	0.24	0.22		
6:	0.18	0.14		
7:	0.20	0.46	(cf. following table)	
8:	0.22	0.16		
10:	0.28	0.28		
12:	0.20	0.26	and 0.22	0.16

Four participants (3,7,14,20) who performed both shifts succesfully used little time on the preparatory phase:

P	sec.	sec.		
3:	0.16	0.14		
7:	0.14	0.14	(cf. table above)	
14:	0.12	0.18	and 0.14	0.14
10:	0.14	0.10		

Most of those participants who performed one or the other of the jumps successfully used more time on the preparatory phase of the successful shift than of the unsuccessful shift (participants 1,5,8,10,11,13,15,16,17,19). The situation was exactly the opposite in the case of some participants, who used less time on the preparatory phase of jumps producing good intonation (participants 3,4,9,11,16,18). In some cases it actually seemed as if an exceptionally drawn-out preparatory phase caused poor intonation (participants 3,4,16,18).

In the initial trial the length of the preparatory phases of unsuccessful shifts was on the average 0.28 sec. while in the final trialit was 0.20 sec. There were more unsuccessful shifts performed in the initial trial than in the final trial. Here also it seems that the disproportionately long preparatory phase led to poor intonation. This is quite natural. We will see later that the duration of the preparatory phase must stand in the proper relationship to the duration of the execution phase (cf.p.321 below).

That a relatively short preparatory phase to a long jump can be defended is supported by the fact that in-tune final notes were achieved three times with extremely short preparation (0.10 sec., participants 6,9,11) and that several successful shifts were made on the basis of rather short preparatory phases (cf. App.5 and 10):

P	sec.	sec.	P	sec.	sec.	
3:	0.16	0.14	14:	0.12	0.14	0.14
6:	0.10	0.14	15:	0.14		
7:	0.14	0.14	16:	0.12		
8:	0.16		18:	0.16	0.16	
9:	0.12	0.10	19:	0.14	0.14	
11:	0.14	0.10				

One could have imagined that such high level violinists (most of them had completed the so-called first course in violin at the Sibelius Academy; the third course leads to the final diploma) would have been able to play both jumps in tune. It is easy to "hear" an octave in the mind beforehand, the initial and final positions are comfortably located on the instrument and the fingerings were easy (1-3). One cannot take artistic intonation "freedoms" with an octave, since it is a fixed interval. This also makes the judges' task easier: there is no room for interpretation. An octave is either in tune or not in tune.

Nevertheless only 6 participants managed to play both octave jumps in tune in the initial trial, and only 8 in the final trial. On the other hand, only one participant played both octave jumps clearly out of tune in both trials. Most of them made use of end glissando in the shift in which the initial and final notes are played legato. Many also used end glissando in the first octave jump, with separate bow strokes. This must be considered questionable, and a clear indication that the shifts were not carefully planned ahead of time. Many players turned their bodies to the right before the hand movement initiating the preparatory phase was seen. This is an unnecessary movement that impedes the shift by creating an unnatural body position and imbalance in the hand.

6. The Relationship between Intonation and the Configuration of the Shifting Movement.

6.1. The Influence of Arm Balance on Intonation.

During the audio-visual analysis of shifts special note was made of how, almost without exception, the participants lost left-hand balance when making downward shifts. There are two reasons for this according to Jankelevits: If the thumb, which has been released from the neck of the violin before the shift, is replaced either with too large or violent a movement or too late, the balance of the arm is disturbed.

A shift involves at least momentary loss of normal contact with the violin. Violin teacher Henrik Botvay at the Sibelius Academy has described the situation in the following terms: Shifting is similar to parachuting, where there is no contact with ground. If the entire left arm is not able to provide support for the execution of a horizontal concept of playing, a downward shift automatically results in severe wavering and insecurity. This was clearly corroborated in this experiment.

The relationship between balance and the average value of all points received for intonational accuracy is given in the table below. For the sake of comparison, the initial and final trials were treated separately. (CG = Control Group, TG = Test Group):

INITIAL TRIAL

P	balance jury points	imbalance jury points
CG 1		12.64
TG 2		11.24
TG 3		13.76
CG 4		14.32
TG 5	16.72	
TG 6	15.72	
TG 7	16.56	
CG 8	14.84 ?	
CG 9		13.24
TG 10		16.16 ?
CG 11		11.68
TG 12		12.68
TG 13		15.84
CG 14		17.20
TG 15	15.48	
CG 16		15.96
TG 17		14.48
CG 18		15.60
CG 19	17.76	
CG 20	17.68	
	$\overline{X}$ = 16.39	$\overline{X}$ = 14.22

FINAL TRIAL

P	balance jury points	imbalance jury points
CG 1		14.16
TG 2	15.64	
TG 3	16.68	
CG 4		13.24
TG 5	18.96	
TG 6		16.12
TG 7	18.80	
CG 8	17.28	
CG 9		13.68
TG 10	17.08	
CG 11		13.32
TG 12	15.48	
TG 13	18.00	
CG 14		20.04
TG 15	16.36	
CG 16	17.44	
TG 17		13.88
CG 18		14.20
CG 19	18.04	
	$\overline{X}$ = 17.25	$\overline{X}$ = 14.83

As can be noticed, the overall average is well below the lower limit of the "excellent" range (16 points) in shifts in which there appeared to be a state of imbalance. There were exceptions, marked by ? on the table.

The participants were divided into two groups according to whether they appeared, on the basis of audio-visual analysis, to achieve good or at least fair balance (1), or whether such balance was obviously lacking (o). The significance of the average differences between the intonation points achieved in the two groups was calculated by means of a one-tail T-test. The value of T obtained for the initial trial was -2.80. Since the size of the two groups was 7 and 13, and the degree of freedom 18, the level of risk is 1%. For the final trial the T-value was -3.05. Since the size of the groups was 11 and 8 and the degree of freedom 17, the level of risk is 0.5%.

6.2. The Relationship of the Playing Position to Intonation.

The audio-visual analysis revealed that many of the participants had difficulty shifting, especially in the higher positions, because the necks of their violins pointed toward the floor. Auer drew attention to this (Auer,1921,p.11) by pointing out that the neck of the violin should always be held high, so that shifting in the higher positions does not become unnecessarily difficult.

The video tape showed that those participants who held the necks of their violins in a horizontal position produced fewer examples of poor intonation in shifts than those whose violin necks pointed to the floor. For the purpose of comparison the initial and final trials were treated separately. (CG = Control Group, TG = Test Group):

INITIAL TRIAL			FINAL TRIAL		
P	neck down jury points	neck horizontal jury points	P	neck down jury points	neck horizontal jury points
CG 1	12.64		CG 1	14.16	
TG 2	11.24		TG 2		15.64
TG 3	13.76		TG 3	16.68	
CG 4	14.32		CG 4	13.24	
TG 5		16.72	TG 5		18.96
TG 6	15.72		TG 6	16.12	
TG 7		16.56	TG 7		18.80
CG 8		14.84 ?	CG 8		17.28
CG 9	13.24		CG 9	13.68	
TG 10		16.16	TG 10		17.08
CG 11	11.68		CG 11	13.32	
TG 12		12.68 ?	TG 12		15.48
TG 13		15.84	TG 13		18.00
CG 14		17.20	CG 14		20.04
TG 15		15.48	TG 15		16.36
CG 16		15.96	CG 16		17.44
TG 17	14.48		TG 17	13.88	
CG 18	15.60		CG 18	14.20	
CG 19		17.76	CG 19		18.04
CG 20		17.68			
	$\overline{X}$ = 13.63	$\overline{X}$= 16.08		$\overline{X}$ = 14.41	$\overline{X}$ = 17.56

As can be seen from the table, not one participant who held the violin with the neck pointing down scored up to the range of "excellent" (16) in the initial trial. In the final trial participants who held the violin neck down exceeded the average value of "excellent" only twice. In addition, most of those playing with the necks of their violins pointing down received the lowest points in the initial trial (participants 1,2,3,4,9,11,and 17). The exception was participant 12, whose playing position appeared to be natural, but who had the fourth lowest average (12.68). In the final trial this player improved his results noticeably (15.48) by improving balance.

In the final trial, of those players who held the necks of their violins down (total of 8), 3 (participants 4,17 and 18) had overall averages weaker than in the initial trial. The remaining 5 improved their results despite the fact that the poor playing position in which they held their instruments remained the same. Participant 2, who was the only one of those players who held their violins with the necks down in the initial trial who improved his playing position in the final trial, improved his average by far the most (4.40 points).

The participants were divided into two groups according to how they held the violin: whether its neck was in a horizontal position (1), or whether its neck pointed toward he floor (0). The significance of the average differences between the intonation points achieved in these two groups was investigated by means of a one-tail T-test. For the initial trial the value of T obtained was -3.62, giving a risk level of 0.5% when the size of the groups was 9 and 11 and the degree of freedom was 18. In the final trial the T-value was -4.99, giving a 0.05% level of risk with groups sizes 8 and 11 and degree of freedom 17.

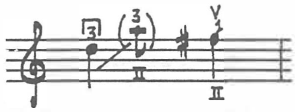
7. The Influence of the Timing of Shifts on Intonation.

7.1. The Influence of Glissando on Intonation.

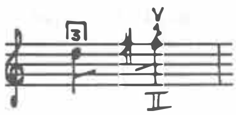
The frequent use of incorrect end glissando revealed a lack of knowledge of glissando on the part of the participants. The following careless use of end glissando was very common in the pieces played during the experiment:

long end glissando (type of shift: "scissoring")

The use of this type of glissando does not, according to modern conceptions, lead to satisfying tonal results. The old German school, represented by such prestigious names as Spohr, David and Joachim, required that the shift shown above should be played either as shown with end glissando (with B as intermediate note) or with initial glissando (with A as intermediate note), thus:



The oscillographic analyses that Jankelevits made of shifts performed by Oistrakh, Tsiganov and Rabinovits showed that these artists carried out the shifts shown above with initial glissando, but without any intermediate note. I.e., the initial glissando faded out toward the end of the shift. In upward shifts, a short glissando on the final finger also appears:



Upward shift with short initial and end glissando, type: "scissoring" (Oistrakh,Tsiganov,Rabinovits).

The same masters played downward shifts using only initial glissando. I.e., the final note was played without glissando (cf. Jankelevits,1983, p.160).

The video tape showed that the use of initial glissando was very often neglected during the experiment at hand, and that end glissando was frequently made use of in shifts where it should have been avoided. Many of the participants used glissando for the most part carelessly, at least in the initial trial, and this caused poor intonation in shifting.

The audio-visual analysis provided the following information about the use of glissando in the Flesch triad exercise: In the initial trial (N = 20) the greater part of the participants performed the shifts with a quick jerking motion. Initial glissando was used by only five players, three of them very slightly. End glissando was used profusely, either systematically or randomly. Often a long end glissando was a disturbing factor at the conclusion of a shift. In the final trial (N = 19) initial glissando was used by ten participants, most of them using it consciously and clearly. Several of the players had also tempered their end glissandos. However, nine participants used only end glissando in the final trial. 10 participants shifted with a quick jerking motion in the initial trial, and 7 in the final trial.

7.2. The Use of Glissando in Shifts.

The audio-visual analysis showed that most of the participants made use of glissando rather carelessly, at least in the initial trial, causing intonation problems. In the initial trial half the participants carried out the shifts with rapid jerking movements. Only four players (N = 20) used initial glissando, three of them only fleetingly. Careless end glissando was used in abundance. In the final trial there were fewer (7) players who shifted with jerking movements, and initial glissando was employed by all of 10 participants.

INITIAL TRIAL (N=20)			FINAL TRIAL (N=19)		
initial gliss.	end gliss.	jerky shift	initial gliss.	end gliss.	jerky shift
4	20	10	10	19	7

The following participants used both initial and end glissando in the final trial: 2,3,5,6,7,10,12,13,14 and 15 (cf. Appendix 20). Nine of them belonged to the test group and one to the control group. These players improved the evaluations they received from the jury by on the average 1.38 points. Participants 1,4,8,9,11,16,17,18 and 19 used only end glissando in both initial and final trial. One of them belonged to the test group and eight to the control group. They improved the evaluations they received in the final trial by an average of 0.33 points. (Included in this calculation are players who received poorer evaluations in the final trial than in the initial trial: in the former group participant 6's evaluation was 0.8 points weaker in the final trial and participant 15's 0.4 points weaker ; in the latter group participant 4 received 2.6 points, participant 17 1.2 points and participant 18 1.6 points less in the final trial.)

7.3. The Variation in Points Received by Participants Using Both Initial and End Glissando in the Final Trial.

Participants Using Both Initial and End Glissando	IT Judges' Evaluat.	FT Judges' Evaluat.	Point Variation
2 TG	10.4	15.8	5.4
3 TG	13.4	15.8	2.4
5 TG	17.2	19.0	1.8
6 TG	15.0	14.2	- 0.8
7 TG	17.0	17.4	0.4
10 TG	14.6	15.2	0.6
12 TG	12.6	14.0	1.4
13 TG	16.6	17.8	1.2
14 CG	16.8	18.6	1.8
15 TG	15.8	15.4	- 0.4
	149.4	163.2	1.38 Average Point Variation

7.4. The Variation In Points Received by Participants Using Only End Glissando in the Initial and Final Trials .

Participants Using Only End Glissando	IT Judges' Evaluat.	FT Judges' Evaluat.	Point Variation
1 CG	13.6	14.6	1.0
4 CG	15.4	12.8	- 2.6
8 CG	14.0	15.6	1.6
9 CG	13.2	13.4	0.2
11 CG	12.6	13.8	1.2
16 CG	14.4	18.8	4.4
17 TG	14.4	13.2	- 1.2
18 CG	15.2	13.6	- 1.6
19 CG	17.4	17.4	0.0
	130.2	133.2	0.33 Average Point Variation

The average point variation is not statistically significant. This is for the most part due to the great internal variation within the groups.

In the final trial, of the 10 participants who made use of both initial and end glissando, four achieved a high "excellent" evaluation for intonation (Flesch, sitting, ♩ =54): 19, 17.4, 17.8

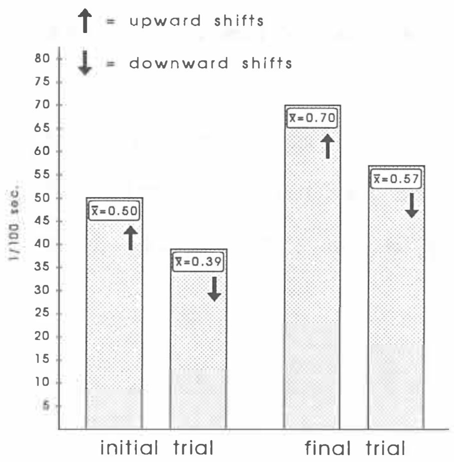
and 18.6). In addition, four more received close to "excellent" evaluations: 15.8, 15.8, 15.2 and 15.4.

Of that group (N = 9) of participants who in both the initial and final trials made use exclusively of end glissando, only two achieved an "excellent" evaluation for intonation: 18.8 and 17.4, plus one participant who received close to an "excellent" evaluation: 15.6.

Thus the group that made use of both initial and end glissando performed the shifts in the final trial considerably better than the other group, that made use exclusively of end glissando. Six members of the former group (N = 10) who did not make use of initial glissando in the initial trial, did make use of it in the final trial (P 2,3,5,10,23 and 13). The change in the average of the evaluations for intonation that they received (the improvement in points received for intonation in the final trial compared to those received in the initial trial) was 2.13 points, which can be considered to be an appreciable improvement.

8. The Average Duration (PREP + EXEC) of Shifts (= the 10 First Shifts, Flesch, sitting ♩ = 54). (Diagram 1).

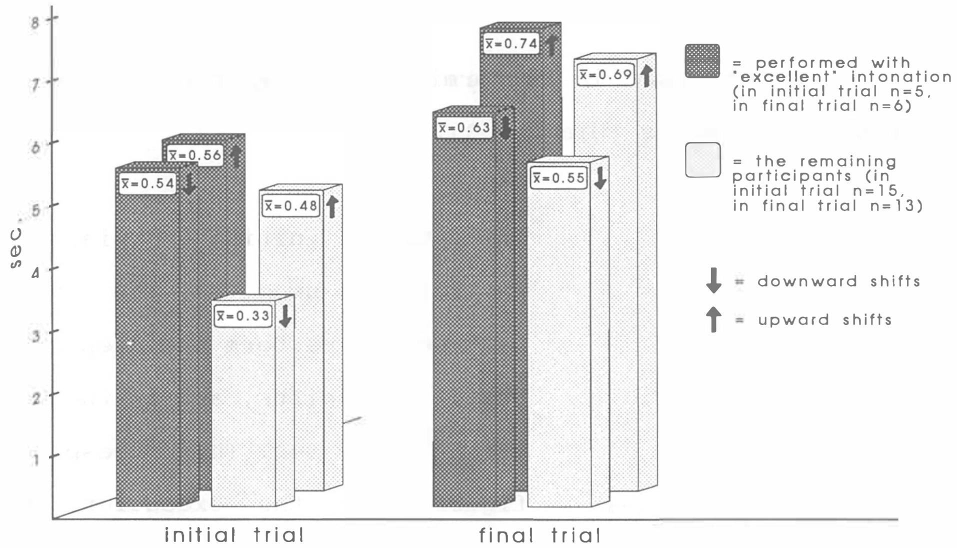
Diagram 1



In the initial trial the participants used on the average 0.50 sec. to perform upward shifts (PREP + EXEC) and 0.39 sec. to perform downward shifts. In the final trial the average total duration of shifts was 0.70 sec. (upward shifts) and 0.57 sec. (downward shifts) (cf. Appendix 11).

9. The Average Duration (PREP + EXEC) of Shifts (= the 10 First Shifts) Performed by Participants Receiving "Excellent" Evaluations Compared to the Duration of Shifts Performed by the Remaining Participants (Diagram 2).

Diagram 2

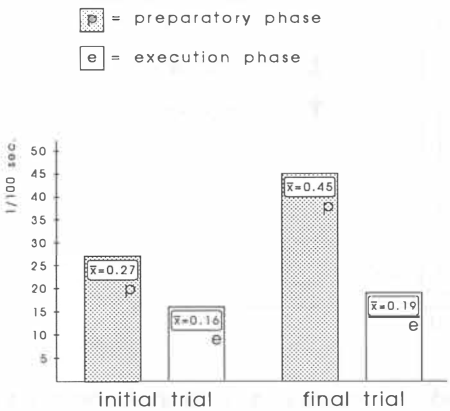


Those participants (N = 5) who received intonation evaluations of "excellent" in the initial trial used on the average 0.56 sec. to perform upward shifts (PREP + EXEC) and 0.54 sec. to perform downward shifts. In the final trial the total duration of their (now N = 6) shifts was 0.74 sec. (upward shifts) and 0.63 sec. (downward shifts). Those participants who did not receive intonation evaluations of "excellent" in the initial trial (N = 15) used respectively on the average 0.48 sec. and 0.33 sec. for these shifts. For the final trial the respective figures were 0.69 and 0.55 sec.:

The differences in average duration are not significant, but they are symptomatic and indicate that it is necessary to use sufficient time in order to perform shifts successfully (those receiving "excellent" intonation evaluations succeeded in performing shifts on the average better than the others).

10. The Average Time Used in Performing the Preparatory Phase and Execution Phase of Shifts (Diagram 3).

Diagram 3



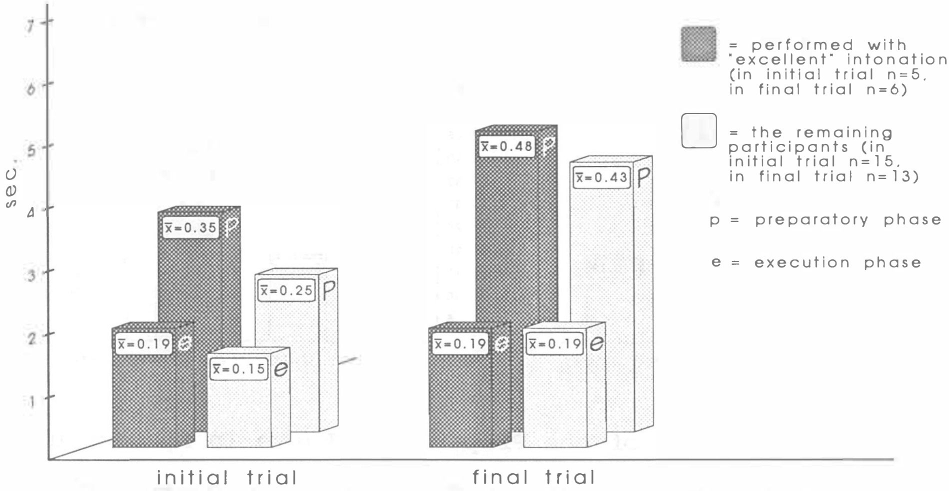
In the initial trial the participants used on the average 0.27 sec.to perform the preparatory phase of shifts, and in the final trial 0.45 sec. The corresponding figures for the execution phase were 0.16 sec. and 0.19 sec. (cf. Appendix 12).

11. The Average Duration of the Preparatory and Execution Phases of Shifts Performed by Participants Receiving "Excellent" Evaluations and by the Remaining Participants (Diagram 4).

Participants who received intonation evaluations of "excellent" used on the average 0.35 sec. on the preparatory phase of shifts in the initial trial and 0.19 sec. on the execution phase. The corresponding figures for other participants were 0.25 and 0.15 sec.. In the final trial the corresponding figures were 0.48 and

0.19 sec. for those receiving "excellent" evaluations, and 0.43 and 0.19 sec. for the remaining participants:

Diagram 4



12. The Average Duration of the Preparatory and Execution Phases in Successful Shifts in the Final Trial (Flesch, sitting, ♩ = 54).

(Diagrams 5 and 6).

In successful shifts upward (N = 57) the participants used on the average 0.54 sec. on the preparatory phase. In successful shifts downward (N = 55) the corresponding figure was 0.33 sec. (Three greatly diverging values were left out in the calculation of this average.) The average durations for the execution phase of successful shifts were: upward 0.20 sec. and downward 0.19 sec.. The average total duration of successful shifts upward was 0.74 sec. and of successful shifts downward 0.52 sec.:

Diagram 5

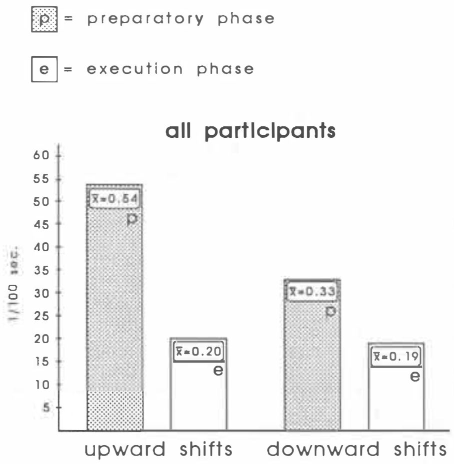
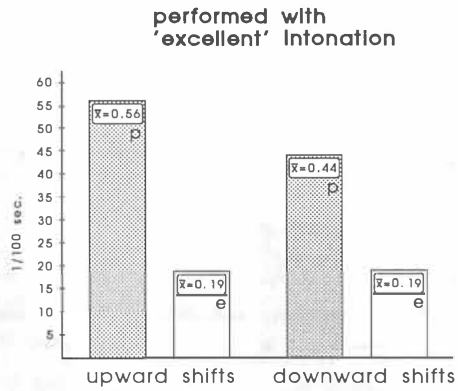


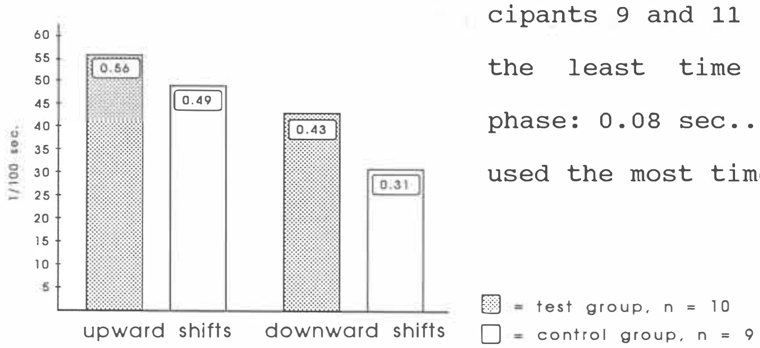
Diagram 6



13. The Average Duration of the Preparatory Phase in Successful Shifts Performed by Members of the Test Group and Control Group in the Final Trial. (Diagram 7)

It is interesting that the duration of preparatory phases in successful shifts upward performed by members of the test group in the final trial is exactly the same (0.56 sec.) as that of participants who received "excellent" evaluations for intonation. Members of the control group used on the average 0.49 sec. on the preparatory phase of shifts upward. The corresponding figures for shifts downward were 0.43 sec. (test group) and 0.31 sec. (control group):

Diagram 7



Participant 6 (test group) and participants 9 and 11 (control group) spent the least time on the preparatory phase: 0.08 sec.. Participant 6 also used the most time: 0.84 sec..

14. The Duration of the Execution Phase in Shifts Upward and Downward.

The total duration (PREP + EXEC) of upward and downward shifts is not necessarily always the same, since the total duration includes the duration of the preparatory phase, and this bears no direct relationship to the extent of the shift to be performed. On the other hand, the execution phases of shifts upward and downward should be approximately of the same duration for the following reasons: the pairs of shifts in the passage in question (i.e., Flesch , shifts 1-2, 3-4, 5-6, 7-8 and 9-10) are of the same extent. E.g., as shown in Diagram 8 for shifts 1-2. The notes of each pair, and thus also the extent of the shifts, are identical.

Diagram 8

Thus when the tempo remains the same the execution phases of the shifts must be just about equal in duration, otherwise the rhythmical impression given is faulty.

The mechanical performance of an upward shift differs from that of a downward shift, and this affects the timing of shifts. One can see from Appendix 13 how much time the participants with "excellent" intonation and the remaining participants used on the execution phases of upward and downward shifts in both the initial and final trials.

The average variation in the duration of execution phases (0.04 and 0.03 sec.) shows that the duration of the execution phase can vary somewhat. Differences of 0.01 - 0.04 sec. do not produce any impression of rhythmical inaccuracy, nor is intonation disturbed.

Participant 4 , however, demonstrated poor intonation in the final trial due to large variations in the duration of the execution phase. In the initial trial the variations in the duration of the execution phase of this participant were only 0.01 sec., and the jury gave a quite acceptable rating of 15.4. In the final trial the timing of this same participant's shifts was such that the variation between the durations of execution phases in the initial and final trials was strikingly great : 0.17 sec.. The rating given by the jury was now 12.8.

A close study of the durations of execution phases shows quite clearly, however, that correct duration of the execution phase does not by itself guarantee good intonation. There were participants who demonstrated quite acceptable durations of execution phases (in some cases precisely the same in both trials), but who nevertheless did not receive "excellent" ratings for intonation.

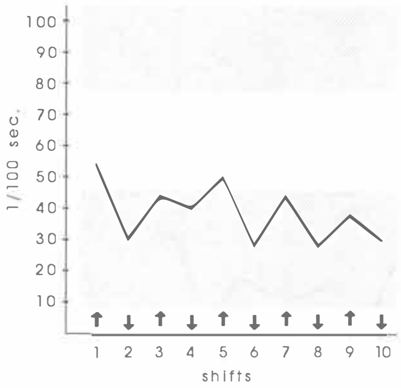
15. The Structure of the Total Duration of Shifts Performed by Participants Receiving "Excellent" Evaluations for Intonation.

That there is a difference in the mechanics of performance of upward and downward shifts is indicated by the following diagrams charting their respective total durations. These are based on the shifts performed by participants receiving "excellent" evaluations for intonation. As will be noticed, there are many similar and many contradictory features. In referring to the following diagrams, the term Ratio between total durations means the ratio of the durations of downward shifts to the durations of upward shifts charted in the same diagram (expressed in decimal form). The term Change in total

<u>durations</u> means the difference between the average length of all durations in the initial trial and the average length of all durations in the final trial. When comparing the points assigned by the jury to the number of notes in tune, it must be remembered that the notes in tune are counted for only one assignment,viz., Flesch ,sitting, ♩ = 54.

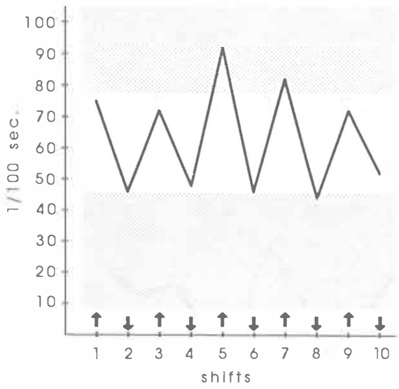
↑ = upward shifts (N=5) ,↓ = downward shifts (N=5), IT = initial trial, FT = final trial.

Diagram 9 ; P 5 (IT)



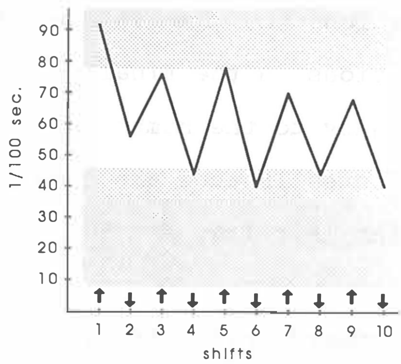
Jury points: 17.2
Notes in tune: 8
Ratio between total durations: 0.68.

Diagram 10 ; P 5 (FT)



Jury points: 19.00
Notes in tune: 8
Ratio between total durations: 0.60.Change in total durations: 0.24 sec.

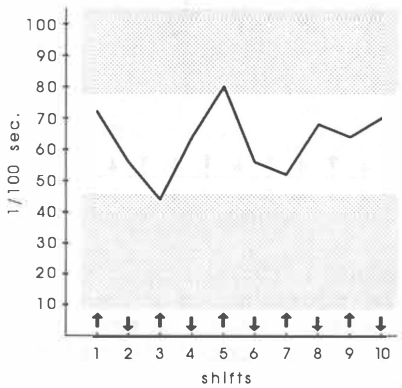
Diagram 11 ; P 16 (FT)



Jury points: 18.8.Notes in tune:8 Ratio between total durations: 0.58. Change in total durations: 0.02 sec.(cf.P 16 IT p.296 below).

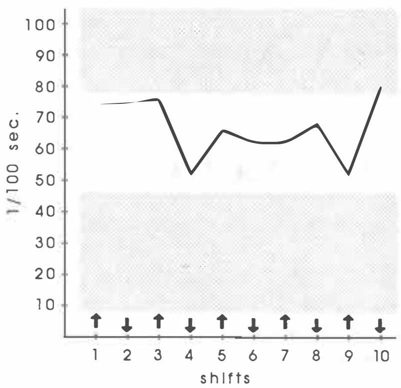
The durations of shifts performed by P 5 and P 16 in the final trial plot out as quite steep "sawtooth" curves , showing that they consistently used more time in performing the upward shifts than the downward shifts ("ideal limits " were obtained by calculating the average of the total durations of shifts performed by P 5 and P 16: upper limit =78,lower limit=46).

Diagram 12 ; P 14 (IT)



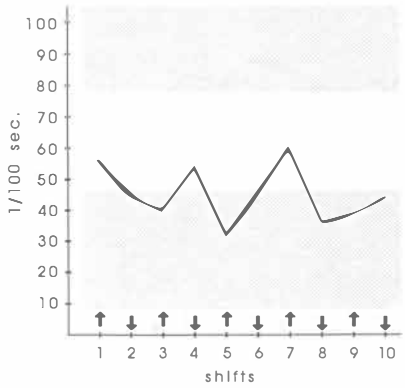
Jury points: 16,8
Notes in tune: 5
Ratio between total durations: 1.01
In three pairs of shifts the total duration is larger in the downward shift than in the upward shift.

Diagram 13 ; P 14 (FT)



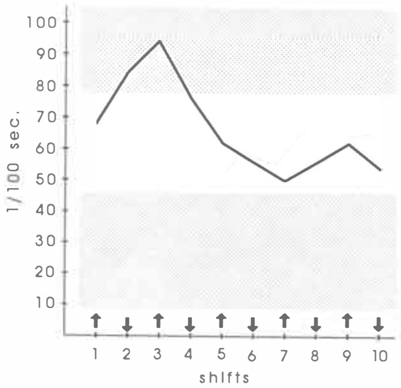
Jury points: 18.6. Notes in tune:5
Change in total durations:0.04 sec.
Ratio between total durations: 1.02
The graph is aberrant and the jury evaluation questionable : there were only 5 notes in tune (in fact, the jury evaluated all 14 notes and 3 of the last 5 were in tune.)

Diagram 14 ; P 13 (IT)



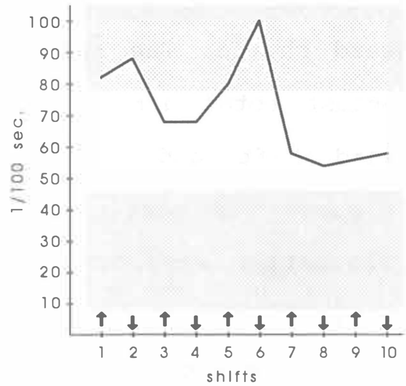
Jury points: 16.6
Notes in tune: 7
Ratio between total durations: 0.98
Mild sawtooth curve, but in three pairs of shifts more time was spent on the downward shifts than on the upward shifts.

Diagram 15 ; P 13 (FT)



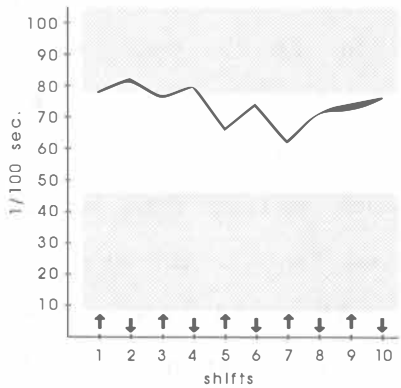
Jury points: 17.8
Notes in tune: 7
Change in total durations: 0.21 sec.
Ratio between total durations: 0.97. A surprisingly good result considering the form of the curve.

Diagram 16 ; P 19 (IT)



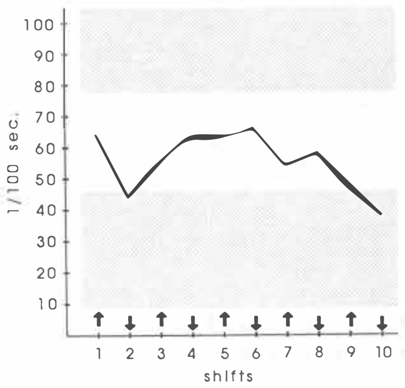
Jury points: 17.9
Notes in tune:6
Ratio between total durations 1.07
Disturbance of balance in the middle of the series of shifts.

Diagram 17 ; P 19 (FT)



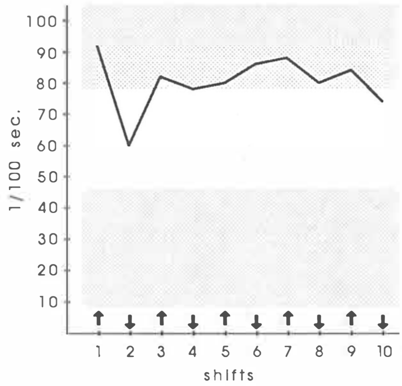
Jury points: 17.4
Notes in tune: 6
Ratio between total durations 1.08
Change in total durations:0.03sec.
Mild sawtooth curve, in which more time is systematically spent of the downward shifts than on the upward shifts.

Diagram 18 ; P 7 (IT)



Jury points: 17
Notes in tune: 8
Ratio between total durations: 0.96
In three pairs of shifts more time is spent on the downward shifts than on the upward shifts.

Diagram 19 ; P 7 (FT)



Jury points: 17.4. Notes in tune: 8. Ratio between total durations: 0.89. Change in total durations: 0.25 sec. More time is spent on the downward shift than on the upward shift in only one pair of shifts.

Participants who received "excellent" evaluations for intonation used on the average 0.66 sec. in the performance of upward shifts and 0.58 sec. in the performance of downward shifts. The largest average variation between longest and shortest total duration of shifts in both trials was 0.23 sec. for upward shifts and 0.21 sec. for downward shifts. (The corresponding figures for participants who received "excellent" evaluations for intonation were 0.28 and 0.24 sec.) It would appear that lengthening the duration of an upward shift somewhat has no detrimental effect on the shift. The upward shifts in which the total durations were exceptionally long (0.94, 0.92, 0.92 and 0.92 sec.) were all successful, i.e., in tune. On the other hand, the one downward shift in which the participant in question spent an entire second on the preparatory phase of the shift, was out of tune.

Participants 5 and 16 received the highest evaluations for intonation in the final trial: 19.00 and 18.8. The extremes for the total durations of upward shifts performed by the former were 0.72 ← → 0.92 sec. and for downward shifts 0.44 ← → 0.52 sec.The corresponding extreme durations of shifts performed by the latter were 0.68 ← →0.92 and 0.40 ← → 0.56 sec.. All other total durations of shifts performed by these participants were located between these values.

The temporal structure of the total durations of shifts performed by these two participants who received the highest evaluations for intonation differed from that of other participants who received "excellent" evaluations for intonation in two respects. The curves plotted from the values of the durations of shifts performed by the former two in the final trial are sharp, regular sawtooth curves in which almost half again as much time is systematically used on upward shifts as on downward shifts. The ratio between total durations of downward to upward shifts performed in the final trial by participant 5 was 0.60 and that of participant 16 0.58. The temporal structure of shifts performed by other participants who received (slightly lower) "excellent" evaluations for intonation produced either mild sawtooth curves or completely irregular curves.

The mild sawtooth curves (produced by P 5 (initial trial), 7,13,14 and 19) were caused partly by the fact that, with a single exception (P 5,IT), the upper prongs of the curves represented the values of the durations of downward shifts: in other words the participants used more time performing shifts downward than upward. In the case of participant 19 this phenomenon made its appearance with complete consistency in both trials.

Participants 13 and 14 (jury points: 17.8 and 18.6 respectively) achieved these unexpectedly good evaluations despite the irregularity of the temporal structure of their shifts. The jury rating of the latter is, however, somewhat questionable: the number of notes in tune was only 5 (out of 10). The jury actually rated all 14 shifts; of the last four shifts, three were in tune. This perhaps explains the high evaluation received by P 14.

16. The Relationship between the Preparatory and Execution Phases in Shifts of Exceptionally Long and Short Duration.

In the upward shift in which P 5 used a total of 0.92 sec., the preparatory and execution phases were respectively 0.66 and 0.26 sec. in duration. In the shift performed by P 16 having a total duration of 0.92 sec., the durations of the preparatory and execution phases were respectively 0.80 and 0.12 sec.. Two other participants performed upward shifts of exceptionally long duration; the durations of the preparatory and execution phases in these cases were P 13: 0.72 + 0.22; P 7: 0.78 + 0.14. These were successful shifts. The ratio (expressed in decimal form) of the duration of the execution phase to the duration of the preparatory phase of these four shifts of exceptionally long duration were: P 5: 0.39, P 16: 0.15, P 13: 0.31, P 7: 0.18.

Thus, bold prolongation of the preparatory phase and shortening of the execution phase has no detrimental effect on upward shifts. However, it should be noted that the difference between the duration of preparatory and execution phases in the shifts of the participant (P 5) who received the best evaluation for intonation was moderate. In the shifts upward in which the preparatory phases were exceptionally short, the ratio (expressed in decimal form) of the duration of the execution phase to the duration of the preparatory phase of shifts performed by those participants who received "excellent" evaluations for intonation was as follows:

	Ratio PREP : EXEC (sec.)		Ratio PREP : EXEC (sec.)
P 5 :	0.72 (0.22 : 0.16) (IT)	;	0.57 (0.46 : 0.26) (FT)
P 16:	0.21 (0.56 : 0.12) (FT)		
P 14:	0.57 (0.28 : 0.16) (IT)	;	0.37 (0.38 : 0.14) (FT)
P 13:	1.0 (0.16 : 0.16) (IT)	;	0.79 (0.28 : 0.22) (FT)
P 19:	0.40 (0.40 : 0.16) (IT)	;	0.35 (0.46 : 0.16) (FT)
P 7 :	0.21 (0.36 : 0.08) (IT)	;	0.38 (0.58 : 0.22) (FT)

With the exception of the shift performed by P 14 in the initial trial, all these shifts were successful, i.e., in tune. In these shifts the length of the preparatory phase ranged from 0.16 to 0.58 sec..

The difference between the durations of the preparatory and execution phases ranged from 0.21 sec. to a full second. A close look at the durations of the upward shifts performed by participants who did not receive "excellent" evaluations for intonation does not reveal any statistically unified result. There is great variation in both the total duration and duration of the execution phase of these shifts. This supports Christina's study (1985) in which he came to the conclusion that the coordination of movements could be successfully achieved by means of two types of strategies: in a "tradeoff" strategy a longer preparatory phase made up for a shorter execution phase or vice versa. In a "covariation" strategy the preparatory phase and the execution phase are each short and quick or longer and slower (Christina,1985, p. 309).

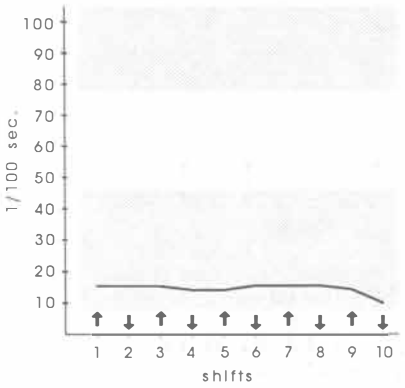
It is not necessary to look closely at long and short durations of downward shifts at this point. They would hardly show any greater regularity than has been demonstrated in the case of upward shifts.

17. The Structure of the Total Duration of Shifts Performed by Participants Who Did Not Receive "Excellent" Evaluations for Intonation.

The structure of the total duration of upward and downward shifts performed by those participants who received the best evaluations for intonation plotted out as regular, steep sawtooth curves. It is interesting to consider what sort of curves were produced by the structure of the total duration of shifts performed by participants who did not receive "excellent" evaluations for intonation. A distinct group was composed of those whose shifts completely lacked a preparatory phase in the initial trial: P 1,2,3 and to a certain extent P 6,9 and 11. As we have seen (cf.,p.268 above), these participants received the lowest evaluations from the jury.

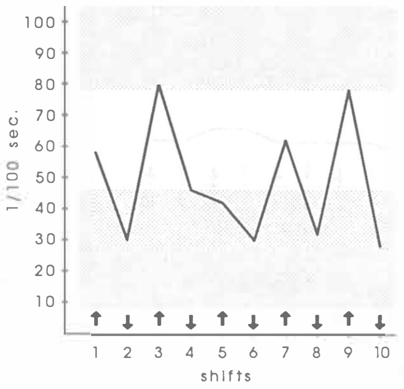
A lack of preparatory phase (as determined by audio-visual analysis) thus appears to have a decisive effect on intonation. The temporal structure of shifts in which the preparatory phase was lacking either entirely or partially takes on the following forms:

Diagram 20 ; P 1 (IT)



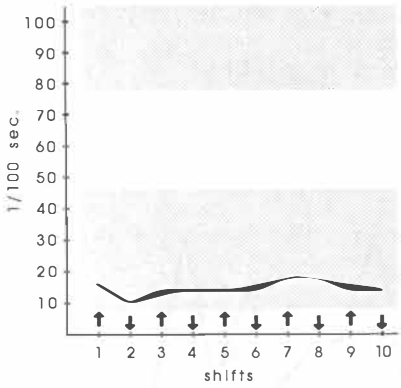
Jury points: 13.6. Notes in tune:4. Ratio between total durations: 0.95. A "dead" curve. The audio - visual analysis showed that the preparatory phase was lacking. The durations of the execution phases are scant.(The average duration of the execution phase for all participants in the study was 0.20 sec.)

Diagram 21 ; P 1 (FT)



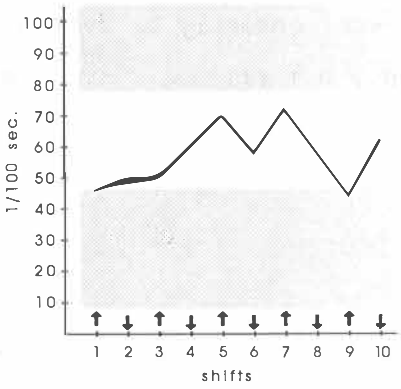
Jury points: 14.6.Notes in tune:5. Ratio between total durations:0.50 Change in total durations:0.35 sec Preparatory phases are present. There is too great variation in the total durations.

Diagram 22 ; P 2 (IT)



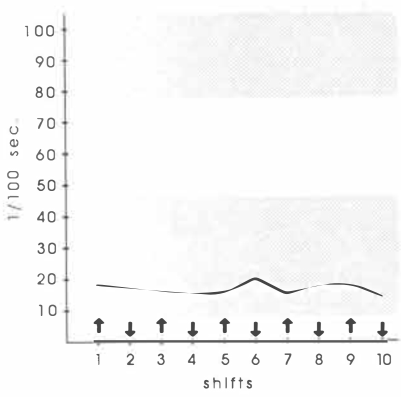
Jury points: 10.4
Notes in tune: 3
Ratio between total durations:0.92
"Dead" curve. The lack of praparatory phase spoils intonation (audio-visual analysis).

Diagram 23 ; P 2 (FT)



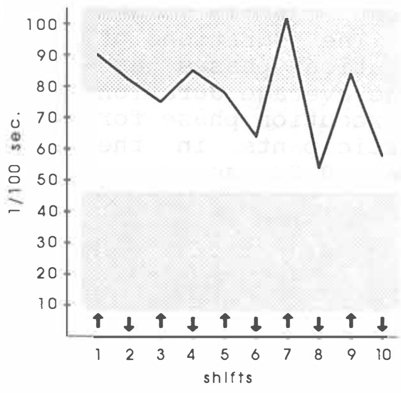
Jury points: 15.8
Notes in tune: 6
Ratio between total durations:1.03
Change in total durations:0.43 sec
If the temporal structure of the central shifts had been consistent an "excellent" evaluation would have been possible.

Diagram 24 ; P 3 (IT)



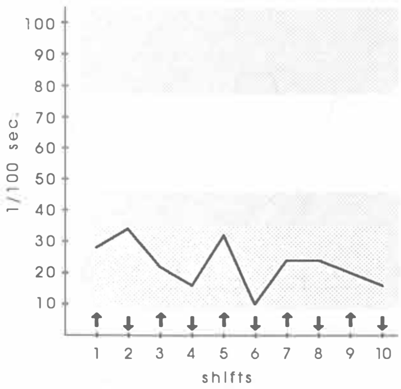
Jury points: 13.4
Notes in tune: 1
Ratio between total durations: 1.02. "Dead" curve.

Diagram 25 ; P 3 (FT)



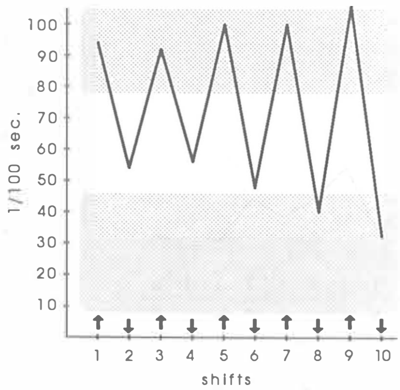
Jury points: 15.8
Notes in tune: 6
Ratio between total durations:0.80
Change in total durations:0.60 sec
Attention paid to the preparatory phase improved intonation.However, too much time was used.

Diagram 26 ; P 6 (IT)



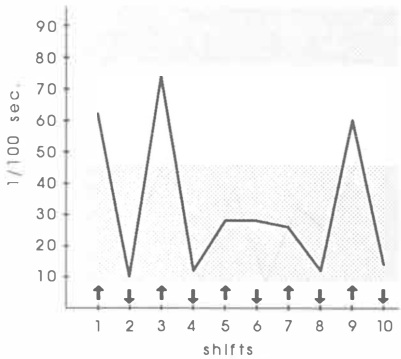
Jury points: 15
Notes in tune: 6
Ratio between total durations:0.78.Scanty use of time. The preparatory phase is lacking.

Diagram 27 ; P 6 (FT)



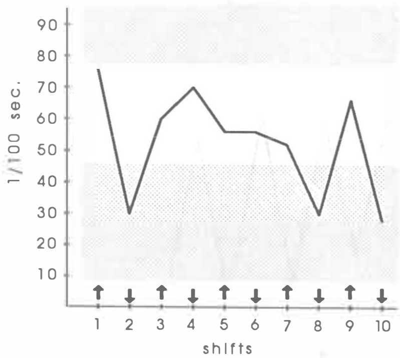
Jury points: 14.2
Notes in tune: 8
Ratio between total durations:0.47
Change in total durations:0.50 sec.
Disproportionately great variations in durations spoil intonation.

Diagram 28 ; P 9 (IT)



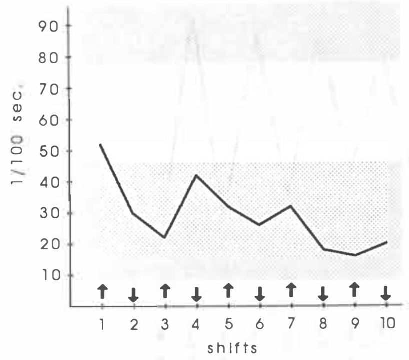
Jury points: 13.2. Notes in tune:2. Ratio between total durations:0.30. Shift durations are random and often scanty. Partially lacking and partially exceptionally short preparatory phases in downward shifts ruin intonation.

Diagram 29 ; P 9 (FT)



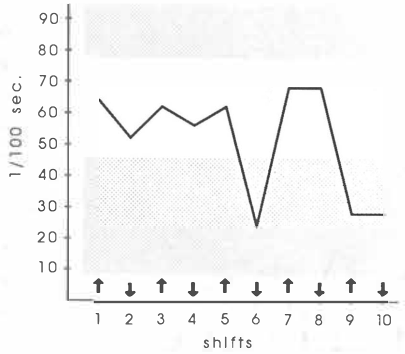
Jury points:13.4. Notes in tune:4. Ratio between total durations:0.69. Change in total durations:0.20 sec. There is now a fuller use of time in shifts, but still inconsistent. The preparatory phases have not, however, been forgotten.

Diagram 30 ; P 11 (IT)



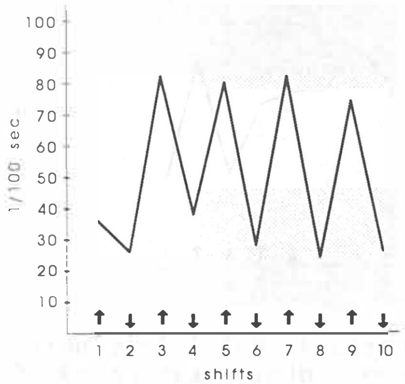
Jury points: 12.6. Notes in tune:4. Ratio between total durations: 0.88.All durations have been severely curtailed and the use of time is inconsistent . Preparatory phases are lacking. Imprecise use of time leads to unclear intonation.

Diagram 31 ; P 11 (FT)



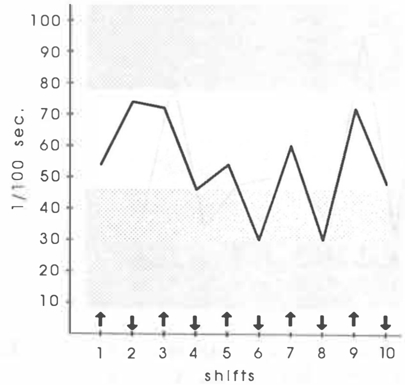
Jury points:13.8.Notes in tune:3. Ratio between total durations:0.80. Change in total durations:0.22 sec. The first couple of pairs of shifts reveal an attempt to control timing. Then the overall performance breaks down. There is, however, care taken with the preparatory phases.

Diagram 32 ; P 4 (IT)



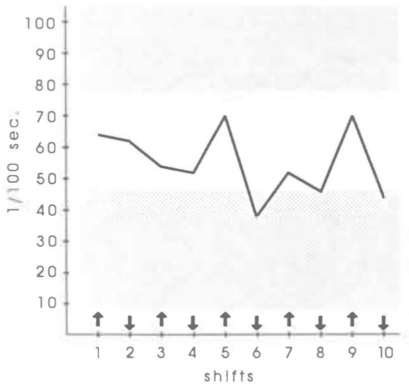
Jury points:15.4
Notes in tune: 3
Ratio between total durations: 0.42.

Diagram 33 ; P 4 (FT)



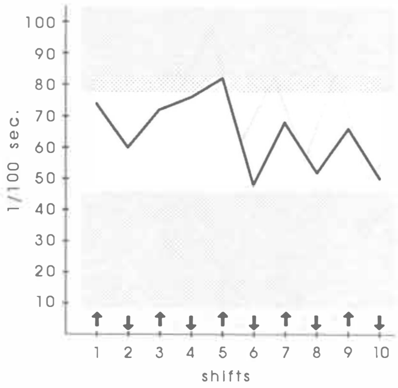
Jury points: 12.8. Notes in tune:4
Ratio between total durations:0.73
Change in total durations:0.03 sec

Diagram 34 ; P 8 (IT)



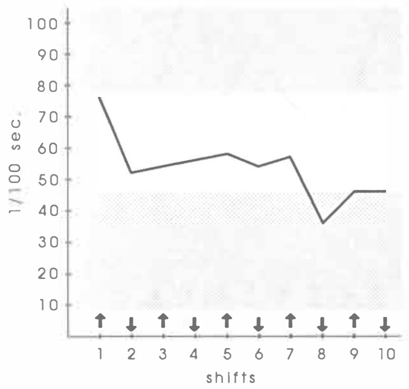
Jury points: 14
Notes in tune: 5
Ratio between total
durations: 0.78

Diagram 35 ; P 8 (FT)



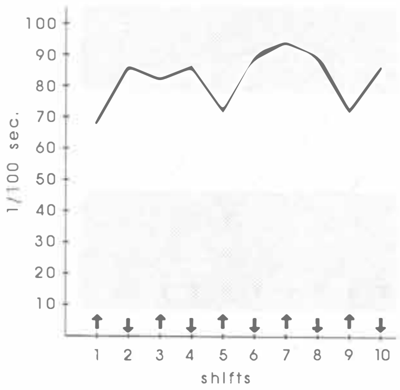
Jury points: 15.6
Notes in tune: 7
Ratio between total durations:
0.79. Change in total durations:
0.10 sec.

Diagram 36 ; P 10 (IT)



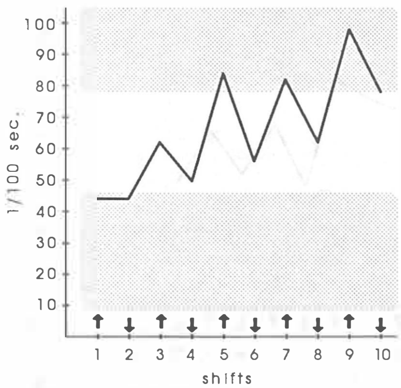
Jury points: 14.6
Notes in tune: 2
Ratio between total
durations:0.84

Diagram 37 ; P 10 (FT)



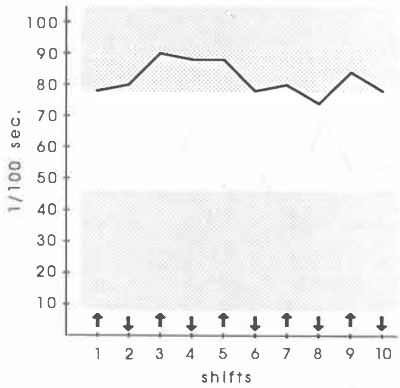
Jury points 15.2
Notes in tune: 8
Ratio between total durations:
1.13. Change in total durations:
0.29 sec.

Diagram 38 ; P 12 (IT)



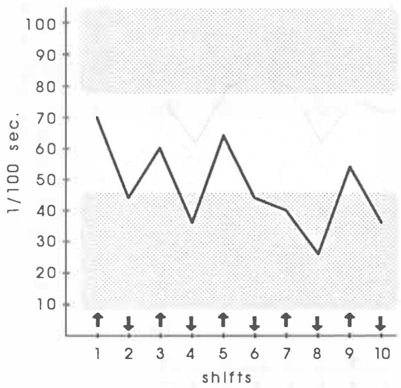
Jury points: 12.6
Notes in tune: 3
Ratio between total durations: 0.78

Diagram 39 ; P 12 (FT)



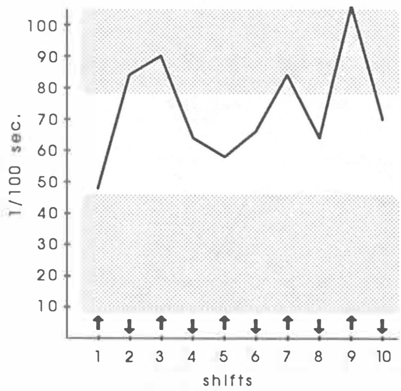
Jury points: 14.0
Notes in tune: 7
Ratio between total durations: 0.95. Change in total durations: 0.16 sec.

Diagram 40 ; P 15 (IT)



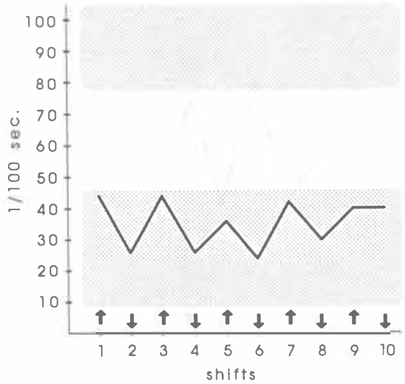
Jury points: 15.8
Notes in tune: 5
Ratio between total durations:0.65

Diagram 41 ; P 15 (FT)



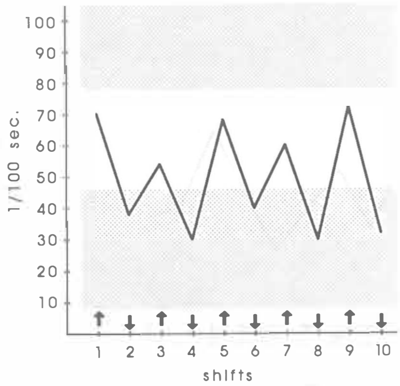
Jury points: 15.4
Notes in tune: 7
Ratio between total durations: 0.90. Change in total durations: 0.26 sec.

Diagram 42 ; P 17 (IT)



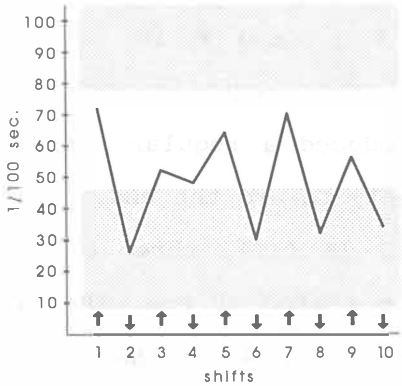
Jury points: 14.4
Notes in tune: 2
Ratio between total durations: 0.71

Diagram 43 ; P 17 (FT)



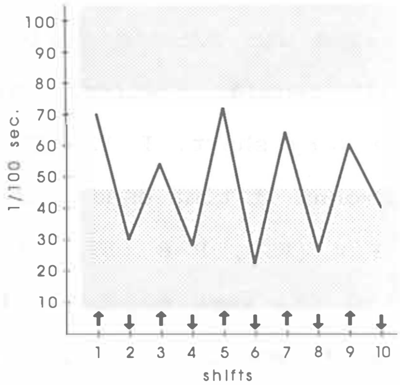
Jury points: 13.2
Notes in tune: 2
Ratio between total durations: 0.52. Change in total durations: 0.14 sec.

Diagram 44 ; P 18 (IT)



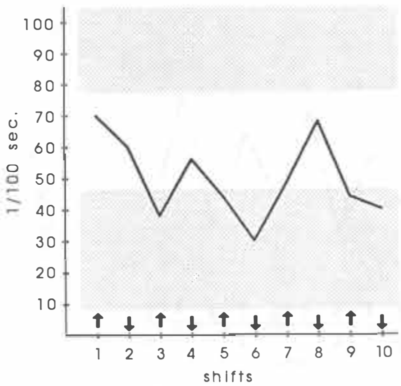
Jury points: 15.2
Notes in tune: 4
Ratio between total durations: 0.54

Diagram 45 ; P 18 (FT)



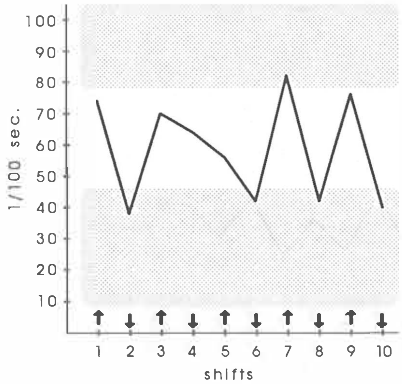
Jury points: 13.6
Notes in tune: 3
Ratio between total durations: 0.46. Change in total durations: -0.02 sec.

Diagram 46 ; P 20 (IT)



Jury points: 15.2
Notes in tune: 7
Ratio between total durations:1.04

Diagram 47 ; P 16 (IT)(cf.FT p.282)



Jury points: 14.4
Notes in tune: 7
Ratio between total durations: 0.63.

A quick glance reveals that the timing of participants who did not receive "excellent" evaluations for intonation was characterized by obvious deficiencies. P 17 and P 18 produced beautifully regular sawtooth curves, but the execution phases of both were very short. P 12 (IT) also produced a regular pattern, but the amount of time used increased evenly toward the end. In the case of P 4 (FT), P 8 (IT and FT) and P 15 (IT), three of five pairs of shifts were regularly timed. The timing of the other two pairs was, however, haphazard. The timing of P 4 in the initial trial was regular as far as four pairs of shifts were concerned, but the differences between the durations of the preparatory phases were very large. The timing of P 10 appears very haphazard and imprecise in both trials, and the same applies to P 15 in the final trial and to P 20 in the initial trial. P 17 used too little time on all phases in the initial trial, while P 12 used too much time on all phases in the final trial.

The sum of total durations (= 5 shifts upward and 5 downward, cf. Appendix 14) correlated as expected with the evaluations of the jury (cf.Appendices 15 and 16): for upward shifts (initial and final trials taken together) the correlation is 0.41 (cf.diagram 48) and for downward shifts 0.50 (cf.diagram 49):

Diagram 48

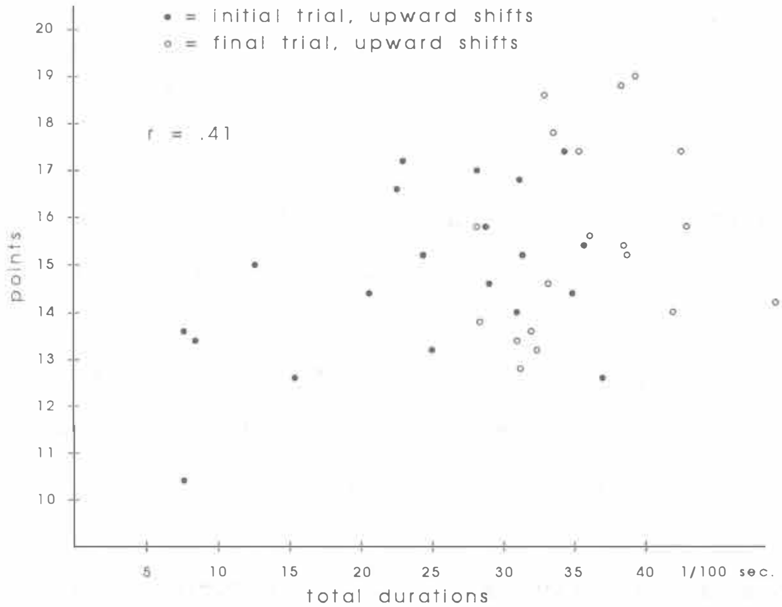
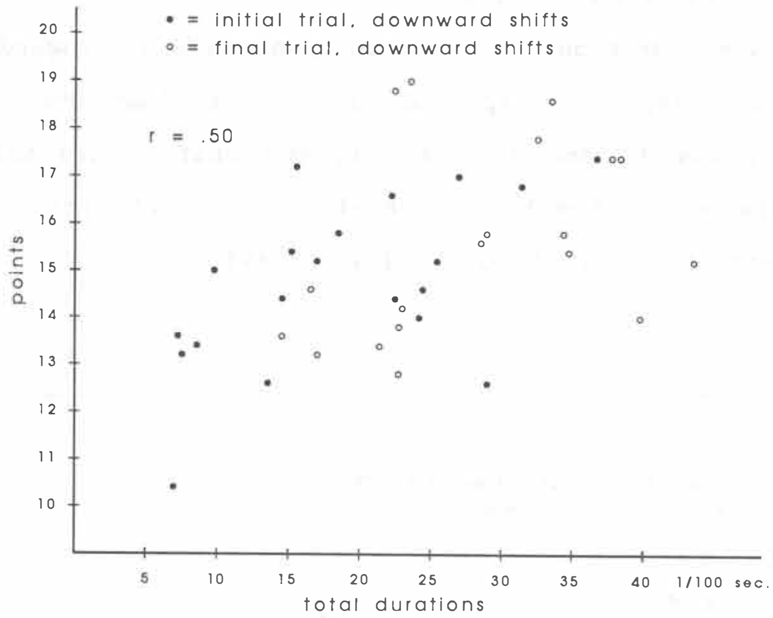


Diagram 49



Intonation has improved both in upward and downward shifts since
a) the best evaluations in the final trial were better than in the initial trial,
b) the most hurried performances were left out in the final trial.
The correlation between the lengthening of total durations and the increase in notes in tune (Flesch, sitting, ♩ = 54) is 0.54.

18. The Optimum and Effective Duration of the Various Phases of the Shift.

Before we take up the question of what sort of temporal relationship there should be between the preparatory and execution phases of the shift, it is necessary to clarify what the optimum duration of each phase should be.

It is first necessary to take under consideration the following factors affecting the timing of the shift:

1. Playing speed
2. The distance covered by the shift in question
3. The direction of the shift (i.e.,upward or downward)
4. The degree of practice (i.e., whether initial or final trial)
5. The amount of guidance received by the participants (initial or final trial, test group or control group)
6. The evaluations received by the participants (excellent or less)
7. The degree of success of the shift (good intonation or poor)

1. There is no need to pay attention to playing speed here. In the last four shifts of this piece more notes per beat are played than in the first ten shifts. For this reason these last four shifts have not been included in the investigation, as explained earlier.
2. The pairs of shifts include 5 different distances. Since the notes are all of the same length and the tempo is kept constant with the aid of a metronome, the shifts of different lengths must be carried out at different speeds, the longer shifts more quickly than the shorter shifts. Since all the participants played for the most part in tempo, i.e., employed different speeds of shifting in shifts of different lengths, shifts of different lengths took approximately the same amount of time. Thus this point can be disregarded.

3. The direction of the shift must be taken into consideration, since the timing of shifts upward differs from that of shifts downward. They must thus be investigated separately.
4. There is good reason to assume that the amount of practice has a substantial effect on the proper duration of movements. It is probable that the participants had practiced more before the final trial than before the initial trial. For this reason the results of the final trial were subjected to investigation. The following observations support this: in the first place, the participants produced better intonation in connection with shifting in the final trial than in the initial trial. In the final trial 147 notes in tune were achieved, in contrast to 124 in the initial trial (participant 20, who did not participate in the final trial due to illness, has been left out of the calculation). Since the quality of intonation is affected by both the player's ear and the quality of the movements involved in the shift, it can be assumed that the increase in the number of notes in tune has been a result of an all-round improvement in the performance of the movements in the final trial, and thus an increase in the effectiveness of the durations of the various parts of the movement compared to that in the initial trial. Secondly, it can be pointed out that the preparatory phases of the shifts were considerably longer in the final phase than in the initial phase. Since the test group had received specific instruction in the performance of shifts and special attention had been paid in this connection to problems of coordination, it can be assumed on this basis that the

preparatory phases of shifts in the final trial were of a more effective duration than in the initial trial.

5. The conclusion arrived at in the preceding point can also partially be applied to the amount of guidance received by the test group before the final trial. This does not, however, make it possible to take only the results achieved by the test group into consideration when studying the question of the effective duration of the phases of the shift, and to set aside the results achieved by the control group. It is true that many members of the test group made considerable progress after the initial trial. It is not, however, possible to assume that the preparatory and execution phases of their shifts displayed more effective durations than those of the control group. The situation could be just the opposite: among the members of the control group there were several individuals who were older and more experienced violinists than members of the test group. The guidance received by the test group did not make the performances of a number of its less experienced members better than those of some of the more experienced members of the control group in the final trial.
6. The evaluation received for intonation is an important factor in the consideration of the effectiveness of the duration of the preparatory and execution phases: it can be assumed that a player who has received an "excellent" evaluation has coordinated his shifting movements better than one who has not received such a high evaluation. Since only 6 participants received "excellent" evaluations in the final trial and the

total number of their successful shifts was only 42, the sample was too small to investigate the effectiveness of the duration of the phases.

7. The acoustic result of the shift is an essential measure of the success of the shift. It can be assumed with good cause that the coordination of a shift that is played in tune is better than one played out of tune. Since the number of successful shifts constituted an appreciable sample (there were a total of 112 successful shifts in the first 10 shifts in the final trial), there is a basis for the achievement of reasonable objectivity.

19. The Determination of the Effective Duration of the Preparatory and Execution Phases of Shifts Carried Out in Flesch, sitting (♩ = 54)

The observations made show that there is a wide range in the duration of both preparatory and execution phases in successful shifts. The calculated optimal durations of the different phases of these shifts (cf.p.309 below) turn out to place too narrow limits on shifts which produce successful temporal (and acoustic) results. The participants achieved good results with widely varying phase durations. By examining their performances we can arrive at time values that quite consistently set practical limits on the effective duration of both phases of shifts.

19.1. The Determination of the Effective Duration of the Execution Phase.

0.20 sec. can be considered to be an optimal value of the duration of the execution phase, based on the observations already made (cf.p.277 above). Limits for the effective duration of the execution phase can be determined by examining the execution phases of the shifts performed by the participants which were of an average duration of 0.20 sec., or just a few hundredths of a second from that value. These were: P 2 (0.19), P 5 (0.22), P 6 (0.21), P 7 (0.19), P 13 (0.20 and 0.22), P 14 (0.19), P 15 (0.18), P 17 (0.18), P 19 (0.21 and 0.20) and P 20 (0.19). The average values in question were achieved in either the initial or final trial. Upper and lower limits for the effective duration of the execution phase can be determined by ascertaining the shortest and longest durations of the execution phase employed by the participants:

P 2: 0.14 ← → 0.26 ; P 5: 0.18 ← → 0.26
P 6: 0.16 ← → 0.28 ; P 7: 0.12 ← → 0.34
P 13: 0.16 ← → 0.28 ; P 14: 0.14 ← → 0.26
P 15: 0.12 ← → 0.28 ; P 17: 0.14 ← → 0.22
P 19: 0.14 ← → 0.28 ; P 20: 0.12 ← → 0.36

As can be seen, the shortest duration produced by three participants was 0.12 sec. and by four participants 0.14. The first of these figures can be considered to be the absolute lower limit for the effective duration of the execution phase. Two participants produced longest durations of 0.26 and four participants 0.28 sec. Two exaggerations (0.34 and 0.36) can be ignored.

A sensible upper limit for the execution phase would seem to be 0.28 sec.. The optimal duration of 0.20 sec. was thus exactly between these two limits, 0.08 sec. from both the lower and upper limit.

An effective duration for the execution phase (of shifts in this particular exercise) would thus seem to be any time value between 0.12 and 0.28 sec., valid for shifts both upward and downward.

19.2. The Determination of the Effective Duration of the Preparatory Phase.

The determination of effective durations for the preparatory phases of both upward and downward shifts is appreciably more difficult than the corresponding determination in the case of execution phases. This is due to the fact that the experimental results show that it is possible to achieve successful results (shifts in tune) with remarkably varying durations of the preparatory phase. It is, however, possible to arrive at a fairly objective figure for an effective duration of the preparatory phase in the following way:

1) The average durations of the preparatory phases of upward and downward successful shifts performed by all the participants in the final trial are calculated separately (cf. following table).

2) The values of these average durations are placed along a scale and it is noted how they group themselves. Values at variance from all others can be eliminated.

3) Borderline cases cause difficulties, whether they are taken into consideration or eliminated from the date. They can be handled in two ways:

a) by looking at the intonation evaluation given the participant in question by the jury. If it is clearly below the level of "excellent", there is cause to consider leaving out the value involved. If, on the other hand, the jury evaluation is a sound "excellent", the value probably belongs among values representing effective durations.

b) The values produced by participants who received "excellent" evaluations for intonation are placed along a scale: the limits that these values form give a good indication of the limits of time values of effective durations.

20. The Duration of Preparatory Phases in Successful Shifts (Flesch, sitting, ♩ = 54; 10 First Shifts).

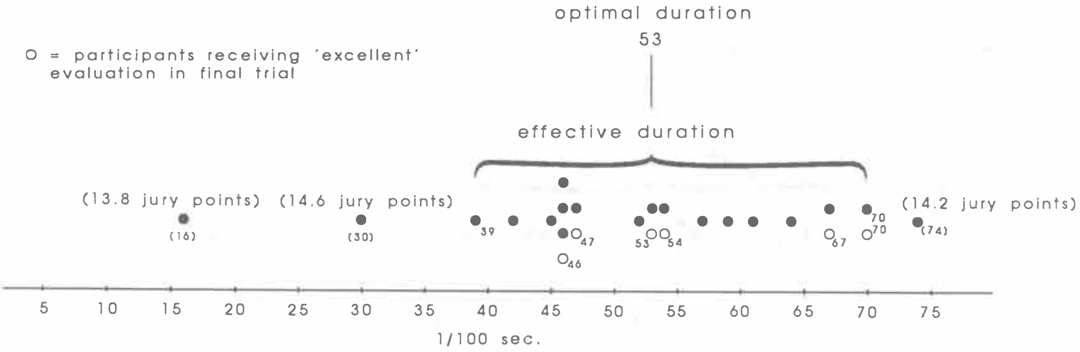
* = values of participants receiving "excellent" evaluation for intonation.

	INITIAL TRIAL		FINAL TRIAL	
P	upward	downward	upward	downward
1	0	0	0.30	0.14
2	0	0	0.39	0.36
3	0	0	0.59	0.47
4	0.67	0.16	0.52	0.41
5	* 0.26	0.16	* 0.54	0.27
6	0.13	0.17	0.74	0.26
7	* 0.44	0.33	* 0.70	0.52
8	0.35	0.17	0.46	0.24
9	0	0	0.57	0.35
10	0.40	0	0.64	0.73
11	0.12	0.10	0.16	0.17
12	0.58	0.46	0.46	0.48
13	* 0.22	0.35	* 0.47	0.36
14	* 0.43	0.37	* 0.46	0.58
15	0.43	0.33	0.61	0.53
16	0.61	0.36	* 0.67	0.34
17	0.23	0	0.42	0.10
18	0.45	0.16	0.45	0.18
19	* 0.49	0.32	* 0.53	0.58
20	0.29	0.37	–	–
$\bar{X}$ =	0.38;	$\bar{X}$ = 0.27	$\bar{X}$ = 0.51;	$\bar{X}$ = 0.37
			(57 successful shifts)	(55 successful shifts)

21. Effective Duration of the Preparatory Phase (Flesch, sitting, ♩= 54).

1. Upward Shifts (Final Trial,Successful Shifts) (cf.App.12)

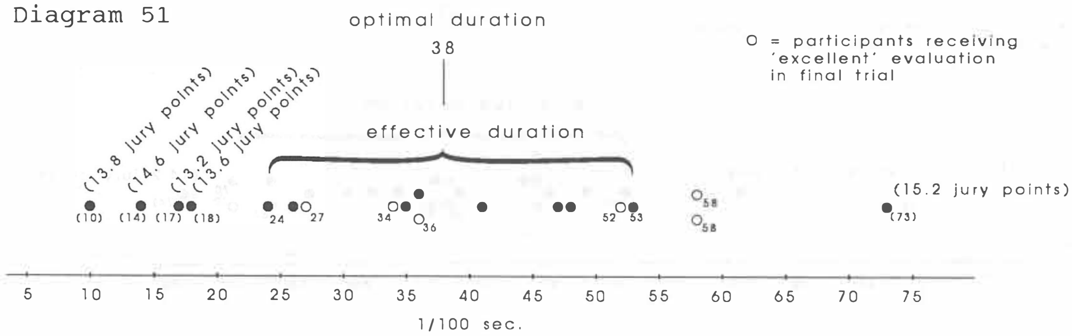
Diagram 50



The two lowest average values (0.16 and 0.30 sec.) can be eliminated immediately. The highest average value (0.74) gives the impression of being exaggerated: the jury evaluation was 14.2, i.e., the shifts of this participant were not completely successful. This value can thus be eliminated as not representing an effective duration. On the other hand, the next two highest average values (0.67 and 0.70) were produced by participants who had received "excellent" evaluations for intonation (respectively 18.8 and 17.4). The former figure was even the best rating for intonation awarded in the final trial. Therefore, despite the fact that these two average values were considerably higher than the remaining average values, they can still be consider to represent effective durations. The diagram indicates that all values between 0.39 and 0.70 represent effective durations for the preparatory phase of upward shifts. The range is 0.31 sec.. The optimal duration for the preparatory phase of upward shifts obtained was 0.53 sec., which was the average of all effective durations.

2. Downward Shifts (Final Trial, Successful Shifts) (cf.App.12)

Diagram 51



The lowest value on the diagram (0.10 sec.) can obviously be eliminated. The following three figures (0.14, 0.17 and 0.18 sec.) can be eliminated because the points for intonation awarded by the jury are far below the "excellent" level. The highest figure (0.73 sec.) is exceptionally far from all other average values and can be considered to be an " accident" and ignored. The next two (both 0.58 sec.) form an interesting group since they were produced by participants who received "excellent" evaluations for intonation. Their rejection is , however, decided by the fact that three out of five of the shifts performed in the final trial by one of these participants (P 19) were unsuccessful. The corresponding figure for the other of these participants (P 14) was all of four out of five. (How the jury arrived at an overall "excellent" evaluation is a question that will not be delved into at this point). All remaining values from 0.24 to 0.53 sec. can thus be considered to represent effective durations of downward shifts. The range is essentially the same as in the previous case: 0.29 sec.. The optimal duration for the preparatory phase of downward shifts obtained was 0.38 sec. (= the average of all effective durations).

22. Optimal,Ideal and Effective Durations of Shifts.

The Material in the above three sections can be summed up as follows:

Diagram 52

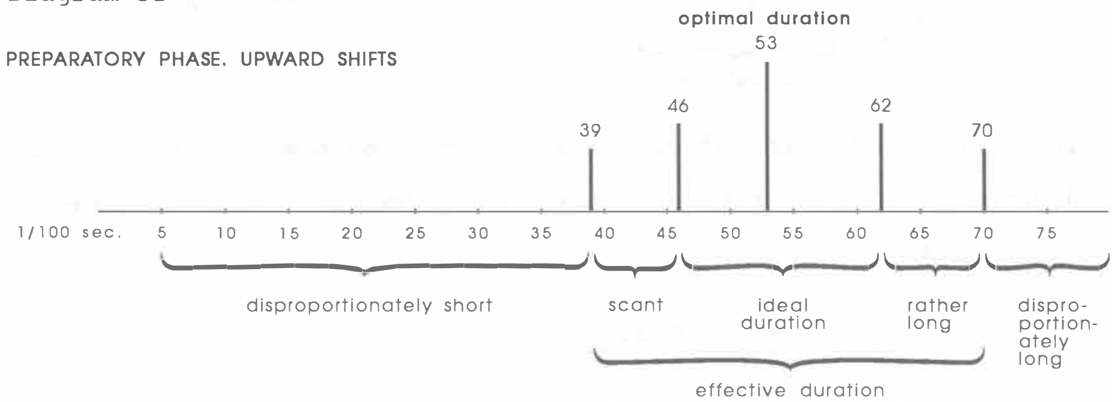


Diagram 53

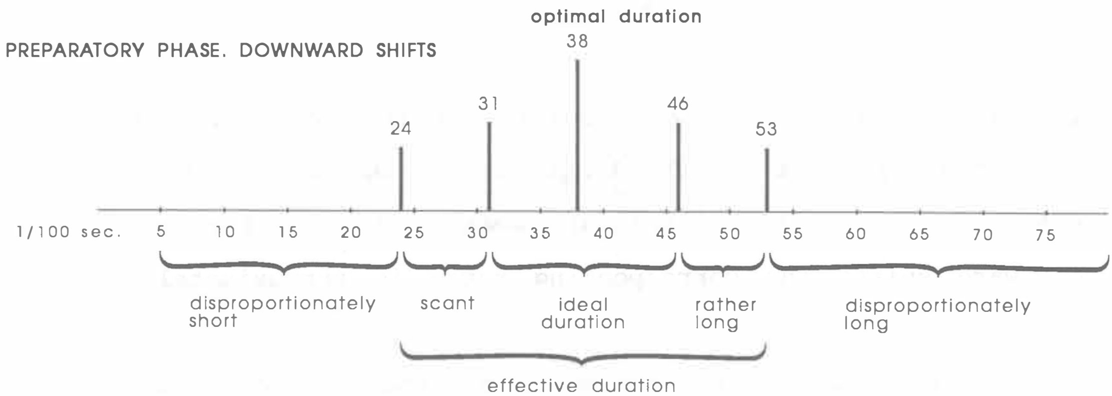
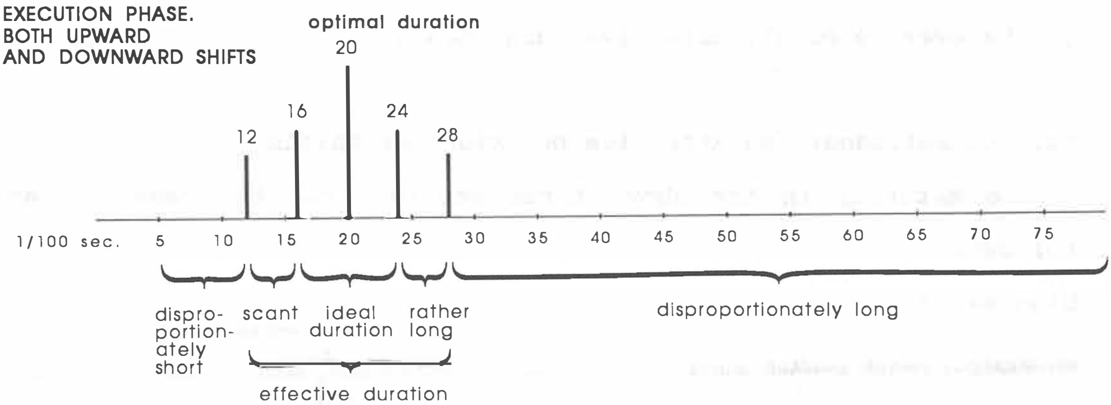


Diagram 54



The ratio of the optimal duration of execution phase to the optimal duration of preparatory phase in upward shifts is easily calculated:

$$\frac{0.20}{0.53} = 0.38$$

The same ratio for downward shifts is

$$\frac{0.20}{0.38} = 0.53$$

This means that the optimal duration of the preparatory phase is approximately 2.5 times the length of the optimal duration of the execution phase in successful upward shifts. For successful downward shifts the corresponding ratio is approximately two to one.

From diagrams 52,53 and 54 we can obtain the upper and lower limits for the effective duration of shifts and the optimal total durations:

1. Upper and Lower Limits for the effective duration of shifts.

Upper Limits:

Upward shifts: 0.98 (0.70 + 0.28) (cf. diagrams 52 and 54)

Downward shifts: 0.81 (0.53 + 0.28) (cf. diagrams 53 and 54)

Lower Limits:

Upward shifts: 0.51 (0.39 + 0.12)

Downward shifts: 0.36 (0.24 + 0.12)

2. Optimal Total Durations:

Upward shifts: 0.73 (0.53 + 0.20)

Downward shifts: 0.58 (0.38 + 0.20)

23. Deficient or Effective Timing in Shifting Movements (Flesch, sitting ♩ =54).

In both the initial and final trials the shifts of a number of participants suffered from clear timing deficiencies. Deficient and effective durations of movements involved in shifting can be grouped as follows:

I The Preparatory Phase of the Movement

1. is completely lacking
2. is of disproportionately short duration:
   - under 0.39 sec. in upward shifts (cf.Diagram 52)
   - under 0.24 sec. in downward shifts (cf. Diagram 53)
3. is scant, but effective:
   - 0.39 - 0.46 sec. in upward shifts
   - 0.24 - 0.31 sec. in downward shifts

4. is of optimal duration:
   - in upward shifts 0.46 - 0.62 sec.
   - in downward shifts 0.31 - 0.46 sec.
5. is rather long, but effective
   - in shifts upward 0.62 - 0.70 sec.
   - in shifts downward 0.46 - 0.53 sec.
6. is of disproportionately long duration:
   - in shifts upward over 0.70 sec.
   - in shifts downward over 0.53 sec.

II. The Execution Phase of the Movement

1. is of disproportionately short duration
   - under 0.12 sec. in upward or downward shifts (cf. Diagram 54)
2. is scant but effective:
   - in upward or downward shifts 0.12 - 0.16 sec.
3. is of ideal duration
   - in upward or downward shifts 0.16 - 0.24 sec.
4. is rather long but effective
   - in upward or downward shifts 0.24 - 0.28
5. is of disproportionately long duration
   - in upward or downward shifts over 0.28 sec.

The average durations of the preparatory and execution phases of the shifts performed by the various participants can be grouped and evaluated as follows:(NB: both <u>scant</u> and <u>rather long</u> durations are within the <u>effective</u> range ; j.p. = jury points)

INITIAL TRIAL	FINAL TRIAL
P	P
1. PREP upward 0 lacking PREP downward 0 lacking EXEC 0.15 scant(j.p.=13.6)	1. PREP upward 0.52 ideal PREP downward 0.16 disproport.short EXEC 0.16 ideal (j.p.= 14.6)
2. PREP upward 0 lacking PREP downward 0 lacking EXEC 0.15 scant (j.p.=10.4)	2. PREP upward 0.39 scant PREP downward 0.38 optimal EXEC 0.19 ideal (j.p.=15.8)
3. PREP upward 0 lacking PREP downward 0 lacking EXEC 0.17 ideal (j.p.=13.4)	3. PREP upward 0.63 rather long PREP downward 0.46 rather long EXEC 0.23 ideal (j.p.=15.8)
4. PREP upward 0.59 ideal PREP downward 0.20 disproport. short EXEC 0.12 scant (j.p.=15.4)	4. PREP upward 0.47 ideal PREP downward 0.36 ideal EXEC 0.13 scant (j.p.=12.8)
5. PREP upward 0.29 disproport. short PREP downward 0.18 disproport. short EXEC 0.15 scant (j.p.=17.2)	5. PREP upward 0.55 ideal PREP downward 0.27 scant EXEC 0.22 ideal (j.p.=19.00)
6. PREP upward 0.12 disproport.short PREP downward 0.07 disproport.short EXEC 0.13 scant(j.p.=15)	6. PREP upward 0.75 disproport. long PREP downward 0.26 scant EXEC 0.21 ideal (j.p.=14.2)
7. PREP upward 0.44 scant PREP downward 0.34 ideal EXEC 0.16 ideal (j.p.=17.00)	7. PREP upward 0.70 rather long PREP downward 0.54 rather long EXEC 0.19 ideal (j.p.=17.4)
8. PREP upward 0.34 disproport. short PREP downward 0.18 disproport. short EXEC 0.29 disproport. long (j.p.= 14.0)	8. PREP upward 0.46 ideal PREP downward 0.24 scant EXEC 0.30 disproport.long (j.p. = 15.6)
9. PREP upward 0.37 disproport. short PREP downward 0.20 disproport. short EXEC 0.13 scant (j.p.=13.2)	9. PREP upward 0.50 ideal PREP downward 0.28 scant EXEC 0.13 scant (j.p.=13.4)

10. PREP upward 0.46 scant
PREP downward 0.39 ideal
EXEC 0.11 disproport.short
(j.p.=14.6)

11. PREP upward 0.19
disproport. short
PREP downward 0.08
disproport. short
EXEC 0.15 scant (j.p.=12.6)

12. PREP upward 0.59 ideal
PREP downward 0.42 ideal
EXEC 0.15 scant (j.p.= 12.6)

13. PREP upward 0.22 disproport
short
PREP downward 0.28 scant
EXEC 0.20 optimal(j.p.= 16.6)

14. PREP upward 0.39 scant
PREP downward 0.38 ideal
EXEC 0.24 rather long
(j.p.= 16.8)

15. PREP upward 0.42 scant
PREP downward 0,26 scant
EXEC 0.14 scant (j.p.=15.8)

16. PREP upward 0.59 ideal
PREP downward 0.36 ideal
EXEC 0.10 disproport.short
(j.p.= 14.4)

17. PREP upward 0.27
disproport. short
PREP downward 0.13
disproport. short
EXEC 0.15 scant (j.p.=14.4)

18. PREP upward 0.47 ideal
PREP downward 0.23
disproport. short
EXEC 0.14 scant (j.p.=15.2)

19. PREP upward 0.50 ideal
PREP downward 0.51 rather
long
EXEC 0.21 ideal (j.p.=17.4)

10. PREP upward 0.60 ideal
PREP downward 0.71 disproport.
long
EXEC 0.17 ideal (j.p.= 15.2)

11. PREP upward 0.45 scant
PREP downward 0.28 scant
EXEC 0.11 disproport.short
(j.p.= 13.8)

12. PREP upward 0.46 ideal
PREP downward 0.48 rather long
EXEC 0.35 disproport. long
(j.p.= 14.00)

13. PREP upward 0.45 scant
PREP downward 0.44 ideal
EXEC 0.22 ideal (j.p.=17.8)

14. PREP upward 0.45 scant
PREP downward 0.50 rather long
EXEC 0.19 ideal (j.p.=18.6)

15. PREP upward 0.60 ideal
PREP downward 0.52 rather long
EXEC 0.18 ideal (j.p.=15.4)

16. PREP upward 0.65 rather long
PREP downward 0.34 ideal
EXEC 0.11 disproport. short
(j.p.= 18.8)

17. PREP upward 0.47 ideal
PREP downward 0.15
disproport.short
EXEC 0.18 ideal (j.p.=13.2)

18. PREP upward 0.52 ideal
PREP downward 0.18
disproport. short
EXEC 0.12 scant (j.p.=13.6)

19. PREP upward 0.54 ideal
PREP downward 0.55 disproport.
long
EXEC 0.20 optimal (j.p.=17.4)

20. PREP upward 0.29 disproport. (did not participate)
short
PREP downward 0.32 ideal
EXEC 0.19 ideal (j.p.=15.2)

The following 11 participants performed both phases of all shifts with average durations within the effective range (scant, ideal or rather long) in either the initial trial (IT), the final trial (FT) or both trials:

2 (FT), 3 (FT), 4 (FT), 5 (FT), 7 (IT and FT), 9 (FT), 12 (IT), 13 (FT), 14 (IT and FT), 15 (IT and FT) , 19 (IT).

17 participants performed shifts either partially or entirely with durations that fell outside the effective range: 1 (IT and FT), 2 (IT), 3 (IT), 4 (IT), 5 (IT), 6 (IT and FT), 8 (IT and FT), 9 (IT), 10 (IT and FT), 11 (IT and FT), 12 (FT), 13 (IT), 16 (IT and FT),17 (IT and FT), 18 (IT and FT), 19 (FT), 20 (IT). Three participants received low jury evaluations even though they performed shifts with phases having durations within the effective range: 4 (FT), 9 (FT) and 12 (IT). On the other hand, four participants who did not perform the phases of shifts with durations within the effective range, nevertheless received high evaluations: 5 (IT), 8 (FT), 13 (IT), 16 (FT). From this we can conclude that it is possible to achieve an "excellent" evaluation for intonation either with correct timing of shifts, or with somewhat faulty timing (cf.pp.287 above and 319 below). I.e., there is no strict one-to-one relationship between correct timing of the shift and intonation, but good timing increases the chance of achieving good intonation.

24. The Relationship between Intonation and the Effective Duration of the Preparatory Phase.

On the basis of the observations made above, it can be determined that in the exercise under consideration (Flesch, sitting, ♩ = 54, andante) the duration of the preparatory phase of upward shifts was not within the effective range if it lasted less than 0.39 sec. or if it was longer than 0.70 sec.. For downward shifts the corresponding figures are 0.24 sec. and 0.53 sec.. We can now calculate the correlation between average jury points and the number of shifts performed by each participant with effective duration of the preparatory phase. Durations that fall outside the effective range by 2/100ths of a second or less are considered to be effective.

Initial Trial				Final Trial			
		Number of preparatory phase durations within effective range	Jury points			Number of preparatory phase durations within effective range	Jury points
P 1	CG	0	13.6	P 1	CG	5	14.6
2	TG	0	10.4	2	TG	7	15.8
3	TG	0	13.4	3	TG	8	15.8
4	CG	4	15.4	4	CG	7	12.8
5	TG	2	17.2	5	TG	9	19.0
6	TG	1	15.0	6	TG	6	14.2
7	TG	10	17.0	7	TG	7	17.4
8	CG	3	14.0	8	CG	7	15.6
9	CG	3	13.2	9	CG	7	13.4
10	TG	10	14.6	10	TG	4	15.2
11	CG	1	12.6	11	CG	6	13.8
12	TG	7	12.6	12	TG	10	14.0
13	TG	3	16.6	13	TG	8	17.8
14	CG	8	16.8	14	CG	8	18.6
15	TG	8	15.8	15	TG	6	15.4
16	CG	9	14.4	16	CG	9	18.8
17	TG	0	14.4	17	TG	6	13.2
18	CG	8	15.2	18	CG	6	13.6
19	CG	8	17.4	19	CG	8	17.4
20	CG	5	15.2	-		-	-
		Σ = 90 (pro maximi 200)				Σ = 134 (pro maximi 190)	

In the initial trial there was a correlation of 0.47 between the points awarded for intonation by the jury and effective duration of the preparatory phase. In the final trial the correlation was 0.48. A clear indication of the importance of the duration of the preparatory phase within the overall timing structure of the shift is given by the fact that those participants (P 1,2,3,6,9 and 11) who performed shifts lacking in preparatory phase in this exercise (Flesch, sitting, ♩=54, andante) in the initial trial also produced fewest notes in tune and received the weakest evaluations for intonation from the jury: the average of the points they received was 13.03 ,compared to 15.47 for the remaining participants.

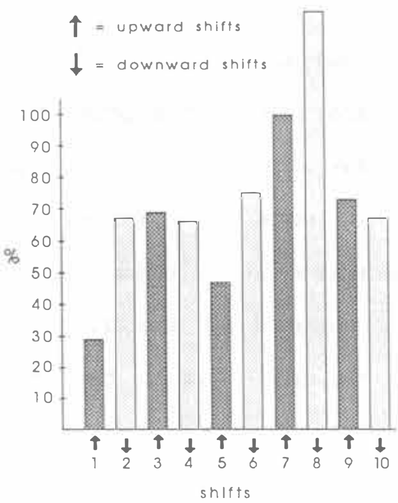
25. The Relationship between the Duration of the Preparatory and Execution Phases of Shifts (Flesch, sitting, ♩=54).

We will now look at the relationship between the duration of the two phases of shifts performed by those participants who received the best evaluations for intonation (P 5, IT and FT, P16 FT).The following three diagrams illustrate the situation (cf.Appendix 21):

Diagram 55

The Ratio of the Duration of the Execution Phase to the Duration of the Preparatory Phase.

P 5 (IT,Jury points 17.2)



In upward shifts, the ratio of the duration of the execution phase to the duration of the preparatory phase was on the average 0.64 and in downward shifts 0,82. Thus the average duration of the execution phase was considerably longer than the optimal values would presume: the ratio of the optimal duration of the execution phase to the optimal duration of the preparatory phase is 0.38 (0.20/0.53) for upward shifts, and 0.53 (0.20/0.38) for downward shifts (cf.p. 310 above).

Diagram 56

P 5 (FT, Jury points 19)

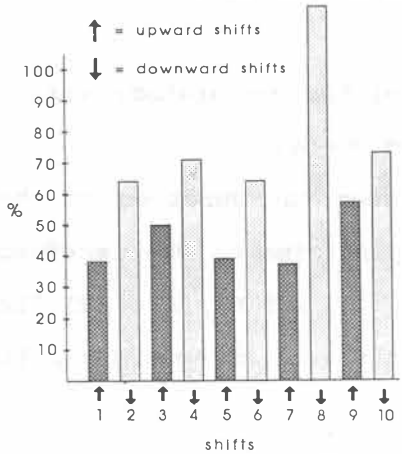
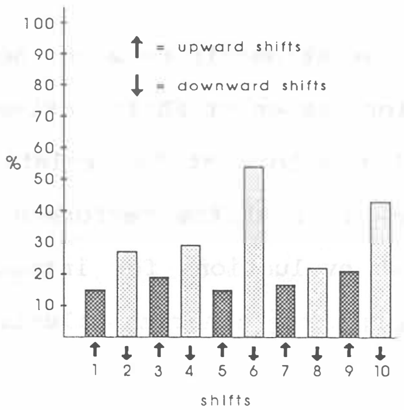


Diagram 57

P 16 (FT, Jury points 18.8)



In the final trial the ratio of the duration of the execution phase to the duration of the preparatory phase of shifts performed by P 5 was on the average 0.24 in upward shifts, and in downward shifts 0.20. One excessive duration (1.20 sec.), was not taken into consideration in calculating the average. The corresponding values for P 16 were 0.12 and 0.11. They are both considerably below the optimal values, i.e., the execution phases are very short. In upward shifts the ratio of the duration of execution to preparatory phase was quite steady, but in downward shifts the execution phases were inordinately stretched out several times. Final notes in tune were, however, produced each time.

From these three examples it can once again be seen that good intonation in shifts can be achieved in spite of considerably different timing strategies being employed (cf.pp.287 and 315 above). It would thus appear that every participant who received an "excellent" evaluation for intonation employed a timing strategy that was uniquely effective for him or her. What was important was that that strategy was employed consistently. That strategy may approached a strategy that included durations close to the optimal or effective durations calculated above, or it may have diverged greatly from such a strategy. The resolution of this problem involved various degrees of freedom, various choices. However, it was possible for bad habits to develop that led to mannerisms and extremes that ruined the best effort. Good intonation in shifts presupposed that certain basic conditions be met in respect to the timing of the shifting movement:

1. A preparatory phase was an essential part of every harmonious movement.
2. The total duration had to be sufficiently long. If the preparatory phase was very short, it had to be compensated for by protracting the execution phase - or vice versa.
3. The total duration could not be disproportionately long. An excessively long total duration led easily to insecure intonation.

4. The same general timing strategy had to be applied to all similar shifts, of which there were 10 in the exercise (Flesch, sitting: ♩ =54, andante) used to investigate timing in shifts. Great differences in timing strategies reduced the chance of achieving good intonation in similar shifts.

26. Conclusions: Total and Partial Durations

The following conclusions can be drawn concerning total and partial durations of shifts based on the above material (10 shifts: Flesch, sitting):

1. The curves representing total durations (PREP+EXEC) of shifts were regular in the best performances. The upward shifts were timed on the average in approximately the same way, and similarly the downward shifts were of approximately the same length. In this way the entire series of shifts (10 shifts) were played in tune (cf.pp.281-282 above).
2. In upward shifts the "ideal limits" for total durations was 0.78 sec. and in downward shifts 0.46 sec. (cf. Diagrams 10 and 11, loc.cit.).Equal total durations in upward and downward shifts was not a favorable condition for the production of good intonation. The greatest deleterious effect was produced when the equal durations were, in addition, very short.
3. If the total durations in upward and downward shifts were excessively different from each other (i.e., one very long and the other very short), good intonation was not produced.
4. The complete lack of a preparatory phase was extremely deleterious to the production of good intonation.

5. If the execution phase was longer than the preparatory phase the chances of producing good intonation were small.
6. If the preparatory phase was longer than the execution phase, the chances of producing excellent intonation were good. It was possible to achieve an excellent result by employing various timing strategies: the durations could be close to the ideal durations or they could diverge from them considerably. There were thus any number of effective solutions possible, but they had to satisfy the conditions mentioned above.

27. The Influence of Tempo on Intonation

The jury was asked to evaluate intonation achieved by the participants in the playing of the Flesch exercise at three different tempos (♩=54; voluntarily selected tempo; ♩=138).The best performance was given the rating 3, the second best the rating 2, and the worst the rating 1. In case it was not possible to arrive at clear-cut ratings, two performances could be assigned the same rating. The average of jury ratings expressed the rating of the performances.

The Averages of the Ratings at Each Tempo:

	FLESCH SITTING						FLESCH STANDING					
	Initial Trial			Final Trial			Initial Trial			Final Trial		
P	♩=54	vol.	♩=138	♩=54	vol.	♩=138	♩=54	vol.	♩=138	♩=54	vol.	♩=138
1	10	10	5	8	13	6	8	6	5	10	9	11
2	5	6	8	9	7	13	6	9	9	12	9	6
3	12	8	6	10	13	5	9	10	8	9	12	7
4	13	10	7	9	11	5	12	9	8	8	10	7
5	13	9	9	13	13	8	10	12	9	13	11	10
6	10	8	7	11	11	5	11	7	12	10	6	11
7	14	11	8	14	8	5	12	12	7	14	11	8
8	12	7	8	14	7	7	12	12	7	15	8	9

	Initial Trial			Final Trial			Initial Trial			Final Trial		
P	♩=54	vol.	♩=138	♩=54	vol.	♩=138	♩=54	vol.	♩=138	♩=54	vol.	♩=138
9	12	7	5	9	12	6	8	12	5	10	7	5
10	12	11	11	11	11	5	9	10	8	11	7	10
11	10	6	6	11	10	7	9	7	5	9	8	5
12	12	10	6	12	10	5	7	10	10	13	10	7
13	12	13	9	11	13	6	11	14	8	12	12	9
14	13	9	10	10	12	12	11	9	13	13	10	8
15	10	10	13	10	12	5	13	11	7	10	13	7
16	10	8	10	9	14	10	11	9	10	15	11	7
17	12	8	10	8	10	9	12	13	7	12	6	9
18	12	12	6	9	9	8	12	11	5	12	9	8
19	14	8	8	10	13	8	14	14	9	12	11	9
20	10	9	9	-	-	-	10	11	10	-	-	-

As can be seen from the above chart, the poorest intonation was in general produced at the faster tempo (circled figures).However, in ten out of 78 cases the best average was achieved at the faster tempo. We can assume that in these cases it was the speed of the movement that produced an elasticity of performance that aided in the production of good intonation. The employment of a voluntary tempo (and at the same time speed of movement) clearly helped several participants (3,4,9,13,15 and 17). It is worth noting in this connection, that these participants were people who played quite stiffly. They apparently were able to play more freely when they could set their own tempo (in reality, even this voluntary tempo was "assigned" in the sense that in the planning of the experiment it was assumed that it would fall between the two assigned tempos, which indeed turned out to be the case). The speed of the movement did not appear to help all those participants who played with stiff left-hand style (e.g., P 1,11,12 and 18). Some participants (11 and 18) produced poorer results consistently as the tempo increased in both trials.

28. Factors Explaining Intonation in Shifts.

The priority order of the factors explaining intonation in shifting were studied by means of regression analysis. The variables were playing position, balance, timing and the use of glissando. The criterion employed was the average of the points awarded for intonation by the jury in each trial separately. Each participant was assigned points on a scale of 1-2-3 for each trial. 1 meant ineffective ,2 rather effective and 3 very effective playing. In other words, 1 = low, 2 = average and 3 = high functional performance level. The multiple correlation squared obtained for the initial trial results (R^2 = . 65865) showed that the variables mentioned above explained 66% of the accuracy of intonation. The best predictors (though not statistically significant) were balance and the use of glissando: the ß-value of balance was .43480 and that of glissando .31254.

Initial Trial:

	ß-value	T-value	Sig T
Glissando	.31254	1.661	.1174
Playing Position	.14082	.552	.5888
Balance	.43480	1.494	.1558
Timing	.07491	.208	.8380
(Constant)		10.790	.0000

In the final trial, 83% of the accuracy of intonation could be explained (multiple correlation squared: R^2 = .83175). The share contributed by balance has increased appreciably and risen to a statistically 1% significance level (ß-value = . 51976, T-value = .0096). The increase in the share contributed by timing was huge: the initial trial value was .07491 and the final trial value

.32485 (Sig T = .0590, which represents a significance level of almost 5%).

In the final trial the share contributed by timing exceeded that contributed by glissando, the ß-value of which was .31254 in the initial trial, but only .19052 in the final trial.

Final Trial:

	ß-value	T-value	Sig T
Glissando	.19052	1.333	.2040
Playing Position	.51976	2.999	.0096
Balance	.32485	2.055	.0590
Timing	.05992	.370	.7168
(Constant)		12.764	.0000

The low share contributed by timing (.07) in explaining accuracy of intonation in the initial trial is striking. The explanation for this is to be found in the correlation matrices for both trials:

Initial Trial

Correlations	Inton.Points	Gliss.	Playing Pos.	Balance
Glissando	.6203			
Play.Position	.5764	.2713		
Balance	.7583	.5291	.6711	
Timing	.7198	.5274	.7873	.8491
N = 20				

Final Trial

Correlations	Inton.Points	Gliss.	Playing Pos.	Balance
Glissando	.5866			
Play.Position	.6529	.4800		
Balance	.8253	.3527	.6843	
Timing	.7754	.5662	.4491	.6076
N = 19				

The initial trial matrix shows that there is a strong correlation between all the variables and accuracy of intonation. In reality, however, all these variables are closely related to each other and it is very difficult to distinguish between them. This is shown clearly by the strong correlation between balance and timing in the initial trial: .85. I.e., participants who had good timing in the initial trial also had good balance, and vice versa. Thus, although there was a strong correlation in the initial trial between timing and intonation (.72), its explaining power in the regression analysis remained insignificant, as has already been pointed out. The high correlation between balance and timing means that these predictors are for the most part overlapping. Using one in the prediction leaves very little predicting power to the other. The correlation matrix between variables and intonation for the final trial shows once more that there is a very strong correlation between all four variables and intonation. Only the correlation between the use of glissando and intonation has decreased compared with the initial trial. Timing correlated considerably less with balance than in the initial trial: .61.

In the final trial the correlations between the predictors have decreased and thus they allow greater shares for the predictors than in the initial trial. The ß-coefficient of timing in the final trial has increased to .32: interrelationship between timing and intonation has thus increased.

An attempt has been made above to determine by means of regression analysis the extent to which balance, timing, playing position and the use of glissando predict accuracy of intonation. It would appear that it is very difficult to determine how great the individual contribution of each one is. Balance, timing, playing position and the use of glissando probably are factors affecting intonation that are very closely related to each other in the performance of shifts.Distinguishing between them is, however, possible to a certain extent, as the correlations in the final trial show.

29. Questionnaires.

As in the case of the ear test, the participants completed questionnaires following both the initial and final trials:

29.1. Initial Trial Questionnaire.

1. What level course in violin playing have you most recently completed? When?
2. Do you think long shifts (longer than a fifth) are more difficult or less difficult than short shifts? In which case are you able to achieve better intonation in the new position?
3. What do you need to do during the performance of a shift in order to produce good intonation on the first note in the new position?
4. What pieces that you played in this test did you think were the most difficult: Flesch, Paganini, Sarasate, Suk? Why?
5. Were you more nervous, just as nervous or less nervous during this test than you were during the ear test?
6. If you were nervous, what was the reason for it?
7. Did it make you nervous that you knew beforehand that you would have to perform a lot of shifts?
8. What is difficult about shifting?

9. How did you feel about your playing position: was it a) comfortable, b) quite comfortable, c) uncomfortable? Did the degree of comfort vary under varying circumstances (e.g., during shifting)? How?
10. During the test, were your fingers cold, numb, clammy, warm, dry, comfortably moist, relaxed, sensitive, supple? Underline all the words that apply.
11. Did playing this test feel more familiar and more natural than playing the previous test?
12. Were you able to breathe interpretative life into your playing in spite of it being a test?
13. In your opinion is it easier (or as easy) to play shifts in tune in shifting exercises or in performance pieces? Do you think that musical content helps the violinist play more in tune in performance pieces than in mechanical exercises?
14. Did you shift better (as well, worse) during this test than under normal performance conditions? What is the reason for this?
15. Have you heard about the following factors affecting shifting? Underline those you have heard about: finger pressure, initial glissando, end glissando, follow-through of the shifting movement, bilateral coordination of the hands, the effect of vibrato, the fundamental balances.
16. How do you think a) the configuration and b) the coordination of the shifting movement affects intonation in shifts ?

17. Do you experience performing (i.e., not taking tests) on the violin as something exhilarating, joyful, positive, tolerable or nerve-wracking? Underline the appropriate words.

Most (16) of the participants experienced this video session as being easier than the first: the situation was familiar to them. Nine participants were less nervous than the first time. Five participants experienced greater nervousness for three reasons: in some of pieces (Paganini, Suk) they had to climb into the high positions, there were many shifts in all pieces, and the amount of practicing they had done was rather little. Six participants were equally nervous both times. The Paganini *Moses Phantasy* was considered to be the most difficult piece for the above-mentioned reasons. Some participants thought the Suk piece was difficult because of the great number of accidentals and shifts in it. Quite a few (9) had balance problems in the *Moses Phantasy*.

Participants considered shifting to be difficult for the following reasons:
- the shift is easily heard
- the shift can spoil intonation
- intermediate notes are heard
- it is difficult to "hit" the final note
- it is difficult to keep the hand relaxed
- the use of the thumb is forgotten
- balance problems arise in the higher positions
- intermediate notes are heard

- it is never easy to achieve good intonation

The participants had heard about the following matters connected with shifting:

- the regulation of pressure (2 participants)
- initial glissando (10)
- end glissando (11)
- extension (17)
- contracting the hand (10)
- the configuration of the movement (6)
- the preparation of the movement (13)
- the follow-through phase of the movement (9)
- the coordination of the movements of the hands (12)
- the fundamental balances during the shift (3)

The following factors were considered to be the most important for the achievement of a successful shift:

- the reduction of pressure on the initial finger (1 participant)
- the use of initial glissando (4)
- the overall correct timing of the shift (slow beginning, acceleration) (4)
- the position of the final finger (1)
- the correct regulation of the pressure on the final finger (2)
- stopping the movement of the final finger precisely (2)
- care taken with the note to be played by the initial finger (1)
- control of the role of the bow (2)

- care taken with the movement of the thumb (1)
- care taken with the role of left hand before the bow stroke (1)
- the correct position of the left hand (4)
- tranquillity of performance (1)
- the determination of the length of the shift beforehand (3)

Only six participants played with cold fingers during this test, and 14 with warm fingers. Eight participants thought long jumps were more difficult than short shifts, six participants thought the degree of difficulty depended on the situation (position, interval, tempo, fingerings) and six thought long jumps were easier than short shifts.

19 participants thought it was easier to play in tune in performance pieces than in the Flesch exercises. They felt that the musical content helps them play more in tune. It was easier to produce "concrete" intonation than "pure" intonation. One participant felt performing was a nerve-wracking experience, four felt it to be tolerable, 15 positive and 10 joyful.

29.2. Final Trial Questionnaire.

1. Is learning first-class violin technique in your opinion a) easy, b) quite difficult, c) very difficult?
2. Is it in your opinion important to do research into matters connected with violin technique? Do you think that understanding such things would help violinists practice more effectively?

3. Do you think that you would be competent to teach shifting technique? Why would you, or would you not, be?
4. Do you know how to practice shifting? What are the greatest faults in your shifting technique? Do they sometimes prevent you from carrying out your artistic intentions in a performance piece that pleases you?
5. Were you during this test more nervous, just as nervous, or less nervous than during the initial trial?
6. If there was a difference, what was the cause of it?
7. Was our playing position comfortable, quite comfortable, uncomfortable ? Did the degree of comfort vary under varying circumstances (e.g., during shifting)? How?
8. During the test, were your fingers cold, numb, clammy, warm, dry, comfortably moist, relaxed, sensitive, supple? Underline all the words that apply.
9. To be answered by the test group:
   Has the explanation of the principles of shifting technique helped or hindered you (or neither) in performing shifts?
10. (Test Group): What other important matters affecting the performance of shifts come to mind? Which of these have helped you most ? Or have any?
11. (Test Group): Were you able to internalize any ways of performing shifts (i.e., master them automatically), or did thinking about them disturb your performance of shifts in this test?
12. To be answered by the control group:

Have you practiced the test pieces since the previous taping session? How often? Have you gone through them with your teacher in a lesson ?

13. (Control Group): Did you play better or worse this time than last time?
14. (Control Group) : What do you think was the reason for this?

29.3. Summary of Answers to the Questionnaire:

Ten participants considered the learning of first class violin technique to be very difficult, while eight considered it to be quite difficult. One participant was of the opinion that it is possible if you have a good teacher. All participants answered positively to the question of whether it is important to do research into matters connected with violin technique. In addition, many supported their opinion with long and forceful comments.

Fourteen participants were less nervous in the final trial than in the initial trial, and 5 were more nervous. These last mentioned gave as the reason for this the fact that they were trying to improve their performances in the final trial. This added pressure led to greater nervousness. This time 14 players had warm hands, 5 had cold hands. Members of the control group said they had practiced the pieces "several times", but not with their teachers.

Four members of the test group thought that the explanations of matters related to shifting technique and practicing them were quite helpful, and the remaining six members found them very helpful. Most participants said that they had not been able to internalize new things so that they became automatic. Thinking about details of shifting during the test had disturbed the performance of several of the participants. (None of them said that they had not understood the explanations about shifting technique).

The members of the test group said that they had received the greatest benefit from taking into consideration the following matters during their practicing:

- the integral nature of the movement (1)
- the preparatory movement of the arm (4)
- the preparatory movement of the wrist (1)
- minimum pressure before the shift (4)
- contraction of the hand (2)
- attention paid to the balance of the arm (4)
- attention paid to initial glissando (2)
- relaxation of the thumb (1)

The members of the test group thus felt that they received the greatest benefit from paying attention to the fundamental balances, the regulation of finger pressure and the preparatory phase.

30. "Pure" Intonation: Flesch, Das Skalensystem (Application of the Pythagorean System of Intonation).

By comparing the results achieved in the initial and final trials in the performances of the Flesch triplet exercise, it can be seen that most of the participants improved their performances in the final trial (cf. App. 1,2 and 12). It can thus be assumed that the participants did some practicing of this exercise after the initial trial. Nine members of the test group (N=10) improved their performances (P 2,3,5,6,7,10,12,13,15), while six members of the control group (N=9) improved theirs (P 1,8,9,11,14,16). Only one member of the test group (P 17) was not able to improve his performance. Three members of the control group (P 4,18,19) performed equally well or more poorly than in the initial trial. Five members of the test group (P 2,3,5,10 and 12) were able to make great improvement in their performances. Three members of the control group (P 8,4,16) were able to improve their performances appreciably.

Thus, 50% of the test group and 33% of the control group improved their performances appreciably. In addition, it is worth pointing out that three of the members of the test group (P 2,3 and, 12) who improved their performances appreciably in the final trial performed the fewest successful shifts in the initial trial (P 2: 3 shifts; P 3: 1 shift; P 12: 3 shifts). The evaluations for intonation given these participants by the jury in the initial trial reflect this situation: P 2: 10.4; P 3: 13.4; P 12: 12.6. The least successful members of the control group in the initial trial were the following: P 1: 4 shifts in tune, jury points 13.6; P 2: 2 shifts in tune, jury points 13.2; P 11: 4 shifts in tune, jury points 12.6. Not one of them improved their performance appreciably in the final trial.

We can conclude on the basis of the above that almost all members of the test group had improved their shifting performances, and that 50% of them had made appreciable improvement. The instructions given, and the practice done on the basis of them, had had great influence on the performances of this group. In addition, it would appear that those who received the greatest benefit from the instruction were those participants who had performed most weakly in the initial trial (P 2 and 3).

As far as timing of the shifting movement is concerned, we can draw the conclusion from the following table that the participants who improved their performances most spent considerably more time on the preparatory phases of their shifts in the final trial than in the initial trial (P 2,3,5 and 8 cf. the table). This would appear to support our conception that an effective duration of the preparatory phase of the shifting movement is decisive for the production of a smooth and integrated shift. A scant or lacking preparatory phase was just as unsuitable from the standpoint of the overall timing of the shift as excessive stretching out of the duration of the preparatory phase (e.g.,P 9 and 12 in the initial trial).

30.1. The Duration of the Preparatory Phase of Shifts Performed by Participants Who Improved their Performances Appreciably (Flesch, sitting, ♩ =54):

INITIAL TRIAL					FINAL TRIAL			
	Notes in tune	Jury Points	Ave. duration of prep.phase		Notes in tune	Jury Points	Ave.duration of prep.phase	
P			upward shifts	downward shifts			upward shifts	downward shifts
2	3	10.4	0	0	6	15.8	0.39	0.38
3	1	13.4	0	0	6	15.8	0.63	0.46
5	8	17.2	0.29	0.18	8	19.0	0.55	0.27
8	5	14.0	0.34	0.18	7	15.6	0.46	0.24
10	2	14.6	0.46	0.39	8	15.2?	0.60	0.71
12	3	12.6	0.59	0.42	7	14.0	0.46	0.48
14	5	16.8	0.39	0.38	5	18.6	0.45	0.50
16	3	14.4	0.59	0.36	8	18.8	0.65	0.34
			Σ = 2.66	Σ=1.91			Σ= 4.19	Σ=3.36

The jury points marked with a question mark are in conflict with the number of final notes in tune produced by this participant: the jury points are surprisingly low.

31. Concrete and Artistic Intonation (Suk: Quasi Ballata).

It was possible to investigate how the participants managed the demands of concrete intonation in connection with the pieces having musical content. In addition, it was possible to evaluate whether or not any of the participants made use of artistic intonation in playing these pieces, and how the jury evaluated these performances. The following table shows the number of notes out of tune counted by the planner of the experiment in each participants's performance of Suk's *Quasi Ballata*, the number of notes out of tune in shifts, and the jury points for each participant. The results for the initial and final trials are presented next to each other.

	INITIAL TRIAL			FINAL TRIAL		
	total notes out of tune	notes out of tune in shifts	jury points	total notes out of tune	notes out of tune in shifts	jury points
P						
1	13	8	9.0	8	4	12.8
2	18	10	10.4	7	1	16.2
3	18	12	13.4	9	5	16.4
4	17	8	14.2	14	5	13.0
5	8	3	15.8	6	4	17.8
6	15	9	13.4	7	5	16.8
7	9	6	15.8	5	2	19.6
8	14	5	14.6	14	4	17.0 ?
9	21	10	12.4	17	10	13.8
10	11	4	17.2	3	2	17.4
11	20	10	11.2	23	9	12.2
12	21	7	12.0	12	5	16.4
13	21	9	15.0 ?	12	4	16.8
14	10	6	17.4	7	4	21.2
15	18	7	15.6 ?	12	4	16.2

	total notes out of tune	notes out of tune in shifts	jury points	total notes out of tune	notes out of tune in shifts	jury points
16	8	3	16.8	9	3	16.0
17	10	6	14.0	9	6	14.0
18	11	7	15.6	11	8	14.2
19	10	4	14.8	17	11	16.4 ?
20	10	6	19.0	-	-	-

As can be seen from the table, insufficient mastery of the piece cause a plethora of intonational mistakes in the initial trial. Many of the players were still struggling with difficulties due to the newness of the piece. It is not possible to talk about them adopting "artistic" intonation in their performances, but simply rather that they did not master concrete intonation in it (P 1,2,3,6,9,11,12).

There were, however, several of the participants who were able to inject interpretive power into their performances and to shade intervals on the basis of an artistic point of view (P 4, 8 , 10, 13, 14, 15, 18, 20). It appears that the jury evaluated these performances either consciously or subconsciously on the basis of artistic intonation criteria. This is shown by the fact that even though the performances of several participants who achieved artistic interpretations contained relatively many clearly audible glissandos and too slowly corrected final notes, they were nevertheless awarded quite high intonation evaluations by the jury. Thus in these cases both the players and their auditors adopted (consciously or subconsciously) the evaluation criteria of artistic intonation. A strong artistic contribution thus made up for slight errors in concrete intonation. At this point the "strict" evaluation criteria of the planner of the study, that call for uncompromising purity of concrete intonation, could perhaps be criticized. Perhaps the intonational "impurities" of an interpretationally strong performance should be evaluated as different degrees of "shading" of intervals, as Garbusov has suggested, rather than intonational errors. Such a "matter of taste" cannot be resolved because the borderline between concrete and artistic intonation cannot be strictly defined.

In those cases where the artistic interpretation was weak, as in the case of the overwhelming majority of the participants' performances in the initial trial, the jury appeared to have listened to the performances by adopting the evaluation norms of concrete intonation. Thus a participant such as P 17, who played quite precisely, but uninvolvedly, was awarded only 14 points by the jury in the initial trial, although the performance contained "only" 10 notes out of tune. The same happened in the case of P 19, with only 10 notes out of tune, but who received no more than an average of 14.8 points from the jury. It would appear that the intensity of the interpretation encourages the listener to evaluate the performance "artistically" and disengages him to a greater or lesser degree from the evaluation principles of concrete intonation. Deficiencies in concrete intonation were made up for in accordance with the theories of Gestalt psychology. This often takes place even though the listener is a highly trained professional violinist.

A third group, which was the best from the standpoint of intonation, was composed of three players in the initial trial who played with nearly impeccable concrete intonation and who in addition gave strong interpretations of the pieces: P 5, 7 and 16.

Many participants improved their performances of *Quasi Ballata* in the final trial. Several of the participants in the test group made great improvement (P 2,3,6,7,12). Eight members of the test group improved their performances appreciably, and one more made clear improvement: P 5, who was awarded 15.8 jury points in the initial trial, compared to 17.8 in the final trial. Only one member of the test group failed to improve his performance: P 17.

31.1. Members of the Test Group Who Appreciably Improved their Performances (Quasi Ballata):

	INITIAL TRIAL		FINAL TRIAL	
	Notes out of tune	Jury points	Notes out of tune	Jury points
P				
2	19	10.4	7	16.2
3	18	13.4	9	16.4
6	15	13.4	7	16.8
7	9	15.8	5	19.6
10	11	17.2	3	17.4 (?)
12	21	12	12	16.4
13	21	15 (?)	12	16.8
15	18	15.6 (?)	12	16.2

The question marks denote inconsistency between jury points and the number of notes out of tune. Six members of the control group (N=9) improved intonation in their performances of *Quasi Ballata*. However, only two of them made appreciable improvement: P 1 and 14. Three members of the control group did not improve their performances at all (P 4,16,18). For some reason P 11 received a better evaluation for intonation in the final trial even while producing a greater number of notes out of tune.

31.2. Improvement of Intonation by Members of the Control Group (Quasi Ballata):

	INITIAL TRIAL		FINAL TRIAL	
	Notes out of tune	Jury points	Notes out of tune	Jury points
P				
1	13	9	8	12.8
4	17	14.2 (?)	14	13
8	14	14.6	14	17(?)
9	21	12.4	17	13.8
14	10	17.4	7	21.2
19	10	14.8	17	16.4

Thus 50% of the members of the test group made great improvement in their playing of *Quasi Ballata*, and another 40% made appreciable improvement, while only a little over 20% of the members of the control group made appreciable improvement and 60% fair improvement. It is thus tempting to assume that the instruction in shifting technique that they received and the attention paid in it to question of balance and the preparatory phase of the shift had a decisive effect in aiding the members of the test group to improve their performances. And indeed, as has been mentioned earlier, the members of the test group reported in the questionnaire that they had experienced the improvement in the fundamental playing balances and the greater effectiveness of the timing of the shifting movement as a great help.

32. The Effect of the Instruction on Performance Improvement.

Performance improvement was evaluated on the basis of change in jury points between initial and final trial in the following way: an increase of 0.5 or less points was considered to represent lack of improvement; an increase of 0.5-1.5 points was considered to represent fair improvement; an increase of more than 1.5 points was considered to represent appreciable improvement. The members of the test group are divided into two groups in the following analysis: those who stated on the questionnaire administered after the final trial that they had not had time to assimilate the instruction provided between initial and final trial, and those who stated that they had been able to assimilate it. A separate table is provided for each assignment played in the two trials (CG= Control Group, TG= Test Group):

1. Flesch, sitting

Improvement	CG	TG total	not assimilated	assimilated
more than 1.5 points	3	4		4
0.5 - 1.5 points	2	2		2
less than 0.5 points	4	4	3	1
	N= 9	N= 10	Σ= 3	Σ= 7

P 20 did not participate in the final trial. This naturally affects the results somewhat.

2. Flesch , standing

Improvement	CG	TG total	not assimilated	assimilated
more than 1.5 points	3	7		7
0.5 - 1.5 points	2			
less than 0.5 points	4	3	3	
	N= 9	N= 10	Σ=3	Σ= 7

3. Paganini

Improvement	CG	TG total	not assimilated	assimilated
more than 1.5 points	4	8	1	7
0.5 - 1.5 points	1			
less than 0.5 points	4	2	2	
	N= 9	N= 10	Σ= 3	Σ= 7

4. Sarasate

Improvement	CG	TG total	not assimilated	assimilated
more than 1.5 points	3	7	3	4
0.5 - 1.5 points	2	2		2
less than 0.5 points	4	1		1
	N= 9	N= 10	Σ= 3	Σ= 7

5. Suk

Improvement	CG	TG total	not assimilated	assimilated
more than 1.5 points	4	7	1	6
0.5 - 1.5 points	2	1	1	
less than 0.5 points	3	2	1	1
	N= 9	N= 10	Σ= 3	Σ= 7

A quick perusal of these charts shows that the test group as a whole made more improvement than the control group. It is worth nothing one fact: the members of the control group who made fair and appreciable improvement (P 8,11,16 and) were respectively 16,17,15 and 16 years of age, i.e.,their playing skills were quite highly developed and they were able to practice efficiently and rationally. On the other hand, the members of the test group who made fair or appreciable improvement in their performances of most of the assignments (P 2,3,5,7,12 and 3) were respectively

12,14,13,13,13 and 14 years of age, i.e., decisively younger. This adds considerably to the significance of the improvement made by the test group.

33. Summary of the Results of the Study.

The purpose of this study was to show that

1. Long shifts are more difficult than short shifts when the hand of the player is not balanced. The shifts then tend to remain too short.
2. Intonation in shifts can be influenced by changing the configuration of the shifting movement.
3. Intonation in shifts can be influenced by changing the timing of the shifting movement.

Intonation in playing the violin is influenced by three factors: the ear of the player, playing technique and the proportions and condition of the instrument. In this tripartite study the role of the player's ear was eliminated by showing that the "musical ear" of every participant was sufficiently precise and practiced to play a single-line melody in tune in accordance with the so-called Pythagorean system of intonation.

33.1. The Relationship between Intonation and the Extent of the Shift.

As has been noted in an earlier context, Jankelevits mentions in passing in his dissertation the common conception that long jumps cause violinists "well-known difficulties" (p.241 above). Jankelevits mentions the fear of playing out of tune or losing the beat as the cause of these special difficulties, but does not substantiate this in any way.

In the present study the participants' success in performing long shifts (intervals of a fifth or more) was compared to their success in performing short shifts. It was shown that long shifts do not cause "special difficulties". Quite to the contrary, the best results were achieved in long shifts **upward**. The direction of the shift - i.e., not its extent - turned out to be the decisive factor: both long and short shifts **downward** resulted in more final notes out of tune. Long shifts did not tend to remain too short as our hypothesis presumed - but both long and short shifts **downward** did.

A comparison of successful long and short shifts in two balance groups produced a surprising result. Those players whose left hands did not appear to be balanced carried out long shifts on the average more successfully than those whose hands appeared to be balanced. An explanation for this may be that the former group concentrated better (for one reason or another) on the long shifts than did the latter group.

33.2. The Relationship between Intonation and the Configuration of the Shift.

In this study the configuration of the shifting movement was considered to include the following factors (cf. p. 242 above):

1. Playing position and the fundamental balances.
2. The paths of movement of the hand and muscular tension.

The influence of the fundamental balances on intonation was studied by dividing the participants into two "balance groups" and comparing the points awarded by the jury for intonation to the members of the two groups. Dividing the participants into the two groups was done by means of audio-visual analysis, according to the following factors involved in the shifting movement: the naturalness of the playing position, the elasticity of the upper arm and wrist, control of the fundamental balances as the hand moved over the edge of the violin and back, the elasticity and activity of the thumb, the angle at which the fingers strike the fingerboard, the distance of the fingers above the string, as well as the type of vibrato and its use (cf. pp. 232-233 above).

The points for intonation received by members of the two groups were compared. On the basis of this comparison it was observed that the average of the points for intonation received by those participants whose shifts were not balanced was well below the "excellent" level (lower limit:16). The averages of these last mentioned were 14.22 (IT) and 14.83 (FT), while the corresponding averages for the group whose shifts were balanced were 16.39 (IT) and 17.25 (FT). The difference between the averages of the two groups represented a risk level of 0.5% in the initial trial and a risk level of 1% in the final trial.

The participants were also divided into two groups according to how they held the violin: either with the neck pointing toward the floor or with the neck in horizontal position. Once again, it could be observed on the basis of the video tape that those participants who held the neck of the violin in a horizontal position played fewer notes out of tune than those who let the neck of the instrument point towards the floor. Not a single participant who "dangled" the violin received an "excellent" evaluation for intonation in the final trial. In the final trial, two such participants achieved an "excellent" evaluation. In addition, several of these "danglers" received the lowest evaluations for intonation in the final trial. The difference between the averages of the two groups represented a risk level of 0.5% in the initial trial and a risk level of 0.05% in the final trial.

33.3. The Relationship between Intonation and the Timing of the Shift.

In studing the timing of shifts, the following factors and their influence on intonation were investigated: a) the use of glissando, b) the preparatory phase of the shift, the execution phase and its associated follow-through stage, and c) the total duration of the shift (preparatory phase + execution phase).

The shifts were taped on video film showing a running time counter. Thus the various phases of the shifts could be measured by observing the hand movements when the film was played at slow motion. The audio-visual analysis showed that most of the participants made use of glissando rather carelessly, at least in the initial trial, causing intonational problems. In the initial trial only four players (N = 20) used initial glissando, three of them only fleetingly. Careless end glissando was used in abundance. In the final trial initial glissando was employed by all of 10 participants. The group that made use of both initial and end glissando performed the shifts in the final trial considerably better than the other group, that made use exclusively of end glissando.

The following points can be made about the relationship between intonation and the total duration (PREP+EXEC; Flesch,sitting, ♩=54) of shifts:

1. Those participants who received "excellent" evaluations for intonation used on the average more time in shifting both upward and downward than the remaining participants (cf. Diagrams 2 and 4).
2. When the preparatory phase was sufficiently long, the shift as a whole was successful. Lack of preparatory phase ruined intonation.
3. Those participants who used the least time in shifting (i.e., lack of preparatory phase and jerky execution phase) also received the lowest evaluations for intonation.
4. Participants who received "excellent" evaluations for intonation used appreciably more time on the preparatory phase of successful **downward** shifts than other participants (cf. Diagrams 5 and 6). The duration of the execution phase was approximately the same in successful shifts both upward and downward in the performances of all participants (0.19 sec.).
5. In the final trial the test group used on the average more time in the performance of the preparatory phase than the control group (cf. Diagram 7).
6. The structure of the total duration of shifts performed by those participants who received the highest evaluations for

intonation (P 5, FT and P 16, FT) formed regular "sawtooth" curves in which more time was made use of consistently in upward shifts than in downward shifts (cf. Diagrams 10 and 11). The total durations of the shifts of other participants receiving "excellent" evaluations for intonation did not produce equally regular curves. The shifts of these last mentioned participants did, however, have one characteristic in common: sufficient time was used in both upward shifts and downward shifts.

7. Great time differences in shifts produce intonational inaccuracies. If all shifts are carried out consistently in the same way, even shifts with scant use of time can produce "excellent" intonation (e.g., P 16, FT).

8. Excessive stretching out of the duration of a shift is not advantageous from the standpoint of the production of good intonation.

9. The sum of total durations (= 5 upward shifts and 5 downward shifts) correlates as expected with the average number of points for intonation given by the jury: the correlation for upward shifts (including both initial and final trial) was .41, and for downward shifts it was .50 (cf. App. 15 and 16).

10. The correlation between extending the total duration and increasing the number of final notes in tune (Flesch, sitting, ♩ = 54) was .54 (cf. App. 17).

11. Good intonation could be achieved by means of many different timing strategies as long as the same strategy was employed consistently. Various degrees of freedom were thus possible in

the timing of shifts. Effective timing could mean the employment of either scant, ideal or rather long durations. On the other hand, disproportionately short or long durations did not produce "excellent" intonation.

12. The correlation between the effective duration of the preparatory phase of shifts and the jury evaluations for intonation was .47 for the initial trial and .48 for the final trial (cf. App. 18).

34. Other Results.

1. The best results were achieved on the average at freely selected tempos (Flesch,sitting).
2. Effective timing of shifts was not in itself sufficient to achieve "excellent" intonation. Although balance and the use of glissando correlated best with intonation in regression analysis in the initial trial, and balance and timing in the final trial, all variables (glissando, playing position, balance, timing) correlated strongly with intonation. In reality, these variables function in close cooperation with each other and it is very difficult to separate them. This is shown, e.g., by the strong correlation between balance and timing obtained in the initial trial: .85.

   It is thus very difficult to determine the separate effects of glissando, playing position, balance and timing. However, distinguishing between them is to a certain extent possible, as the correlations for the final trial show.

3. Musical content improved intonation. Playing with concrete (and to some extent artistic) intonation was more successful on the average than playing with pure intonation.
4. The empirical section of the study showed that intonation can be influenced positively by means of performance instructions. Guidance helped the test group to improve their performances. This viewpoint is supported by the opinions of the members of the test group expressed on the questionnaire administered in connection with the final trial. The greatest benefit from performance instruction accrued to those members of the test group who played most poorly and with the most deficient technique in the initial trial.
5. According to the answers given by the members of the test group they had the greatest benefit from instructions concerning attention paid to the preparatory phase, the regulation of finger-tip pressure and the fundamental balances.
6. When the results of the initial and final trials were compared with each other, it could be seen that the test group had made appreciably more progress than the control group. The number of members of the two groups who improved appreciably in the various assignments in both the initial and final trials can be tabulated as follows:

	TG	CG
Flesch, sitting	4	3
Flesch,standing	7	3
Paganini	8	4
Sarasate	7	3
Suk	7	4

7. The best results were achieved when a shift was carried out with a totally integrated combination of all elements of its configuration and timing.

35. Summary of the Audio-visual Analysis:

The principle errors made by many of the participants were the following:

- the playing position did not appear to be balanced
- the shifting movement was not integrated and did not originate in the movement of the upper arm
- the upper arm was often stiff and rigid. If it moved, it followed the rest of the arm rather than initiating the movement. Playing was too concentrated in the fingers.
- initial glissando was in the beginning not used at all, end glissando was used incorrectly
- lack of fundamental balances during the shift: finger pressure is not regulated, the arm is extremely tense and pulls the neck of the violin down
- the timing of the shifting movement was not under control: the shifts were often sudden and jerky. The preparatory phase was often unclear and sometimes totally lacking. If it could be observed at all, it was usually scant. Not enough attention was paid to the follow-through: the scantiness of the execution phase revealed this deficiency.
- the overall timing of the shift (slow beginning, acceleration toward the end) was not carried out correctly

- the thumb and wrist of few participants were elastic and active enough.
- the thumb did not function efficiently as a distributor of pressure.

(cf. Appendix 22 for detailed description of the performance of each participant).

36. Discussion.

It is a fatal mistake in professional violin playing to leave the technical aspects of performance to chance. The same is true of the violin teacher: the more professional he is, the less he leaves to chance in his teaching methods. This requires that the teacher be completely familiar with all the critical details of violin playing: mechanics and biomechanics, the paths of movement, the possibilities of employing speed and strength under various circumstances, the technical aspects of the coordination of movements, the personal qualities of his pupils, and the influence of both internal and external conditions on performance. The feedback provided by the teacher is based (once proper recognition has been given for a good attempt) on visual and aural observations and comparisons he makes with an ideal performance that he has clearly in mind.

In diagnosing a pupil's playing, the teacher must be able to distinguish, in each and every situation, between what is essential musically and technically and what is not essential. Otherwise, his teaching is non-productive. Unless he has the knowledge, and the skill to adapt it at the right time under the right circumstances, there is no possibility that he will be able to make a successful series of diagnoses.

A really knowledgeable and skilful teacher is worth his weight in gold especially in the beginning stages, when it is of primary importance that the child not get into any bad senso-motor habits that will impede his development. Once he has made his diagnosis, the teacher prescribes appropriate "medicine", i.e., gives advice and assigns exercises that will allow the pupil to develop in the right direction. Brilliant examples of exceptionally skilful "violin doctors" are Carl Flesch, who along with Leopold Auer was the most outstanding violin pedagogue in the world in the first half of the 20th century, and also Juri Jankelevits, whose teaching still radiates strength even today through the playing of his many brilliant pupils.

The pupil must also have attained a certain artistic and technical level in order to be able to be receptive to the instructions of his teacher and to put them into effect. First, the pupil must understand the instructions linguistically, grasp how to implement what has been explained or demonstrated to him, and then he must be able to keep the muscular tensions in his arms and body under control. In carrying out the instructions of his teacher, it is of use to the pupil that he have in mind as many motor movement models (so-called engrams) as possible. To put it another way: his reserve of basic movements must be sufficiently large.

The empirical part of the present study supports the assumption that, by properly learning the basics of shifting technique, intonation in violin playing can be improved, especially a) when the player has basic technical weaknesses and b) when he has to perform unusually difficult shifts. The experiment showed that if excellent intonation is to be achieved in shifts, the duration of the preparatory phase of the shift must stand in proper proportion to the duration of the execution phase. When intonation achieved was less than excellent, the preparatory phase of the shift was either too long or too short in relationship to the execution phase, or was lacking altogether. There were, however, exceptions to this. The follow-through phase of the movement also affected the quality of the intonation: careless follow-through resulted in poor intonation.

Even violinists with good ears played out of tune when their movements were uneconomical or their muscles appeared to be unnecessarily tensed. Proper guidance, treating the configuration and coordination of movement, the fundamental balances, the regulation of fingertip pressure, the use of glissando, the activization of only necessary groups of muscles and the formation of strong mental images, resulted in substantial improvement in the performances of nearly all members of the test group. Those participants who produced poorest intonation in the initial trial benefitted most from this guidance. It is thus possible to maintain that the proper overall coordination of the shifting movement (preparatory phase, execution phase and follow-through) positively affected intonation achieved in shifts.

The necessity of cognitive processes in connection with motor actions is shown by the so-called degrees of freedom or alternate possibilities. There is not only one optimal way to achieve a given goal, but rather various alternatives. During the experiment it became clear that it is possible to achieve excellent intonation through the use of more than one timing strategy in shifts. Every participant who received "excellent" evaluations for intonation coordinated the shifts in a manner that suited him best and which worked together with his own peculiar set of muscular tension, balances and regulation of fingertip pressure and glissando. There were thus many degrees of freedom, and most of them led to the desired result.

In future studies it would be useful to investigate the coordination of shifting movements in the playing of master violinists. Juri Jankelevits' dissertation is an excellent example of this type of work, the results of which can be applied directly to violin teaching in practice. It would be especially illuminating to compare how master violinists and pupils coordinate shifts. The effectiveness of video-taping playing movements could be increased by using more than one camera at a time. The measurement of the duration of the various phases of the shifts could be carried out by strictly automatic methods in order to eliminate the delay introduced by human reaction time. Video tape could also be used to help teach movements, as athletes have been doing for a long time with great success: the pupil could watch the movements of the masters in slow motion (e.g., there are excellent films of the playing of Heifets, Oistrakh and Kogan), as well as their own movements. The most natural taping enviroment would, of course, be a concert or playing test, the video-taping of which would provide much useful information about other things than shifting.

The study of the effects of the bilateral isolation of the hands could with profit be continued along the lines set down by Szende. It would be, e.g., interesting to find out how the regulation of the muscular tension and application of pressure of the bowing arm affects the carrying out of shifts. Research into the different types of "creative" intonation employed in shading intervals (cf. Garbusov) would also be a challenging task. It would be interesting to know how given performers play the same intervals under different circumstances and how creative intonation changes as one moves from one style of music to another.

Science is the sister of art. Therefore, the artist can - at the same time that he is delving into problems of musical interpretation - take advantage of the observations of both natural science and the human sciences and in this way gain a still deeper understanding of his own nature. Science can also serve to promote the attainment of artistic goals if the artist, in his search for ever higher levels of achievement, is able to unite the results of scientific inverstigation with his own in-born gifts, strong motivation and practical experience.

The history of violin playing shows us that violin pedagogues have been carrying out investigative work for several hundred years. Many famous violinists have also be known for their research in the field. In the 18th century Tartini wrote articles on violin pedagogy and developed his method of practicing bowings, toward the end of that century Viotti helped Tourte create the modern bow, at the turn of the century Paganini renewed violin technique, and at the beginning of the 19th century Spohr developed the first chin-rest, to give a few examples. During the 20th century many outstanding violinists in addition to Carl Flesch, Konstantin Mostrass, Paul Rolland and Ottó Szende have carried on investigative work that has promoted violin pedagogy internationally.

Samuel Applebaum's extensive series, *The Way They Play* (Books 1-14) gives a clear picture of the fact that it is often precisely the greatest violinists who have devoted themselves to exploring the intricacies of violin technique in addition to questions of interpretation. In general, they have not employed scientific methods, but their many sophisticated insights based on practical experience have been comparable to scientific observations in their clarity.

Steinhausen made the wise observation that "we can teach our body nothing; we can only learn from it " (Steinhausen,1928, p.10). By this he meant that the violinist must strive for as natural a performance as possible when he is practicing. A thoroughly practiced movement becomes automatic, and when it reaches that stage the violinist no longer has to check it in detail. As he proceeds through the interpretive stage to the final performance stage he must have faith that his hands will carry out their assignment by themselves: the movements must be allowed to flow freely. Only when thoughts that delay the action of movements are no longer necessary, are movements ready to be used for musical expression. Only then can there arise resonant movements that allow the violinist to express the most profound depths of both the music and himself.

APPENDIX 1. POINTS FOR INTONATION GIVEN BY EACH JURY MEMBER
Evaluation Scale: 11-25, Flesch,at three different tempos 1-3. P = Participant

INITIAL TRIAL

Jury member no 1

P	Flesch sitting		Flesch standing		Paganini	Sarasate	Suk
1	13	1 2 1	13	1 1 1	14	13	12
2	12	1 1 2	13	1 2 2	12	13	12
3	13	2 1 1	13	1 2 2	13	15	12
4	12	1 2 1	14	2 2 2	12	12	12
5	15	2 2 3	15	1 3 2	16	15	14
6	13	2 2 1	14	2 1 2	17	16	14
7	16	3 2 2	16	2 3 1	18	19	18
8	15	2 1 1	15	2 3 2	17	15	16
9	12	2 1 1	11	1 2 1	13	13	12
10	14	2 3 2	13	2 3 2	18	19	19
11	12	2 1 1	11	2 1 1	11	11	11
12	12	3 2 1	11	2 2 3	14	14	10
13	14	3 2 1	16	2 3 2	12	14	14
14	18	3 2 1	17	2 2 3	18	16	18
15	16	2 2 2	17	3 2 2	16	17	16
16	15	2 2 2	15	2 2 2	16	18	15
17	15	2 1 2	16	2 3 1	14	12	13
18	16	2 2 1	17	2 2 1	18	17	18
19	18	2 1 2	19	3 3 2	20	20	19
20	17	2 2 2	18	2 3 2	21	22	23

Jury member no 2

P	Flesch sitting		Flesch standing		Paganini	Sarasate	Suk
1	15	2 3 1	13	3 2 1	12	12	10
2	13	1 1 2	14	1 2 2	8	10	13
3	15	3 2 1	16	2 3 2	15	12	15
4	16	3 2 2	14	2 1 2	12	12	14
5	19	3 2 2	18	1 3 2	18	18	19
6	16	2 1 2	16	2 1 3	18	16	14
7	16	2 3 1	16	2 3 2	14	14	14
8	16	3 1 2	16	2 3 1	15	14	14
9	14	2 1 1	13	1 2 1	14	13	15
10	15	3 2 2	14	1 2 2	16	17	16
11	13	2 1 1	13	2 1 1	14	11	13
12	14	2 3 1	14	1 2 3	10	13	10
13	14	1 3 2	14	3 2 1	15	11	12
14	15	2 1 3	15	2 1 3	16	14	14
15	15	2 2 3	15	3 2 1	13	12	15
16	15	2 1 2	15	2 1 3	15	14	16
17	16	2 1 3	16	2 3 2	14	13	15
18	15	2 3 1	15	3 2 1	15	15	14
19	16	3 1 2	18	3 2 2	18	17	15
20	17	3 2 2	18	3 2 2	18	20	19

Jury member no 3

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	13	3	1		10	1	1	1	15	13	8
2	7	1	1	1	10	2	1	1	14	12	10
3	10	2	1	1	12	3	2	1	17	15	11
4	14	3	2	1	13	3	2	1	14	14	15
5	16	3	1	1	15	3	2	1	18	15	13
6	12	1	1	1	12	1	1	2	17	16	13
7	17	3	2	1	15	3	2	1	19	21	17
8	14	3	2	1	13	3	2	1	16	16	14
9	13	3	2	1	11	3	2	1	17	15	10
10	12	3	2	1	9	2	1	1	17	18	17
11	11	2	1	1	9	1	1	1	16	9	9
12	11	2	1	1	8	1	2	1	15	16	15
13	15	3	2	2	14	2	3	1	18	15	16
14	16	3	2	2	16	2	2	2	18	18	18
15	14	2	2	2	13	2	3	1	13	13	13
16	13	1	1	2	14	2	3	1	17	18	16
17	14	3	2	1	13	2	3	1	15	15	14
18	15	3	3	1	14	2	3	1	17	15	16
19	16	3	2	1	18	3	3	2	20	17	13
20	14	2	2	2	14	2	2	2	15	16	17

Jury member no 4

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	13	3	2	1	12	1	1	1	16	14	5
2	8	1	1	1	12	1	2	3	13	11	8
3	13	3	2	1	14	2	1	1	13	12	10
4	16	3	2	1	15	3	2	1	15	16	16
5	16	3	2	1	17	3	2	2	17	15	16
6	15	3	2	1	16	3	2	2	20	15	13
7	15	3	2	2	13	3	2	2	14	16	15
8	13	2	2	2	13	3	2	2	16	17	15
9	14	3	2	1	13	2	3	1	17	16	13
10	16	2	2	3	14	2	3	1	18	18	17
11	11	2	1	1	10	2	3	1	11	10	12
12	12	3	2	1	11	2	3	2	13	17	14
13	19	3	3	2	15	2	3	2	19	15	14
14	14	2	2	2	14	2	2	3	17	17	18
15	16	2	2	3	17	3	2	1	16	18	17
16	15	3	2	2	15	3	2	2	17	18	18
17	13	3	2	2	14	3	2	1	15	13	14
18	15	3	2	2	14	3	2	1	13	14	13
19	18	3	2	1	18	2	3	1	20	17	14
20	10	1	1	1	10	1	1	1	18	18	17

Jury member no 5

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	14	1	1	2	13	2	1	1	15	18	10
2	12	1	2	2	12	1	2	1	10	13	9
3	16	2	2	2	13	1	2	2	13	17	19
4	19	3	2	2	17	2	2	2	13	17	14
5	20	2	2	2	18	2	2	2	19	19	17
6	19	2	2	2	19	3	2	3	21	18	13
7	21	3	2	2	18	2	2	1	18	19	15
8	12	2	1	2	14	2	2	1	15	16	14
9	13	2	1	1	10	1	2	1	13	14	12
10	16	2	2	3	14	2	1	2	19	21	17
11	16	2	2	2	14	2	1	1	12	11	11
12	14	2	2	2	10	1	1	1	12	16	11
13	21	2	3	2	19	2	3	2	22	19	19
14	21	3	2	2	21	3	2	2	20	22	19
15	18	2	2	3	18	2	2	2	15	17	17
16	14	2	2	2	16	2	1	2	15	20	19
17	14	2	2	2	17	3	2	2	19	14	14
18	15	2	2	1	15	2	2	1	18	19	17
19	19	3	2	2	21	3	3	2	19	21	13
20	18	2	2	2	19	2	3	3	21	23	19

APPENDIX 2. POINTS FOR INTONATION GIVEN BY EACH JURY MEMBER
Evaluation Scale: 11-25,Flesch, at three different tempos 1-3

FINAL TRIAL

Jury member no 1

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	13	1	2	1	14	2	1	2	13	12	12
2	14	2	1	3	14	2	2	1	12	14	16
3	16	2	2	1	16	2	1	1	18	17	16
4	12	1	2	1	12	1	1	1	13	13	12
5	18	3	2	3	19	3	2	3	20	20	19
6	18	3	2	1	17	2	1	2	18	19	20
7	18	2	1	1	19	2	2	2	20	20	21
8	18	2	1	2	17	3	2	2	22	21	18
9	13	1	1	1	11	1	1	1	13	12	12
10	15	2	1	1	16	2	1	2	20	21	18
11	15	2	2	1	13	2	2	1	10	10	11
12	13	2	2	1	13	2	1	1	15	16	15
13	16	2	2	1	17	2	2	2	19	19	18
14	20	2	2	3	20	2	2	3	21	20	20
15	16	2	1	1	16	1	2	2	18	18	17
16	20	3	3	2	19	3	2	2	20	19	18
17	14	1	1	2	13	2	1	1	15	16	12
18	12	1	2	1	13	1	2	2	14	14	13
19	16	1	2	2	17	2	2	2	20	20	16

Jury member no 2

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	16	2	2	1	15	2	1	3	15	13	14
2	16	1	2	3	14	1	2	1	16	14	16
3	14	2	2	1	16	1	3	2	17	15	15
4	13	1	2	1	14	1	2	2	15	11	13
5	18	2	3	2	19	2	3	2	20	18	17
6	15	3	2	1	16	2	1	3	16	17	16
7	17	3	1	1	18	2	3	2	20	18	20
8	15	3	1	2	16	3	1	2	20	17	16
9	14	2	3	2	12	2	1	1	15	14	15
10	15	2	3	1	15	2	1	3	18	17	18
11	14	2	1	3	13	1	2	1	14	15	13
12	13	2	1	1	14	3	1	2	15	15	17
13	17	2	3	1	17	3	2	2	16	16	16
14	17	2	2	3	17	3	2	1	21	21	22
15	15	2	3	1	16	2	3	2	16	16	15
16	17	1	3	2	16	3	2	1	17	15	16
17	13	1	2	3	13	2	1	3	14	15	14
18	14	2	1	3	14	2	2	3	16	15	15
19	17	2	3	2	17	2	3	1	18	19	17

Jury member no 3

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	14	2	3	1	12	2	2	1	14	15	13
2	15	1	2	2	16	3	2	1	16	14	15
3	15	2	3	1	17	2	3	1	18	16	17
4	13	2	2	1	13	2	2	1	16	14	12
5	19	2	3	1	18	2	2	2	20	19	18
6	12	1	2	1	12	1	2	1	17	18	16
7	18	3	2	1	18	3	2	1	21	19	20
8	14	3	2	1	13	3	2	1	20	18	18
9	13	2	2	1	12	2	2	1	17	14	14
10	16	2	3	1	17	2	3	1	20	18	18
11	15	3	2	1	13	2	1	1	16	17	13
12	14	2	3	1	16	2	3	1	18	18	16
13	17	2	2	1	17	2	2	2	21	21	17
14	15	2	2	2	16	2	2	1	21	20	22
15	17	2	2	1	16	3	2	1	19	17	17
16	19	2	2	2	16	3	2	1	17	16	15
17	14	2	2	1	12	2	2	1	15	15	13
18	16	2	2	2	14	3	2	1	14	14	14
19	17	2	2	1	16	2	1	3	21	20	17

Jury member no 4

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	14	2	3	1	15	3	1	2	16	15	13
2	14	3	1	2	13	3	2	1	17	16	15
3	16	2	3	1	15	3	2	1	19	16	17
4	13	3	2	1	12	2	2	2	15	15	15
5	17	3	3	1	18	3	2	2	20	17	17
6	13	2	2	1	12	3	1	2	19	17	16
7	15	3	2	1	16	3	2	2	20	17	18
8	14	3	1	1	15	3	2	2	17	17	16
9	13	2	3	1	11	2	1	1	17	16	15
10	14	2	2	1	13	3	1	1	20	18	17
11	12	2	2	1	11	1	1	1	13	14	13
12	14	3	2	1	14	3	3	2	18	17	17
13	17	3	3	2	18	3	3	2	17	18	17
14	19	3	3	2	20	3	2	2	22	23	20
15	13	2	3	1	14	2	3	1	17	18	16
16	19	2	3	2	19	3	3	2	19	17	16
17	13	1	3	2	13	3	1	2	14	15	15
18	13	2	1	1	14	3	1	1	16	17	15
19	18	3	3	2	19	3	3	2	19	20	19

Jury member no 5

P	Flesch sitting				Flesch standing				Paganini	Sarasate	Suk
1	16	1	3	2	18	1	2	3	14	16	12
2	20	2	1	3	19	3	1	2	18	18	19
3	18	2	3	1	18	1	3	2	17	19	17
4	13	2	3	1	13	2	3	1	12	14	13
5	23	3	2	1	22	3	2	1	21	19	18
6	13	2	3	1	15	2	1	3	17	18	16
7	19	3	2	1	20	2	3	1	20	19	19
8	17	3	2	1	16	3	1	2	21	19	17
9	14	2	3	1	13	3	2	1	15	14	13
10	16	3	2	1	16	2	1	3	17	18	16
11	13	2	3	1	12	3	2	1	11	12	11
12	16	3	2	1	14	3	2	1	17	15	17
13	22	2	3	1	23	2	3	1	20	18	16
14	22	1	3	2	21	3	2	1	19	20	22
15	16	2	3	1	16	2	3	1	18	16	16
16	19	1	3	2	18	3	2	1	17	17	15
17	12	3	2	1	12	3	1	2	14	15	16
18	13	2	3	1	13	3	2	1	13	15	14
19	19	2	3	1	18	3	2	1	18	20	13

APPENDIX 3.
AVERAGES POINTS FOR INTONATION GIVEN FOR EACH ASSIGNMENT SEPARATELY.
Key:
P = Participant,1 = male, 0 = female, TG = Test Group, CG = Control Group. 1= Flesch sitting, 2= Flesch standing, 3= Paganini, 4 = Sarasate, 5 = Suk. The same pieces were played in the same order in the initial and final trials.

INITIAL TRIAL

P	age		sex	1	2	3	4	5
1	13	CG	1	13.6	12.2	14.4	14.0	9.0
2	12	TG	1	10.4	12.2	11.4	11.8	10.4
3	14	TG	0	13.4	13.6	14.2	14.2	13.4
4	12	CG	1	15.4	14.6	13.2	14.2	14.2
5	13	TG	1	17.2	16.6	17.6	16.4	15.8
6	17	TG	0	15.0	15.4	18.6	16.2	13.4
7	12	TG	0	17.0	15.6	16.6	17.8	15.8
8	16	CG	0	14.0	14.2	15.8	15.6	14.6
9	16	CG	0	13.2	11.6	14.8	14.2	12.4
10	12	TG	0	14.6	12.8	17.6	18.6	17.2
11	17	CG	0	12.6	11.4	12.8	10.4	11.2
12	13	TG	1	12.6	10.8	12.8	15.2	12.0
13	14	TG	0	16.6	15.6	17.2	14.8	15.0
14	15	CG	0	16.8	16.6	17.8	17.4	17.4
15	15	TG	0	15.8	16.0	14.6	15.4	15.6
16	16	CG	0	14.4	15.0	16.0	17.6	16.8
17	17	TG	1	14.4	15.2	15.4	13.4	14.0
18	17	CG	0	15.2	15.0	16.2	16.0	15.6
19	17	CG	0	17.4	18.8	19.4	18.4	14.8
20	14	CG	0	15.2	15.8	18.6	19.8	19.0

FINAL TRIAL

P	age		sex	1	2	3	4	5
1	13	CG	1	14.6	14.8	14.4	14.2	12.8
2	12	TG	1	15.8	15.2	15.8	15.2	16.2
3	14	TG	0	15.8	16.4	18.2	16.6	16.4
4	12	CG	1	12.8	12.8	14.2	13.4	13.0
5	13	TG	1	19.0	19.2	20.2	18.6	17.8
6	17	TG	0	14.2	14.4	17.4	17.8	16.8
7	12	TG	0	17.4	18.2	20.2	18.6	19.6
8	16	CG	0	15.6	15.4	20.0	18.4	17.0
9	16	CG	0	13.4	11.8	15.4	14.0	13.8
10	12	TG	0	15.2	15.4	19.0	18.4	17.4
11	17	CG	0	13.8	12.4	14.6	13.6	12.2
12	13	TG	1	14.0	14.2	16.6	16.2	16.4
13	14	TG	0	17.8	18.4	18.6	18.4	16.8
14	15	CG	0	18.6	18.8	20.8	20.8	21.2
15	15	TG	0	15.4	15.6	17.6	17.0	16.2
16	16	CG	0	18.8	17.6	18.0	16.8	16.0
17	17	TG	1	13.2	12.6	14.4	15.2	14.0
18	17	CG	0	13.6	13.6	14.6	15.0	14.2
19	17	CG	0	17.4	17.4	19.2	19.8	16.4

APPENDIX 4
RELIABILITY OF EVALUATION POINTS FOR INTONATION GIVEN BY JURY MEMBERS.

Each case is treated as an individual case. (CASE = Individual Case).

I N I T I A L   T R I A L

CASE	MEMBER I	MEMBER II	MEMBER III	MEMBER IV	MEMBER V
1.1	13	15	13	13	14
1.2	13	13	10	12	13
1.3	14	12	15	16	15
1.4	13	12	13	14	18
1.5	12	10	8	5	10
2.1	12	13	7	8	12
2.2	13	14	10	12	12
2.3	12	8	14	13	10
2.4	13	10	12	11	13
2.5	12	13	10	8	9
3.1	13	15	10	13	16
3.2	13	16	12	14	13
3.3	13	15	17	13	13
3.4	15	12	15	12	17
3.5	12	15	11	10	19
4.1	12	16	14	16	19
4.2	14	14	13	15	17
4.3	12	12	14	15	13
4.4	12	12	14	16	17
4.5	12	14	15	16	14
5.1	15	19	16	16	20
5.2	15	18	15	17	18
5.3	16	18	18	17	19
5.4	15	18	15	15	19
5.5	14	19	13	16	17
6.1	13	16	12	15	19
6.2	14	16	12	16	19
6.3	17	18	17	20	21
6.4	16	16	16	15	18
6.5	14	14	13	13	13
7.1	16	16	17	15	21
7.2	16	16	15	13	18
7.3	18	14	19	14	18
7.4	19	14	21	16	19
7.5	18	14	17	15	15

8.1	15	16	14	13	12
8.2	15	16	13	13	14
8.3	17	15	16	16	15
8.4	15	14	16	17	16
8.5	16	14	14	15	14
9.1	12	14	13	14	13
9.2	11	13	11	13	10
9.3	13	14	17	17	13
9.4	13	13	15	16	14
9.5	12	15	10	13	12
10.1	14	15	12	16	16
10.2	13	14	9	14	14
10.3	18	16	17	18	19
10.4	19	17	18	18	21
10.5	19	16	17	17	17
11.1	12	13	11	11	16
11.2	11	13	9	10	14
11.3	11	14	16	11	12
11.4	11	11	9	10	11
11.5	11	13	9	12	11
12.1	12	14	11	12	14
12.2	11	14	8	11	10
12.3	14	10	15	13	12
12.4	14	13	16	17	16
12.5	10	10	15	14	11
13.1	14	14	15	19	21
13.2	16	14	14	15	19
13.3	12	15	18	19	22
13.4	14	11	15	15	19
13.5	14	12	16	14	19
14.1	18	15	16	14	21
14.2	17	15	16	14	21
14.3	18	16	18	17	20
14.4	16	14	18	17	22
14.5	18	14	18	18	19
15.1	16	15	14	16	18
15.2	17	15	13	17	18
15.3	16	13	13	16	15
15.4	17	12	13	18	17
15.5	16	15	13	17	17
16.1	15	15	13	15	14
16.2	15	15	14	15	16
16.3	16	15	17	17	15
16.4	18	14	18	18	20
16.5	15	16	16	18	19

17.1	15	16	14	13	14
17.2	16	16	13	14	17
17.3	14	14	15	15	19
17.4	12	13	15	13	14
17.5	13	15	14	14	14
18.1	16	15	15	15	15
18.2	17	15	14	14	15
18.3	18	15	17	13	18
18.4	17	15	15	14	19
18.5	18	14	16	13	17
19.1	18	16	16	18	19
19.2	19	18	18	18	21
19.3	20	18	20	20	19
19.4	20	17	17	17	21
19.5	19	15	13	14	13
20.1	17	17	14	10	18
20.2	18	18	14	10	19
20.3	21	18	15	18	21
20.4	22	20	16	18	23
20.5	23	19	17	17	19

F I N A L T R I A L

CASE	MEMBER I	MEMBER II	MEMBER III	MEMBER IV	MEMBER V
1.1.	13	16	14	14	16
1.2	14	15	12	15	18
1.3	13	15	14	16	14
1.4	12	13	15	15	16
1.5	12	14	13	13	12
2.1	14	16	15	14	20
2.2	14	14	16	13	19
2.3	12	16	16	17	18
2.4	14	14	14	16	18
2.5	16	16	15	15	19
3.1	16	14	15	16	18
3.2	16	16	17	15	18
3.3	18	17	18	19	17
3.4	17	15	16	16	19
3.5	16	15	17	17	17
4.1	12	13	13	13	13
4.2	12	14	13	12	13
4.3	13	15	16	15	12
4.4	13	11	14	15	14
4.5	12	13	12	15	13

5.1	18	18	19	17	23
5.2	19	19	18	18	22
5.3	20	20	20	20	21
5.4	20	18	19	17	19
5.5	19	17	18	17	18
6.1	18	15	12	13	13
6.2	17	16	12	12	15
6.3	18	16	17	19	17
6.4	19	17	18	17	18
6.5	20	16	16	16	16
7.1	18	17	18	15	19
7.2	19	18	18	16	20
7.3	20	20	21	20	20
7.4	20	18	19	17	19
7.5	21	20	20	18	19
8.1	18	15	14	14	17
8.2	17	16	13	15	16
8.3	22	20	20	17	21
8.4	21	17	18	17	19
8.5	18	16	18	16	17
9.1	13	14	13	13	14
9.2	11	12	12	11	13
9.3	13	15	17	17	15
9.4	12	14	14	16	14
9.5	12	15	14	15	13
10.1	15	15	16	14	16
10.2	16	15	17	13	16
10.3	20	18	20	20	17
10.4	21	17	18	18	18
10.5	18	18	18	17	16
11.1	15	14	15	12	13
11.2	13	13	13	11	12
11.3	10	14	16	13	11
11.4	10	15	17	14	12
11.5	11	13	13	13	11
12.1	13	13	14	14	16
12.2	13	14	16	14	14
12.3	15	15	18	18	17
12.4	16	15	18	17	15
12.5	15	17	16	17	17
13.1	16	17	17	17	22
13.2	17	17	17	18	23
13.3	19	16	21	17	20
13.4	19	16	21	18	18
13.5	18	16	17	17	16

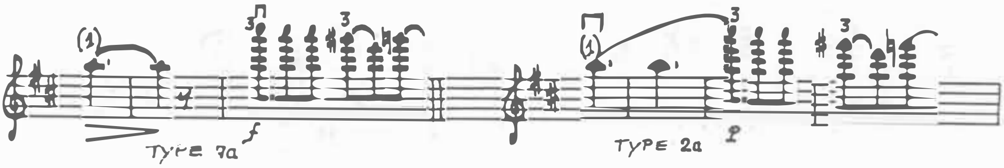
14.1	20	17	15	19	22
14.2	20	17	16	20	21
14.3	21	21	21	22	19
14.4	20	21	20	23	23
14.5	20	22	22	20	22
15.1	16	15	17	13	16
15.2	16	16	16	14	16
15.3	18	16	19	17	18
15.4	18	16	17	18	16
15.5	17	15	17	16	16
16.1	20	17	19	19	19
16.2	19	16	16	19	18
16.3	20	17	17	19	17
16.4	19	15	16	17	17
16.5	18	16	15	16	15
17.1	14	13	14	13	12
17.2	13	13	12	13	12
17.3	15	14	15	14	14
17.4	16	15	15	15	15
17.5	12	14	13	15	16
18.1	12	14	16	13	13
18.2	13	14	14	14	13
18.3	14	16	14	16	13
18.4	14	15	14	17	15
18.5	13	15	14	15	14
19.1	16	17	17	18	19
19.2	17	17	16	19	18
19.3	20	18	21	19	18
19.4	20	19	20	20	20
19.5	16	17	17	19	13

APPENDIX 5

INTONATION IN LONG SHIFTS UPWARD (OCTAVE).

o = T = In Tune
+ = S = Sharp
- = F = Flat
P = Participant

SARASATE: Malaguena



P	INITIAL TRIAL Type 7a	INITIAL TRIAL Type 2a	FINAL TRIAL Type 7a	FINAL TRIAL Type 2a
1	o	-	o	o
2	+	-	o	o
3	o	o	o	+
4	-	o	-	-
5	o	-	o	o
6	+	o	o	o
7	o	o	o	o
8	o	-	o	o
9	-	o	+	o
10	o	o	+	o
11	-	o	o	+
12	o	o	o	o
13	o	+	+	o
14	o	o	o	o
15	o	-	-	o
16	o	-	+	o
17	o	-	+	o
18	+	o	+	o
19	-	o	o	+
20	o	o		
	T =13	T = 12	T = 11	T = 15
	S = 3	S = 1	S = 6	S = 3
	F = 4	F = 7	F = 2	F = 1

Total = 78 : In Tune 51, Sharp 13, Flat 14.

APPENDIX 6

INTONATION IN LONG SHIFTS DOWNWARD (MAJOR SIXTH, FIFTH)

o = T = In Tune
+ = S = Sharp
- = F = Flat
P = Participant

SUK: Quasi Ballata

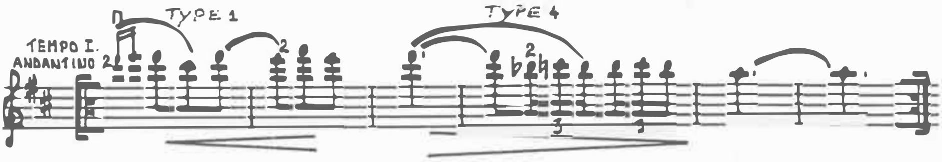
	INITIAL TRIAL		FINAL TRIAL	
P	Sixth	Fifth	Sixth	Fifth
1	+	o	o	-
2	o	+	o	+
3	+	+	o	o
4	+	o	o	-
5	+	o	o	-
6	o	o	o	o
7	o	-	+	o
8	o	+	+	+
9	o	+	+	+
10	+	o	-	o
11	-	o	+	-
12	o	+	o	+
13	+	o	o	-
14	+	o	+	o
15	+	+	o	+
16	o	o	+	o
17	o	+	+	+
18	+	+	o	o
19	+	+	o	+
20	o	o		
	T = 9	T = 10	T = 11	T = 7
	S = 10	S = 9	S = 7	S = 7
	F = 1	F = 1	F = 1	F = 5
	N = 20		N = 19	

Total = 78 : In Tune 37, Sharp 33, Flat 8

APPENDIX 7
INTONATION IN SHORT SHIFTS (MAJOR SECOND UPWARD, MAJOR THIRD DOWNWARD)

o = T = In Tune
\+ = S = Sharp
\- = F = Flat
P = Participant

SARASATE: Malaguena



INITIAL TRIAL

P	Second		Third	
1	o	-	+	o
2	o	-	+	+
3	+	+	+	o
4	o	o	+	+
5	o	+	o	o
6	o	o	o	+
7	o	o	+	+
8	-	o	o	+
9	o	-	+	+
10	-	-	+	+
11	-	-	+	+
12	o	o	+	+
13	+	+	+	+
14	-	-	+	o
15	-	o	o	+
16	o	o	o	o
17	-	o	+	+
18	-	o	o	o
19	o	-	o	o
20	o	-	o	o
	T=11	T=9	T=8	T= 8
	S=2	S=3	S=12	S=12
	F=7	F=8	F=0	F=0

FINAL TRIAL

P	Second		Third	
1	-	-	o	o
2	o	o	o	+
3	o	o	o	-
4	+	o	o	+
5	o	o	+	o
6	-	o	o	o
7	o	o	+	+
8	o	o	o	+
9	-	-	+	+
10	-	o	+	o
11	o	-	o	o
12	o	+	o	+
13	o	-	+	+
14	-	-	o	+
15	o	o	+	o
16	o	o	o	o
17	-	-	+	+
18	+	-	o	+
19	-	o	o	o
	T=10	T=11	T=12	T=8
	S=2	S=1	S=7	S=10
	F=7	F=7	F=0	F=1

Total (78 + 78)
SECONDS (78) : In Tune 41, Sharp 8, Flat 29
THIRDS (78) : In Tune 36, Sharp 41, Flat 1

APPENDIX 8

THE INFLUENCE OF BALANCE IN LONG AND SHORT SHIFTS
Each case is treated as an individual case (CASE = Individual Case)
(b) = Final Trial

BAD INTONATION IN BALANCE GROUP:

CASE	Long shifts	Short shifts
5	2	1
6	1	1
7	1	2
8	2	2
15	3	2
19	3	1
20	0	1
2(b)	1	1
3(b)	1	1
5(b)	1	1
7(b)	1	2
8(b)	2	1
10(b)	2	2
12(b)	1	2
13(b)	2	3
15(b)	2	1
16(b)	2	0
19(b)	2	1
	$\bar{X}$ = 1,61	$\bar{X}$ = 1,39

APPENDIX 9

THE INFLUENCE OF BALANCE IN LONG AND SHORT SHIFTS
Each case is treated as an individual case (CASE = Individual Case
(b) = Final Trial

BAD INTONATION IN IMBALANCE GROUP:

CASE	Long Shifts	Short Shifts
1	2	2
2	3	3
3	2	3
4	2	2
9	2	3
10	1	4
11	2	4
12	1	2
13	2	4
14	1	3
16	1	0
17	2	3
18	3	1
4(b)	3	2
6(b)	0	1
9(b)	3	4
11(b)	3	1
14(b)	1	3
17(b)	3	4
18(b)	1	3
	$\overline{X}$ = 1,90	$\overline{X}$ = 2,60

APPENDIX 10

THE DURATION OF THE PREPARATORY PHASE IN OCTAVE JUMPS (N = 78)
SARASATE: Malaguena

INITIAL TRIAL		FINAL TRIAL	
P 1	7a: 0.18 2a: 0.00	P 1	7a: 0.00 2a: 0.00
P 2	7a: 0.08 2a: 0.18	P 2	7a: 0.20 2a: 0.18
P 3	7a: 0.16 2a: 0.14	P 3	7a: 0.18 2a: 0.44
P 4	7a: 0.24 2a: 0.14	P 4	7a: 0.14 2a: 0.12
P 5	7a: 0.20 2a: 0.16	P 5	7a: 0.24 2a: 0.22
P 6	7a: 0.10 2a: 0.10	P 6	7a: 0.18 2a: 0.14
P 7	7a: 0.14 2a: 0.14	P 7	7a: 0.20 2a: 0.46
P 8	7a: 0.18 2a: 0.16	P 8	7a: 0.22 2a: 0.16
P 9	7a: 0.12 2a: 0.12	P 9	7a: 0.14 2a: 0.10
P 10	7a: 0.28 2a: 0.28	P 10	7a: 0.30 2a: 0.32
P 11	7a: 0.10 2a: 0.14	P 11	7a: 0.10 2a: 0.16
P 12	7a: 0.20 2a: 0.26	P 12	7a: 0.22 2a: 0.16
P 13	7a: 0.32 2a: 0.20	P 13	7a: 0.20 2a: 0.22
P 14	7a: 0.12 2a: 0.18	P 14	7a: 0.14 2a: 0.14
P 15	7a: 0.14 2a: 0.12	P 15	7a: 0.16 2a: 0.20

P 16	7a: 0.12 2a: 0.22	P 16	7a: 0.16 2a: 0.26
P 17	7a: 0.22 2a: 0.14	P 17	7a: 0.20 2a: 0.28
P 18	7a: 0.18 2a: 0.16	P 18	7a: 0.30 2a: 0.16
P 19	7a: 0.12 2a: 0.14	P 19	7a: 0.14 2a: 0.12
P 20	7a: 0.14 2a: 0.10		

APPENDIX 11

THE AVERAGE DURATION (PREP + EXEC) OF ALL (10 FIRST) SHIFTS IN THE ASSIGNMENT IN QUESTION.
* = performed with "excellent" intonation

	INITIAL TRIAL		FINAL TRIAL	
P	PREP + EXEC UPWARD	PREP + EXEC DOWNWARD	PREP + EXEC UPWARD	PREP + EXEC DOWNWARD
1	0.15	0.14	0.66	0.33
2	0.15	0.14	0.56	0.58
3	0.34	0.34	0.86	0.68
4	0.72	0.30	0.62	0.58
5	* 0.46	0.34	* 0.78	0.48
6	0.26	0.16	0.98	0.54
7	* 0.56	0.54	* 0.86	0.76
8	0.62	0.48	0.62	0.58
9	0.50	0.14	0.62	0.42
10	0.58	0.48	0.78	0.88
11	0.30	0.28	0.32	0.38
12	0.74	0.58	0.84	0.80
13	* 0.46	0.44	* 0.68	0.66
14	* 0.62	0.62	* 0.66	0.68
15	0.58	0.38	0.78	0.70
16	0.72	0.46	* 0.76	0.44
17	0.42	0.30	0.64	0.34
18	0.64	0.34	0.64	0.30
19	* 0.68	0.74	* 0.70	0.76
20	0.48	0.50		
	$\bar{X}$ =0.50	$\bar{X}$ = 0.39	$\bar{X}$ = 0.70	$\bar{X}$ = 0.57

APPENDIX 12

THE DURATION OF THE PREPARATORY PHASE AND EXECUTION PHASE OF EACH SHIFT AND THE NUMBER OF NOTES IN TUNE (FLESCH sitting ♩ = 54)

Key: o = In Tune; + = Sharp; - = Flat; PREP = Preparatory Phase; EXEC = Execution Phase; INT = Intonation; $\overline{X}$ = Average; P = Participant

PARTICIPANT 1 (Control Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	lacking	0.16	-	1	0.54	0.14	-
2	lacking	0.16	o	2	0.16	0.14	o
3	lacking	0.16	o	3	0.66	0.14	-
4	lacking	0.14	+	4	0.28	0.18	-
5	lacking	0.14	o	5	0.30	0.12	o
6	lacking	0.16	-	6	0.12	0.18	o
7	lacking	0.16	o	7	0.44	0.18	+
8	lacking	0.16	-	8	0.14	0.18	o
9	lacking	0.14	-	9	0.64	0.16	+
10	lacking	0.10	+	10	0.12	0.16	o
11	lacking	0.12	-	11	0.18	0.14	o
12	lacking	0.12	-	12	0.10	0.08	o
13	lacking	0.14	-	13	0.26	0.14	o
14	lacking	0.12	-	14	0.12	0.10	o

$\overline{X}$ PREP shifts upward = 0

$\overline{X}$ PREP shifts downward = 0

$\overline{X}$ EXEC shifts upward and downward = 0.15

$\overline{X}$ PREP shifts upward = 0.52

$\overline{X}$ PREP shifts donward = 0.10

$\overline{X}$ EXEC shifts upward and downward = 0.16

Ave. of Points for Intonation 13.6 Ave. of Points 14.6
(NB: the averages are calculated for the first 10 shifts)

PARTICIPANT 2 (Test Group)

I N I T I A L T R I A L

SHIFT	PREP	EXEC	INT
1	lacking	0.16	-
2	lacking	0.10	+
3	lacking	0.14	-
4	lacking	0.14	+
5	lacking	0.14	-
6	lacking	0.14	o
7	lacking	0.18	-
8	lacking	0.18	+
9	lacking	0.14	o
10	lacking	0.14	o
11	lacking	0.12	-
12	lacking	0.10	o
13	lacking	0.12	o
14	lacking	0.12	-

$\bar{X}$ PREP shifts upward = 0

$\bar{X}$ PREP shifts downward = 0

$\bar{X}$ EXEC = 0.15

Ave. of Points for Intonation 10.4

The execution phases are consistently scanty.

F I N A L T R I A L

SHIFT	PREP	EXEC	INT
1	0.26	0.20	-
2	0.34	0.16	o
3	0.32	0.18	o
4	0.44	0.18	-
5	0.52	0.18	+
6	0.38	0.20	+
7	0.54	0.18	o
8	0.32	0.26	o
9	0.30	0.14	o
10	0.42	0.20	o
11	0.16	0.16	o
12	0.24	0.12	o
13	0.18	0.18	o
14	0.16	0.14	o

$\bar{X}$ PREP shifts upward = 0.39

$\bar{X}$ PREP shifts downward = 0.38

$\bar{X}$ EXEC = 0.19

Ave. of Points 15.8

Care is taken with the preparatory phase.

PARTICIPANT 3 (Test Group)

I N I T I A L   T R I A L

SHIFT	PREP	EXEC	INT
1	lacking	0.18	-
2	lacking	0.18	-
3	lacking	0.16	o
4	lacking	0.16	-
5	lacking	0.16	-
6	lacking	0.20	-
7	lacking	0.16	-
8	lacking	0.18	-
9	lacking	0.18	-
10	lacking	0.14	-
11	lacking	0.14	+
12	lacking	0 14	-
13	lacking	0.14	-
14	lacking	0.12	o

$\bar{X}$ PREP shifts upward = 0

$\bar{X}$ PREP shifts downward = 0

$\bar{X}$ EXEC = 0.17

Ave. of Points for Intonation 13.4

The execution phases represent an even, beautiful series.

F I N A L   T R I A L

SHIFT	PREP	EXEC	INT
1	0.68	0.22	o
2	0.54	0.28	+
3	0.54	0.22	o
4	0.68	0.18	o
5	0.54	0.24	o
6	0.36	0.28	-
7	0.74	0.28	+
8	0.38	0.16	o
9	0.66	0.18	-
10	0.34	0.24	o
11	0.30	0.14	o
12	0.26	0.18	o
13	0.64	0.16	o
14	0.28	0.18	o

$\bar{X}$ PREP shifts upward = 0.60

$\bar{X}$ PREP shifts downward = 0.40

$\bar{X}$ EXEC = 0.23

Ave. of Points 15.8

Care is taken with the preparatory phase but it is stretched out excessively .

PARTICIPANT 4 (Control Group)

I N I T I A L	T R I A L			F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.30	0.06	-	1	0.42	0.12	-
2	0.14	0.12	+	2	0.64	0.10	o
3	0.74	0.08	-	3	0.52	0.20	o
4	0.36	0.12	-	4	0.40	0.06	o
5	0.68	0.12	o	5	0.40	0.14	-
6	0.16	0.12	-	6	0.20	0.10	+
7	0.66	0.18	o	7	0.42	0.18	+
8	0.16	0.08	o	8	0.20	0.10	o
9	0.58	0.18	+	9	0.58	0.14	-
10	0.16	0.10	-	10	0.38	0.10	-
11	0.14	0.14	o	11	0.24	0.10	o
12	0.36	0.12	o	12	0.22	0.10	-
13	0.22	0.12	-	13	0.24	0.08	-
14	0.16	0.10	o	14	0.28	0.06	-

$\overline{X}$ PREP shifts upward = 0.59 $\overline{X}$ PREP shifts upward = 0.40

$\overline{X}$ PREP shifts downward = 0.20 $\overline{X}$ PREP shifts downward = 0.30

$\overline{X}$ EXEC = 0.12 $\overline{X}$ EXEC = 0.13

Ave. of Points for Intonation 15.4 Ave. of Points 12.8

The preparatory phase in shifts upward is noticeably longer than in shifts downward. A surprising change in this situation appears in shifts 11-12 (initial trial). The execution phase is in general rather scanty. The three shortest execution phases in this series occur in shifts 1 (initial trial) and 4 and 14 (final trial): 0.06.

PARTICIPANT 5 (Test Group)

INITIAL TRIAL SHIFT	PREP	EXEC	INT	FINAL TRIAL SHIFT	PREP	EXEC	INT
1	0.42	0.12	-	1	0.56	0.20	o
2	0.18	0.12	o	2	0.28	0.18	o
3	0.26	0.18	o	3	0.48	0.24	o
4	0.24	0.16	-	4	0.28	0.20	-
5	0.34	0.16	o	5	0.66	0.26	o
6	0.16	0.12	o	6	0.28	0.18	o
7	0.22	0.22	o	7	0.60	0.22	-
8	0.12	0.16	o	8	0.20	0.24	o
9	0.22	0.16	o	9	0.46	0.26	o
10	0.18	0.12	o	10	0.30	0.22	o
11	0.24	0.18	o	11	0.24	0.18	o
12	0.18	0.14	-	12	0.10	0.16	-
13	0.28	0.14	o	13	0.28	0.14	-
14	0.12	0.16	-	14	0.20	0.10	-

$\bar{X}$ PREP shifts upward = 0.29

$\bar{X}$ PREP shifts downward = 0.18

$\bar{X}$ EXEC = 0.15

Ave. of points for Intonation 17.2

With the exception of shifts 1 and 5 the preparatory phase is short. In shifts upward the thumb clearly is realeased from the neck of the violin during the preparatory phase. In the even series of execution phases four rather scanty shifts occur (0.12).

$\bar{X}$ PREP shifts upward = 0.50

$\bar{X}$ PREP shifts downward = 0.20

$\bar{X}$ EXEC = 0.22

Ave. of Points 19

The extension phases have clearly been lengthened.

PARTICIPANT 6 (Test Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.14	0.14	-	1	0.68	0.26	o
2	0.24	0.10	o	2	0.38	0.16	o
3	0.08	0.14	o	3	0.72	0.20	o
4	lacking	0.14	o	4	0.24	0.28	-
5	0.18	0.14	o	5	0.72	0.28	o
6	lacking	0.10	o	6	0.30	0.18	o
7	0.12	0.12	-	7	0.80	0.20	-
8	0.10	0.14	o	8	0.20	0.20	o
9	0.10	0.10	-	9	0.84	0.22	o
10	lacking	0.16	+	10	0.16	0.16	o
11	0.16	0.14	+	11	0.16	0.12	o
12	lacking	0.10	o	12	0.10	0.14	o
13	0.10	0.18	o	13	0.40	0.14	o
14	lacking	0.12	+	14	0.14	0.14	o

$\bar{X}$ PREP shifts upward = 0.12

$\bar{X}$ PREP shifts downward = 0.07

$\bar{X}$ EXEC = 0.13

Ave. of Points for Intonation 15

The preparatory phase is disturbed by vibrato, and is thus difficult to distinguish. The preparatory phase is either very short or lacking completely.

$\bar{X}$ PREP shifts upward = 0.75

$\bar{X}$ PREP shifts downward = 0.26

$\bar{X}$ EXEC = 0.21

Ave. of Points 14.2

The low rating assigned by the jury is surprising. Care has been taken with the preparatory phases and the execution phases have been lengthened.

PARTICIPANT 7 (Test Group)

I N I T I A L   T R I A L

SHIFT	PREP	EXEC	INT
1	0.48	0.16	o
2	0.26	0.18	o
3	0.40	0.16	o
4	0.36	0.28	o
5	0.52	0.10	o
6	0.46	0.20	-
7	0.40	0.14	o
8	0.38	0.20	o
9	0.38	0.08	o
10	0.24	0.14	-
11	0.34	0.12	o
12	0.22	0.10	o
13	0.28	0.10	-
14	0.24	0.14	-

$\overline{X}$ PREP shifts upward = 0.44

$\overline{X}$ PREP shifts downward = 0.34

$\overline{X}$ EXEC = 0.16

Ave. of Points for Intonation 17

F I N A L   T R I A L

SHIFT	PREP	EXEC	INT
1	0.78	0.14	o
2	0.44	0.16	o
3	0.70	0.12	o
4	0.60	0.18	-
5	0.58	0.22	o
6	0.52	0.34	o
7	0.72	0.16	o
8	0.60	0.20	o
9	0.70	0.14	o
10	0.54	0.20	-
11	0.34	0.12	o
12	0.28	0.14	o
13	0.46	0.10	o
14	0.18	0.12	o

$\overline{X}$ PREP shifts upward = 0.70

$\overline{X}$ PREP shifts downward = 0.54

$\overline{X}$ EXEC = 0.19

Ave. of Points 17.4

Overall beautiful, even playing.

PARTICIPANT 8 (Control Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.30	0.34	+	1	0.44	0.30	+
2	0.22	0.40	-	2	0.26	0.34	-
3	0.24	0.30	-	3	0.40	0.32	o
4	0.18	0.34	o	4	0.40	0.36	o
5	0.44	0.26	+	5	0.50	0.32	o
6	0.12	0.26	o	6	0.16	0.32	o
7	0.26	0.26	o	7	0.48	0.20	o
8	0.16	0.30	+	8	0.20	0.32	o
9	0.44	0.26	o	9	0.46	0.20	+
10	0.20	0.22	o	10	0.18	0.32	o
11	0.30	0.18	o	11	0.26	0.22	o
12	0.18	0.22	o	12	0.26	0.20	o
13	0.24	0.10	-	13	0.28	0.18	-

$\bar{X}$ PREP shifts upward = 0.34 — $\bar{X}$ PREP shifts upward = 0.46

$\bar{X}$ PREP shifts donward = 0.18 — $\bar{X}$ PREP shifts downward = 0.24

$\bar{X}$ EXEC = 0.29 — $\bar{X}$ EXEC = 0.30

Ave. of Points for Intonation 14 — Ave. of Points 15.6

During the initial glissando on the initial finger, the (lower number) final finger also slides on the fingerboard. Thus the end glissando is relatively long, but the overall legato is good. Poor intonation occurs otherwise than in connection with shifts. The execution phase has been stretched out excessively. In the final trial the temporal relationship of the two phases has become more natural.

PARTICIPANT 9 (Control Group)

I N I T I A L T R I A L				F I N A L T R I A L			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.48	0.14	-	1	0.62	0.14	o
2	lacking	0.10	o	2	0.12	0.18	-
3	0.66	0.08	-	3	0.48	0.12	-
4	lacking	0.12	o	4	0.54	0.16	o
5	0.14	0.14	+	5	0.46	0.10	-
6	0.10	0.18	+	6	0.44	0.12	+
7	0.12	0.14	-	7	0.40	0.12	-
8	lacking	0.12	+	8	0.16	0.14	o
9	0.44	0.16	-	9	0.52	0.14	o
10	lacking	0.14	+ *	10	0,14	0.14	+
11	0.16	0.14	o *	11	0.28	0.14	+
12	0.10	0.12	o	12	0.10	0.10	o
13	0.18	0.10	-	13	0.24	0.12	+
14	0.08	0.12	o	14	0.22	0.12	o

$\bar{X}$ PREP shifts upward =0.37 $\bar{X}$ PREP shifts upward= 0.50

$\bar{X}$ PREP shifts downward = 0.02 $\bar{X}$ PREP shifts downward=0.28

$\bar{X}$ EXEC = 0.13 $\bar{X}$ EXEC = 0.13

Ave. of Points for Intonation 13.2 Ave. of Points 13.4

The duration of the preparatory phase in the initial trial varied considerably or was totally lacking. The execution phase in both trials was quite scanty: there was no follow-through.
* = No shortening of the execution phase took place although the tempo increased.

PARTICIPANT 10 (Test Group)

I N I T I A L T R I A L A				F I N A L T R I A L			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.56	0.20	-	1	0.44	0.24	-
2	0.40	0.12	+	2	0.66	0.20	+
3	0.42	0.12	o	3	0.64	0.18	o
4	0.46	0.10	+	4	0.72	0.14	o
5	0.50	0.08	-	5	0.58	0.14	o
6	0.42	0.12	-	6	0.72	0.18	o
7	0.46	0.10	-	7	0.74	0.20	o
8	0.26	0.10	-	8	0.76	0.14	o
9	0.38	0.08	o	9	0.58	0.14	o
10	0.40	0.06	-	10	0.70	0.16	o
11	0.30	0.08	o	11	0.30	0.14	-
12	0.26	0.14	o	12	0.30	0.10	o
13	0.26	0.08	o	13	0.34	0.12	o
14	0.48	0.12	-	14	0.24	0.14	o

$\bar{X}$ PREP shifts upward = 0.46

$\bar{X}$ PREP shifts downward = 0.39

$\bar{X}$ EXEC = 0.11

Ave. of Points for Intonation 14.6

Execution phase is very scanty, indicating lack of follow-through.

$\bar{X}$ PREP shifts upward = 0.60

$\bar{X}$ PREP shifts downward = 0.71

$\bar{X}$ EXEC = 0.17

Ave. of Points 15.2

A clear pause between preparatory and execution phases is observable. The preparatory phase of downward shifts is excessively long. There are, however, a considerable number of successful shifts, so the low ratings by the jury are surprising.

PARTICIPANT 11 (Control Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFTS	PREP	EXEC	INT	SHIFTS	PREP	EXEC	INT
1	0.42	0.10	-	1	0.52	0.12	-
2	0.14	0.16	-	2	0.40	0.12	+
3	0.12	0.10	o	3	0.52	0.10	-
4	0.12	0.30	o	4	0.50	0.06	-
5	0.20	0.12	-	5	0.48	0.14	-
6	lacking	0.26	+	6	0.14	0.10	+
7	0.20	0.12	-	7	0.56	0.12	+
8	0.08	0.10	o	8	0.16	0.16	o
9	lacking	0.16	o	9	0.16	0.12	o
10	0.08	0.12	+	10	0.18	0.10	o
11	lacking	0.10	-	11	0.12	0.08	o
12	lacking	0.10	-	12	0.24	0.08	o
13	0.32	0.08	+	13	0.30	0.08	-
14	lacking	0.14	-	14	0.20	0.12	-

$\bar{X}$ PREP shifts upward = 0.19 $\bar{X}$ PREP shifts upward = 0.45

$\bar{X}$ PREP shifts downward = 0.08 $\bar{X}$ PREP shif downward = 0.28

$\bar{X}$ EXEC = 0.15 $\bar{X}$ EXEC = 0.11

Ave. of Points for Intonation 12.6 Ave. of Points 13.8

In the initial trial there are only random appearances of the preparatory phase, and its duration is variable. The execution phase is in general scanty; in the initial trial it is several times excessively stretched out. In the initial trial the initial finger completely loses contact with the fingerboard at the beginning of the execution phase.

PARTICIPANT 12 (Test Group)

I N I T I A L	T R I A L			F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.32	0.12	-	1	0.46	0.32	o
2	0.28	0.16	-	2	0.50	0.30	+
3	0.48	0.14	o	3	0.44	0.46	o
4	0.38	0.12	-	4	0.54	0.34	o
5	0.68	0.16	o	5	0.50	0.38	o
6	0.42	0.14	-	6	0.44	0.34	+
7	0.68	0.14	+	7	0.48	0.32	-
8	0.46	0.16	o	8	0.44	0.30	o
9	0.80	0.18	+	9	0.44	0.40	o
10	0.58	0.20	-	10	0.46	0.32	o
11	0.32	0.08	-	11	0.28	0.16	o
12	0.16	0.08	+	12	0.34	0.16	o
13	0.28	0.10	-	13	0.28	0,16	o
14	0.20	0.12	-	14	0.26	0.18	o

$\bar{X}$ PREP shifts upward = 0.59

$\bar{X}$ PREP shifts downward = 0.42

$\bar{X}$ EXEC = 0.15

Ave. of Points for Intonation 12.6

Sufficient time is used for preparation. The preparatory phase of several shifts (5,7,9) is relatively long. The execution phases are in general scanty.

$\bar{X}$ PREP shifts upward = 0.46

$\bar{X}$ PREP shifts downward = 0.48

$\bar{X}$ EXEC = 0.35

Ave. of Points 14

The execution phases are relatively stretched out. The overall stiffness of performance was the probable cause of the jury's low rating, which was surprising considering the number of notes in tune.

PARTICIPANT 13 (Test Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFTS	PREP	EXEC	INT	SHIFTS	PREP	EXEC	INT
1	0.24	0.32	o	1	0.44	0.24	o
2	0.28	0.16	-	2	0.54	0.30	-
3	0.20	0.20	o	3	0.72	0.22	o
4	0.40	0.14	o	4	0.56	0.20	-
5	0.16	0.16	o	5	0.38	0.24	-
6	0.30	0.14	o	6	0.38	0.18	o
7	0.32	0.28	o	7	0.28	0.22	o
8	0.20	0.16	+	8	0.38	0.18	o
9	0.16	0.22	o	9	0.42	0.20	o
10	0.20	0.22	+	10	0.32	0.22	0
11	0.16	0.14	-	11	0.22	0.16	o
12	0.12	0.10	-	12	0.20	0.12	o
13	0.24	0.14	o	13	0.38	0.24	o
14	0.14	0.16	o	14	0.36	0.14	-

$\bar{X}$ PREP shifts upward = 0.22 $\bar{X}$ PREP shifts downward = 0.45

$\bar{X}$ PREP shifts downward = 0.28 $\bar{X}$ PREP shifts downward = 0.44

$\bar{X}$ EXEC = 0.20 $\bar{X}$ EXEC = 0.22

Ave. of Points for Intonation 16.6 Ave. of Points 17.8

The preparatory phase is scanty.

The duration of the preparatory phase has been increased. The execution phases represent an even, beautiful series.

PARTICIPANT 14 (Control Group)

I N I T I A L	T R I A L			F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.44	0.28	o	1	0.48	0.26	o
2	0.34	0.22	o	2	0.58	0.16	o
3	0.28	0.16	-	3	0.56	0.20	o
4	0.42	0.22	-	4	0.36	0.16	-
5	0.54	0.26	+	5	0.42	0.24	-
6	0.28	0.28	o	6	0.40	0.22	-
7	0.26	0.26	-	7	0.42	0.20	o
8	0.34	0.34	+	8	0.50	0.18	+
9	0.42	0.22	o	9	0.38	0.14	o
10	0.50	0.20	o	10	0.66	0.14	-
11	0.22	0.14	-	11	0.28	0.18	o
12	0.32	0.12	-	12	0.28	0.14	o
13	0.18	0.16	-	13	0.26	0.18	o
14	0.34	0.14	-	14	0.28	0.20	-

$\bar{X}$ PREP shifts upward = 0.39 $\bar{X}$ PREP shifts upward = 0.45

$\bar{X}$ PREP shifts downward = 0.38 $\bar{X}$ PREP shifts downward = 0.50

$\bar{X}$ EXEC = 0.24 $\bar{X}$ EXEC = 0.19

Ave. of Points for Intonation 16.8 Ave. of Points 18.6

A fair amount of time was used for preparation. In some pairs of shifts downward more time was used for preparation than in shifts upward. This could be a function of the audio-visual analysis: before the shifts downward the participant freed the thumb from the fingerboard, but replaced it before actually shifting. This has been interpreted as being a preparatory movement, but is possibly just an excessive mannerism. The duration of the execution phases represents in both trials an even, beautiful series.

PARTICIPANT 15 (Test Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.54	0.16	-	1	0.30	0.18	o
2	0.32	0.12	o	2	0.56	0.28	o
3	0.44	0.16	o	3	0.72	0.18	o
4	0.26	0.10	-	4	0.50	0.14	o
5	0.48	0.18	o	5	0.44	0.14	-
6	0.34	0.10	o	6	0.46	0.20	o
7	0.26	0.14	-	7	0.70	0.14	-
8	0.16	0.10	+	8	0.48	0.16	+
9	0.38	0.16	0	9	0.82	0.24	o
10	0.22	0.14	+	10	0.58	0.12	o
11	0.22	0.10	o	11	0.28	0.16	-
12	0.12	0.10	-	12	0.34	0.12	o
13	0.30	0.10	+	13	0.36	0.12	o
14	0.18	0.10	-	14	0.28	0.10	o

$\bar{X}$ PREP shifts upward = 0.42 $\bar{X}$ PREP shifts upward = 0.60

$\bar{X}$ PREP shifts downward = 0.26 $\bar{X}$ PREP shifts downward = 0.52

$\bar{X}$ EXEC = 0.14 $\bar{X}$ EXEC = 0.18

Ave. of Points for Intonation 15.8 Ave. of Points 15.4

The preparatory phase is carefully attended to: it is regularly longer before upward shifts than before downward shifts. In the initial trial the duration of the execution phase is 0.10 seconds long in seven shifts: this indicates lack of follow-through.

PARTICIPANT 16 (Control Group)

I N I T I A L		T R I A L		F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.62	0.12	o	1	0.80	0.12	o
2	0.30	0.08	o	2	0.44	0.12	o
3	0.60	0.10	o	3	0.64	0.12	o
4	0.56	0.08	o	4	0.34	0.10	-
5	0.42	0.14	+	5	0.68	0.10	o
6	0.32	0.10	+	6	0.26	0.14	o
7	0.70	0.12	o	7	0.58	0.12	-
8	0.36	0.06	o	8	0.36	0.08	o
9	0.62	0.14	+	9	0.56	0.12	o
10	0.28	0.12	o	10	0.28	0.12	o
11	0.36	0.10	o	11	0.36	0.10	o
12	0.26	0.08	o	12	0.30	0.08	o
13	0.34	0.08	o	13	0.34	0.10	-
14	0.34	0.10	o	14	0.40	0.08	o

$\bar{X}$ PREP shifts upward = 0.59 $\bar{X}$ PREP shifts upwar =0.65

$\bar{X}$ PREP shifts downward = 0.36 $\bar{X}$ PREP shifts downward = 0.34

$\bar{X}$ EXEC = 0.10 $\bar{X}$ EXEC = 0.11

Ave. of Points for Intonation 14.4 Ave. of Points 18.8

Sufficient time is devoted to the preparatory phase in both the initial and final trials. The PREP columns are very regular. The execution phases are in general remarkably scanty. In the final trial, however, they are extremely even (e.g., the duration of the execution phase is 0.12 seconds in six shifts). In the final trial the relationship between the duration of the two phases is better than in the initial trial.

PARTICIPANT 17 (Test Group)

I N I T I A L	T R I A L			F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.26	0.18	o	1	0.56	0.14	-
2	0.12	0.14	-	2	0.22	0.16	+
3	0.28	0.16	+	3	0.38	0.16	-
4	0.12	0.14	-	4	0.12	0.18	-
5	0.20	0.16	o	5	0.46	0.22	-
6	0.10	0.14	+	6	0.20	0.20	-
7	0.32	0.10	-	7	0.42	0.18	o
8	0.12	0.18	+	8	0.10	0.20	o
9	0.28	0.12	-	9	0.54	0.18	+
10	0.20	0.20	-	10	0.10	0.22	-
11	0.14	0.14	o	11	0.18	0.14	o
12	lacking	0.22	-	12	0.26	0.20	o
13	0.20	0.18	+	13	0.26	0.14	-
14	lacking	0.20	o	14	0.22	0.18	-

$\bar{X}$ PREP shifts upward = 0.27 $\bar{X}$ PREP shifts upward = 0.47

$\bar{X}$ PREP shifts downward = 0.13 $\bar{X}$ PREP shifts donward = 0.15

$\bar{X}$ EXEC = 0.15 $\bar{X}$ EXEC = 0.18

Ave. of Points for Intonation 14.4 Ave. of Points 13.2

In the initial trial the preparatory phase is on the scant side or lacking completely. In the initial trial the duration of the execution phases is quite consistent. In the final trial they form an extremely even series.

PARTICIPANT 18 (Control Group)

INITIAL TRIAL				FINAL TRIAL			
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.50	0.22	o	1	0.56	0.14	+
2	0.14	0.12	+	2	0.18	0.12	o
3	0.38	0.14	o	3	0.44	0.10	o
4	0.36	0.12	-	4	0.14	0.14	-
5	0.48	0.18	o	5	0.58	0.14	-
6	0.16	0.14	o	6	0.14	0.08	+
7	0.60	0.10	+	7	0.56	0.08	-
8	0.22	0.10	-	8	0.16	0.10	-
9	0.40	0.16	-	9	0.46	0.14	o
10	0.26	0.08	-	10	0.28	0.12	-
11	0.12	0.12	+	11	0.18	0.10	o
12	0.10	0.10	+	12	0.16	0.10	o
13	0.14	0.12	o	13	0.18	0.08	o
14	0.12	0.10	o	14	0.14	0.12	-

$\bar{X}$ PREP shifts upward = 0.47

$\bar{X}$ PREP shifts downward = 0.23

$\bar{X}$ EXEC = 0.14

Ave. of Points for Intonation 15.2

Enough time has been reserved for the preparatory phase in upwards shifts. In downward shifts the preparatory phase is scanty. The durations of execution phases are very scanty.

$\bar{X}$ PREP shifts upward = 0.52

$\bar{X}$ PREP shifts downward = 0.18

$\bar{X}$ EXEC = 0.12

Ave. of Points 13.6

The durations of the preparatory phases of downward shifts are shorter than in the initial trial. Follow-through is neglected.

PARTICIPANT 19 (Control Group)

I N I T I A L	T R I A L			F I N A L	T R I A L		
SHIFT	PREP	EXEC	INT	SHIFT	PREP	EXEC	INT
1	0.62	0.20	o	1	0.58	0.20	+
2	0.68	0.20	-	2	0.58	0.24	-
3	0.54	0.14	-	3	0.58	0.18	o
4	0.48	0.20	-	4	0.62	0.18	o
5	0.52	0.28	o	5	0.48	0.18	o
6	0.76	0.24	-	6	0.48	0.26	+
7	0.40	0.18	o	7	0.46	0.16	o
8	0.26	0.28	o	8	0.52	0.20	+
9	0.40	0.16	o	9	0.58	0.14	o
10	0.38	0.20	o	10	0.54	0.22	o
11	0.22	0.16	o	11	0.30	0.16	o
12	0.28	0.22	o	12	0.16	0.16	+
13	0.20	0.16	-	13	0.28	0.12	+
14	0.18	0.16	o	14	0.20	0.20	o

$\bar{X}$ PREP shifts upward = 0.50 $\bar{X}$ PREP shifts upward = 0.54

$\bar{X}$ PREP shifts downward = 0.51 $\bar{X}$ PREP shifts downward = 0.55

$\bar{X}$ EXEC = 0.21 $\bar{X}$ EXEC = 0.20

Ave. of Points for Intonation 17.4 Ave. of Points 17.4

The preparatory phase is clear and long. The PREP column is extremely consistent, especially in the final trial. The durations of the execution phases are ideal in both trials and form a series of model evenness. The end of the execution phase is slowed down.

PARTICIPANT 20 (Control Group)

I N I T I A L T R I A L   F I N A L T R I A L

(did not participate)

SHIFT	PREP	EXEC	INT
1	0.40	0.30	o
2	0.40	0.20	o
3	0.20	0.18	o
4	0.46	0.10	o
5	0.26	0.18	o
6	0.18	0.12	-
7	0.32	0.16	-
8	0.32	0.36	-
9	0.28	0.16	o
10	0.26	0.14	o
11	0.18	0.16	+
12	0.22	0.18	o
13	0.19	0.16	-
14	0.17	0.16	-

$\bar{X}$ PREP shifts upward = 0.29

$\bar{X}$ PREP shifts downward = 0.32

$\bar{X}$ EXEC = 0.19

Ave. of Points for Intonation 15.2

Preparation for shifts upward is too scanty. The execution phases form an even series with the exception of several disproportionately long shifts (shifts 1 and 8).

APPENDIX 13

THE AVERAGE CHANGE OF THE DURATION OF EXECUTION PHASES IN SHIFTS UPWARD AND DOWNWARD.

In calculating these averages, the difference between the durations of the execution phases for participant 4 in the final trial (0.17 sec.) has been ignored, since it differed so radically from the other results. (Participant 4 received an average intonation evaluation from the jury of 15.4 in the initial trial, but only 12.8 in the final trial. This striking difference between the execution phases indicates a total failure in timing.)

	INITIAL TRIAL			FINAL TRIAL		
EXCELLENT						
P	upward	downward	difference	upward	downward	difference
5	0.17	0.14	0.03	0.24	0.20	0.04
7	0.13	0.20	0.07	0.16	0.22	0.06
13	0.24	0.16	0.08	0.22	0.22	0.00
14	0.24	0.25	0.01	0.21	0.17	0.04
16	not excel.in the initial trial			0.12	0.11	0.01
19	0.19	0.22	0.03	0.17	0.22	0.05
		$\bar{X}$ =	0.04		$\bar{X}$ =	0.04

OTHERS						
P	upward	downward	difference	upward	downward	difference
1	0.15	0.14	0.01	0.15	0.17	0.02
2	0.15	0.14	0.01	0.18	0.20	0.02
3	0.19	0.17	0.02	0.23	0.23	0.00
4	0.12	0.11	0.01	0.16	0.09	0.17
6	0.13	0.13	0.00	0.23	0.20	0.03
8	0.28	0.30	0.02	0.27	0.33	0.06
9	0.13	0.13	0.00	0.12	0.14	0.02
10	0.12	0.10	0.02	0.18	0.16	0.02
11	0.12	0.19	0.07	0.12	0.11	0.01
12	0.15	0.16	0.01	0.38	0.32	0.06
15	0.16	0.11	0.05	0.18	0.18	0.00
16	0.12	0.08	0.06	(excellent in the final trial)		
17	0.14	0.16	0.02	0.18	0.19	0.01
18	0.16	0.11	0.05	0.12	0.11	0.01
20	0.20	0.18	0.02	(did not participate)		
		$\bar{X}$ =	0.03		$\bar{X}$ =	0.03

APPENDIX 14

THE TOTAL DURATION (PREP + EXEC) OF SHIFTS (in hundreths of seconds)

Σ = sum of total duration
$\bar{x}$ = average of total durations
Σ:Σ = ratio between sums of total durations (EXEC/PREP)

PARTICIPANT 1

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward		FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	16	16		68	30
	16	14		80	46
	14	16		42	30
	16	16		62	32
	14	10		80	28
Σ =	76	72	Σ =	332	166
$\bar{X}$ =	15	14	$\bar{X}$ =	66	33
Σ:Σ =	0.95		Σ:Σ =	0.50	

PARTICIPANT 2

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward		FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	16	10		46	50
	14	14		50	62
	14	14		70	58
	18	18		72	58
	14	14		44	62
Σ =	76	70	Σ =	282	290
$\bar{X}$ =	15	14	$\bar{X}$ =	56	58
Σ:Σ =	0,92		Σ:Σ =	1,03	

PARTICIPANT 3

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward		FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	18	18		90	82
	16	16		76	86
	16	20		78	64
	16	18		102	54
	18	14		84	58
Σ =	84	86	Σ =	430	344
$\bar{X}$ =	17	17	$\bar{X}$ =	86	69
Σ:Σ =	1,02		Σ:Σ =	0,80	

PARTICIPANT 4

INITIAL shifts upward	TRIAL shifts downward	FINAL shifts upward	TRIAL shifts downward
36	26	54	74
82	48	72	46
80	28	54	30
84	24	60	30
76	26	72	48
Σ = 358	152	Σ = 312	228
$\bar{X}$ = 72	30	$\bar{X}$ = 62	46
$\Sigma:\Sigma$ = 0,42		$\Sigma:\Sigma$ = 0,73	

PARTICIPANT 5

INITIAL shifts upward	TRIAL shifts downward	FINAL shifts upward	TRIAL shifts downward
54	30	76	46
44	40	72	48
50	28	92	46
44	28	82	44
38	30	72	52
Σ = 230	156	Σ = 394	236
$\bar{X}$ = 46	31	$\bar{X}$ = 79	47
$\Sigma:\Sigma$ = 0,68		$\Sigma:\Sigma$ = 0,60	

PARTICIPANT 6

INITIAL shifts upward	TRIAL shifts downward	FINAL shifts upward	TRIAL shifts downward
28	34	94	54
22	14	92	56
32	10	100	48
24	24	100	40
20	16	106	32
Σ = 126	98	Σ = 492	230
$\bar{X}$ = 25	20	$\bar{X}$ = 98	46
$\Sigma:\Sigma$ = 0,78		$\Sigma:\Sigma$ = 0,47	

PARTICIPANT 7

INITIAL shifts upward	TRIAL shifts downward	FINAL shifts upward	TRIAL shifts downward
64	44	92	60
56	64	82	78
62	66	80	86
54	58	88	80
46	38	84	74
Σ = 282	270	Σ = 426	378
$\bar{X}$ = 56	54	$\bar{X}$ = 85	76
$\Sigma:\Sigma$ = 0,96		$\Sigma:\Sigma$ = 0,89	

PARTICIPANT 8

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	64	62	74	60
	54	52	72	76
	70	38	82	48
	52	46	68	52
	70	44	66	50
Σ =	310	242	362	286
$\bar{X}$ =	62	48	72	57
$\Sigma:\Sigma$ =	0,78		0,79	

PARTICIPANT 9

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	62	10	76	30
	74	12	60	70
	28	28	56	56
	26	12	52	30
	60	14	66	28
Σ =	250	76	310	214
$\bar{X}$ =	50	15	62	43
$\Sigma:\Sigma$ =	0,30		0,69	

PARTICIPANT 10

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	76	52	68	86
	54	56	82	86
	58	54	72	90
	56	36	94	90
	46	46	72	86
Σ =	290	244	388	438
$\bar{X}$ =	58	49	78	88
$\Sigma:\Sigma$ =	0,84		1,13	

PARTICIPANT 11

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	52	30	64	52
	22	42	62	56
	32	26	62	24
	32	18	68	68
	16	20	28	28
Σ =	154	136	284	228
$\bar{X}$ =	31	27	57	46
$\Sigma:\Sigma$	0,88		0,80	

PARTICIPANT 12

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	44	44	78	80
	62	50	90	88
	84	56	88	78
	82	62	80	74
	98	78	84	78
Σ =	370	290	420	398
$\bar{X}$ =	74	58	84	80
$\Sigma:\Sigma$ =	0,78		0,95	

PARTICIPANT 13

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	56	44	68	84
	40	54	94	76
	32	44	62	56
	60	36	50	56
	38	44	62	54
Σ =	226	222	336	326
$\bar{X}$ =	45	44	67	65
$\Sigma:\Sigma$ =	0,98		0,97	

PARTICIPANT 14

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	72	56	74	74
	44	64	76	52
	80	56	66	62
	52	68	62	68
	64	70	52	80
Σ =	312	314	330	336
$\bar{X}$ =	64	63	66	67
$\Sigma:\Sigma$ =	1,01		1,02	

PARTICIPANT 15

	INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
	70	44	48	84
	60	36	90	64
	64	44	58	66
	40	26	84	64
	54	36	106	70
Σ =	288	186	386	348
$\bar{X}$ =	58	37	77	70
$\Sigma:\Sigma$ =	0,65		0,90	

PARTICIPANT 16

INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
74	38	92	56
70	64	76	44
56	42	78	40
82	42	70	44
76	40	68	40
Σ = 358	226	Σ = 384	224
$\bar{X}$ = 72	45	$\bar{X}$ = 77	45
$\Sigma:\Sigma$ 0,63		$\Sigma:\Sigma$ = 0,58	

PARTICIPANT 17

INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
44	26	70	38
44	26	54	30
36	24	68	40
42	30	60	30
40	40	72	32
Σ = 206	146	Σ = 324	170
$\bar{X}$ = 41	29	$\bar{X}$ = 65	34
$\Sigma:\Sigma$ = 0,71		$\Sigma:\Sigma$ = 0,52	

PARTICIPANT 18

INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
72	26	70	30
52	48	54	28
64	30	72	22
70	32	64	26
56	34	60	40
Σ = 314	170	Σ = 320	146
$\bar{X}$ = 63	34	$\bar{X}$ = 64	29
$\Sigma:\Sigma$ = 0,54		$\Sigma:\Sigma$ = 0,46	

PARTICIPANT 19

INITIAL TRIAL shifts upward	INITIAL TRIAL shifts downward	FINAL TRIAL shifts upward	FINAL TRIAL shifts downward
82	88	78	82
68	68	76	80
80	100	66	74
58	54	62	72
56	58	72	76
Σ = 344	368	Σ = 354	384
$\bar{X}$ = 69	74	$\bar{X}$ = 71	77
$\Sigma:\Sigma$ = 1,07		$\Sigma:\Sigma$ = 1,08	

PARTICIPANT 20 INITIAL TRIAL FINAL TRIAL (did not participate)

	shifts upward	shifts downward
	70	60
	38	56
	44	30
	48	68
	44	40
Σ =	244	254
$\bar{X}$ =	49	51
$\Sigma:\Sigma$ =	1,04	

APPENDIX 15

THE CORRELATION OF THE SUM OF TOTAL DURATIONS (5 shifts upward) WITH THE AVERAGE OF INTONATION POINTS RECEIVED (Flesch, sitting ♩ = 54)

INITIAL AND FINAL TRIALS
x = sum of total duration, y = average of intonation points

INITIAL TRIAL

P	x	y
1	0.76	13.6
2	0.76	10.4
3	0.84	13.4
4	3.58	15.4
5	2.30	17.2
6	1.26	15.0
7	2.82	17.0
8	3.10	14.0
9	2.50	13.2
10	2.90	14.6
11	1.54	12.6
12	3.70	12.6
13	2.26	16.6
14	3.12	16.8
15	2.88	15.8
16	3.58	14.4
17	2.06	14.4
18	3.14	15.2
19	3.44	17.4
20	2.44	15.2

FINAL TRIAL

P	x	y
1	3.32	14.6
2	2.82	15.8
3	4.30	15.8
4	3.12	12.8
5	3.94	19.0
6	4.92	14.2
7	4.26	17.4
8	3.62	15.6
9	3.10	13.4
10	3.88	15.2
11	2.84	13.8
12	4.20	14.0
13	3.36	17.8
14	3.30	18.6
15	3.86	15.4
16	3.84	18.8
17	3.24	13.2
18	3.20	13.6
19	3.54	17.4

$r = .41$

APPENDIX 16

THE CORRELATION OF THE SUM OF TOTAL DURATIONS (5 shifts downward) WITH THE AVERAGE OF INTONATION POINTS RECEIVED (Flesch, sitting ♩ = 54)

INITIAL AND FINAL TRIALS.
x = sum of total duration, y = average of intonation points

	INITIAL TRIAL	
P	x	y
1	0.72	13.6
2	0.70	10.4
3	0.86	13.4
4	1.52	15.4
5	1.56	17.2
6	0.98	15.0
7	2.70	17.0
8	2.42	14.0
9	0.76	13.2
10	2.44	14.6
11	1.36	12.6
12	2.90	12.6
13	2.22	16.6
14	3.14	16.8
15	1.86	15.8
16	2.26	14.4
17	1.46	14.4
18	1.70	15.2
19	3.68	17.4
20	2.54	15.2

	FINAL TRIAL	
1	1.66	14.6
2	2.90	15.8
3	3.44	15.8
4	2.28	12.8
5	2.36	19.0
6	2.30	14.2
7	3.78	17.4
8	2.86	15.6
9	2.14	13.4
10	4.38	15.2
11	2.28	13.8
12	3.98	14.0
13	3.26	17.8
14	3.36	18.6
15	3.48	15.4
16	2.24	18.8
17	1.70	13.2
18	1.46	13.6
19	3.84	17.4

r = .50

APPENDIX 17

THE CORRELATION BETWEEN THE LENGHTENING OF TOTAL DURATIONS AND THE INCREASE OF NOTES IN TUNE (Flesch, sitting ♩ = 54):

P	Lenghtening of total duration	Increase in notes in tune
1	0.35 sec.	1
2	0.43	3
3	0.60	5
4	0.03	1
5	0.24	0
6	0.50	2
7	0.25	0
8	0.10	2
9	0.20	2
10	0.29	6
11	0.22	-1
12	0.16	4
13	0.21	0
14	0.04	0
15	0.26	2
16	0.02	1
17	0.14	0
18	-0.02	-1
19	0.03	0

$r = .54$

APPENDIX 18

THE RELATIONSHIP BETWEEN THE IDEAL DURATION OF THE PREPARATORY PHASE OF SHIFTS AND INTONATION.

	INITIAL TRIAL		FINAL TRIAL	
P	Ideal duration	Intonation points	Ideal duration	Intonation points
1	0	13.6	5	14.6
2	0	10.4	7	15.8
3	0	13.4	8	15.8
4	4	15.4	7	12.8
5	2	17.2	9	19
6	1	15	6	14.2
7	10	17	7	17.4
8	3	14	7	15.6
9	3	13.2	7	13.4
10	10	14.6	4	15.2
11	1	12.6	6	13.8
12	7	12.6	10	14
13	3	16.6	8	17.8
14	8	16.8	8	18.6
15	8	15.8	6	15.4
16	9	14.4	9	18
17	0	14.4	6	13.2
18	8	15.2	6	13.6
19	8	17.4	8	17.4
20	5	15.2		

CORRELATIONS:	IT ideal duration	IT intonation points	FT ideal duration
IT: intonation points	.4738		
FT: ideal duration	.0956	.1319	
FT: intonation points	.3104	.5324	.4828

N = 19

r = .47 (IT)
r = .48 (FT)

APPENDIX 19

SHIFTING FACTORS INFLUENCING INTONATION

3 = high level of performance.
2 = average level of performance.
1 = low level of performance.   P = Participant

I N I T I A L   T R I A L

P/Piece	Playing Position	Balance	Time used	Glissando	Intonation Points
1: Flesch	1	1	1	1	13.6
Flesch	1	1	1	1	12.2
Paganini	1	1	1	1	14.4
Sarasate	1	1	1	1	14.0
Suk	1	1	1	1	9.0
2: Flesch	1	1	1	1	10.4
Flesch	1	1	1	1	12.2
Paganini	1	1	1	1	11.4
Sarasate	1	1	1	1	11.8
Suk	1	1	1	1	10.4
3: Flesch	1	1	1	1	13.4
Flesch	1	1	1	1	13.6
Paganini	1	1	1	1	14.2
Sarasate	1	1	1	1	14.2
Suk	1	1	1	1	13.4
4: Flesch	1	1	1	1	15.4
Flesch	1	1	1	1	14.6
Paganini	1	1	1	1	13.2
Sarasate	1	1	1	1	14.2
Suk	1	1	1	1	14.2
5: Flesch	3	3	2	1	17.2
Flesch	3	3	2	1	16.6
Paganini	3	3	2	1	17.6
Sarasate	3	3	2	1	16.4
Suk	3	3	2	1	15.8
6: Flesch	2	2	2	2	15.0
Flesch	2	2	2	2	15.4
Paganini	2	2	2	2	18.6
Sarasate	2	2	2	2	16.2
Suk	2	2	2	2	13.4
7: Flesch	2	3	3	2	17.0
Flesch	2	3	3	2	15.6
Paganini	2	3	3	2	16.6
Sarasate	2	3	3	2	17.8
Suk	2	3	3	2	15.8

8:	Flesch	3	3	3	1	14.0
	Flesch	3	3	3	1	14.2
	Paganini	3	3	3	1	15.8
	Sarasate	3	3	3	1	15.6
	Suk	3	3	3	1	14.6
9:	Flesch	1	1	1	1	13.2
	Flesch	1	1	1	1	11.6
	Paganini	1	1	1	1	14.8
	Sarasate	1	1	1	1	14.2
	Suk	1	1	1	1	12.4
10:	Flesch	3	1	2	1	14.6
	Flesch	3	1	2	1	12.8
	Paganini	3	1	2	1	17.6
	Sarasate	3	1	2	1	18.6
	Suk	3	1	2	1	17.2
11:	Flesch	2	1	1	1	12.6
	Flesch	2	1	1	1	11.4
	Paganini	2	1	1	1	12.8
	Sarasate	2	1	1	1	10.4
	Suk	2	1	1	1	11.2
12:	Flesch	3	1	2	1	12.6
	Flesch	3	1	2	1	10.8
	Paganini	3	1	2	1	12.8
	Sarasate	3	1	2	1	15.2
	Suk	3	1	2	1	12.0
13:	Flesch	2	2	3	1	16.6
	Flesch	2	2	3	1	15.6
	Paganini	2	2	3	1	17.2
	Sarasate	2	2	3	1	14.8
	Suk	2	2	3	1	15.0
14:	Flesch	3	3	3	2	16.8
	Flesch	3	3	3	2	16.6
	Paganini	3	3	3	2	17.8
	Sarasate	3	3	3	2	17.4
	Suk	3	3	3	2	17.4
15:	Flesch	3	2	3	2	15.8
	Flesch	3	2	3	2	16.0
	Paganini	3	2	3	2	14.6
	Sarasate	3	2	3	2	15.4
	Suk	3	2	3	2	15.6
16:	Flesch	3	2	2	1	14.4
	Flesch	3	2	2	1	15.0
	Paganini	3	2	2	1	16.0
	Sarasate	3	2	2	1	17.6
	Suk	3	2	2	1	16.8

17:	Flesch	1	1	1	1	14.4
	Flesch	1	1	1	1	15.2
	Paganini	1	1	1	1	15.4
	Sarasate	1	1	1	1	13.4
	Suk	1	1	1	1	14.0
18:	Flesch	1	1	1	2	15.2
	Flesch	1	1	1	2	15.0
	Paganini	1	1	1	2	16.2
	Sarasate	1	1	1	2	16.0
	Suk	1	1	1	2	15.6
19:	Flesch	3	3	3	2	17.4
	Flesch	3	3	3	2	18.8
	Paganini	3	3	3	2	19.4
	Sarasate	3	3	3	2	18.4
	Suk	3	3	3	2	14.8
20:	Flesch	3	3	3	2	15.2
	Flesch	3	3	3	2	15.8
	Paganini	3	3	3	2	18.6
	Sarasate	3	3	3	2	19.8
	Suk	3	3	3	2	19.0

F I N A L   T R I A L

P/Piece		Playing Position	Balance	Time used	Glissando	Intonation Points
1:	Flesch	2	2	2	1	14.6
	Flesch	2	2	2	1	14.8
	Paganini	2	2	2	1	14.4
	Sarasate	2	2	2	1	14.2
	Suk	2	2	2	1	12.8
2:	Flesch	2	1	3	2	15.8
	Flesch	2	1	3	2	15.2
	Paganini	2	1	3	2	15.8
	Sarasate	2	1	3	2	15.2
	Suk	2	1	3	2	16.2
3:	Flesch	1	2	3	2	15.8
	Flesch	1	2	3	2	16.4
	Paganini	1	2	3	2	18.2
	Sarasate	1	2	3	2	16.6
	Suk	1	2	3	2	16.4
4:	Flesch	1	1	1	1	12.8
	Flesch	1	1	1	1	12.8
	Paganini	1	1	1	1	14.2
	Sarasate	1	1	1	1	13.4
	Suk	1	1	1	1	13.0

5:	Flesch	3	3	3	3	19.0
	Flesch	3	3	3	3	19.2
	Paganini	3	3	3	3	20.2
	Sarasate	3	3	3	3	18.6
	Suk	3	3	3	3	17.8
6:	Flesch	2	1	2	3	14.2
	Flesch	2	1	2	3	14.4
	Paganini	2	1	2	3	17.4
	Sarasate	2	1	2	3	17.8
	Suk	2	1	2	3	16.8
7:	Flesch	2	3	3	3	17.4
	Flesch	2	3	3	3	18.2
	Paganini	2	3	3	3	20.2
	Sarasate	2	3	3	3	18.6
	Suk	2	3	3	3	19.6
8:	Flesch	3	3	3	2	15.6
	Flesch	3	3	3	2	15.4
	Paganini	3	3	3	2	20.0
	Sarasate	3	3	3	2	18.4
	Suk	3	3	3	2	17.0
9:	Flesch	1	1	2	1	13.4
	Flesch	1	1	2	1	11.8
	Paganini	1	1	2	1	15.4
	Sarasate	1	1	2	1	14.0
	Suk	1	1	2	1	13.8
10:	Flesch	3	2	2	2	15.2
	Flesch	3	2	2	2	15.4
	Paganini	3	2	2	2	19.0
	Sarasate	3	2	2	2	18.4
	Suk	3	2	2	2	17.4
11:	Flesch	2	1	1	2	13.8
	Flesch	2	1	1	2	12.4
	Paganini	2	1	1	2	14.6
	Sarasate	2	1	1	2	13.6
	Suk	2	1	1	2	12.2
12:	Flesch	3	2	2	2	14.0
	Flesch	3	2	2	2	14.2
	Paganini	3	2	2	2	16.6
	Sarasate	3	2	2	2	16.2
	Suk	3	2	2	2	16.4
13:	Flesch	2	2	3	2	17.8
	Flesch	2	2	3	2	18.4
	Paganini	2	2	3	2	18.6
	Sarasate	2	2	3	2	18.4
	Suk	2	2	3	2	16.8

14:	Flesch	3	3	3	2	18.6
	Flesch	3	3	3	2	18.8
	Paganini	3	3	3	2	20.8
	Sarasate	3	3	3	2	20.8
	Suk	3	3	3	2	21.2
15:	Flesch	3	2	3	3	15.4
	Flesch	3	2	3	3	15.6
	Paganini	3	2	3	3	17.6
	Sarasate	3	2	3	3	17.0
	Suk	3	2	3	3	16.2
16:	Flesch	3	3	2	1	18.8
	Flesch	3	3	2	1	17.6
	Paganini	3	3	2	1	18.0
	Sarasate	3	3	2	1	16.8
	Suk	3	3	2	1	16.0
17:	Flesch	1	1	2	1	13.2
	Flesch	1	1	2	1	12.6
	Paganini	1	1	2	1	14.4
	Sarasate	1	1	2	1	15.2
	Suk	1	1	2	1	14.0
18:	Flesch	1	1	1	1	13.6
	Flesch	1	1	1	1	13.6
	Paganini	1	1	1	1	14.6
	Sarasate	1	1	1	1	15.0
	Suk	1	1	1	1	14.2
19:	Flesch	3	2	3	2	17.4
	Flesch	3	2	3	2	17.4
	Paganini	3	2	3	2	19.2
	Sarasate	3	2	3	2	19.8
	Suk	3	2	3	2	16.4

20: did not participate

APPENDIX 20

The Use of Glissando (Flesch,sitting,♩ = 54)

■ = jerky shift; ╞ = initial glissando; ╡ = end glissando;
╞ ╡ = initial and end glissando

INITIAL	TRIAL		FINAL	TRIAL	
P		jury points	P		jury points
1	╡ ■	13.6	1	╡ ■	14.6
2	╡ ■	10.4	2	╞ ╡	15.8
3	╡ ■	13.4	3	╞ ╡	15.8
4	╡ ■	15.4	4	╡ ■	12.8
5	╡	17.2	5	╞ ╡	19.0
6	╞ ╡	15.0	6	╞ ╡	14.2
7	╞ ╡	17.0	7	╞ ╡	17.4
8	╡	14.0	8	╡	15.6
9	╡ ■	13.2	9	╡ ■	13.4
10	╡ ■	14.6	10	╞ ╡	15.2
11	╡ ■	12.6	11	╡ ■	13.8
12	╡ ■	12.6	12	╞ ╡	14.0
13	╡	16.6	13	╞ ╡	17.8
14	╞ ╡	16.8	14	╞ ╡	18.8
15	╞ ╡	15.8	15	╞ ╡	15.4
16	╡ ■	14.4	16	╡ ■	18.8
17	╡ ■	14.4	17	╡ ■	13.2
18	╡	15.2	18	╡ ■	13.6
19	╡	17.4	19	╡	17.4
20	╡	15.2	20	(did not participate)	

APPENDIX 21

The Ratio of the Duration of the Execution Phase to the Duration of the Preparatory Phase (Participants 5 and 16; cf. App. 12):

P 5 IT

Shift	EXEC/PREP sec.		Ratio
1	0.12/0.42	=	0.29
2	0.12/0.18	=	0.67
3	0.18/0.26	=	0.69
4	0.16/0.24	=	0.66
5	0.16/0.34	=	0.47
6	0.12/0.16	=	0.75
7	0.22/0.22	=	1.00
8	0.16/0.12	=	1.33
9	0.16/0.22	=	0.73
10	0.12/0.18	=	0.67

P 5 FT

Shift	EXEC/PREP sec.		Ratio
1	0.20/0.56	=	0.38
2	0.18/0.28	=	0.64
3	0.24/0.48	=	0.50
4	0.20/0.28	=	0.71
5	0.26/0.66	=	0.39
6	0.18/0.28	=	0.64
7	0.22/0.60	=	0.37
8	0.24/0.20	=	1.20
9	0.26/0.46	=	0.57
10	0.22/0.30	=	0.73

P 16 FT

Shift	EXEC/PREP sec.		Ratio
1	0.12/0.80	=	0.15
2	0.12/0.44	=	0.27
3	0.12/0.64	=	0.19
4	0.10/0.34	=	0.29
5	0.10/0.68	=	0.15
6	0.14/0.26	=	0.54
7	0.12/0.58	=	0.17
8	0.08/0.36	=	0.22
9	0.12/0.56	=	0.21
10	0.12/0.28	=	0.43

APPENDIX 22.

Audio-visual Analysis of the Performance of Each Participant.

(cf. pp. 232-235 for a description of the different aspects of the players' performances included in this analysis and the nature of the instruction given to the members of the test group) (TG = Test Group, CG = Control Group).

INITIAL TRIAL

Participant No 1 (CG).

1. The player dangles the violin. His head is angled considerably toward the bowing arm. The violin is held at a very steep angle The shoulder is raised.
2. Shifting movements are jerky. The shift is not smooth.
3. Almost no movement of the upper arm. It can be seen in the Flesch exercise only when the 4th finger is reaching for the highest note: then the upper arm follows the stretching movement of the 4th finger. Balance of the arm is lacking: pressure is not regulated between the thumb and the gliding finger.
4. The preparatory phase cannot be seen in the picture. The shifts are carried out by sliding the final finger as quickly as possible (also in slow shifts) in the direction of the final note. The intonation of the final notes is unclear. No balance is achieved on the final finger in the final position.The hand dangles from the neck of the violin.
5. No initial glissando appears. Shifts are carried out without exception with hurried end glissando. Jerky movements are used even at slow tempos.
6. The movement of the wrist is stiff.
7. No finger action in the preparatory phase (preparatory phase lacking).
8. The thumb appears stiff, and does not regulate pressure with the the fingers.
9. Since the elbow does not move freely to the side, it remains - especially when playing on the G-string - too far under the violin. Therefore the player's fingers have to fall at too flat an angle onto the fingerboard. This affects intonation.
10. The distance at which the fingers are held above the strings strings appears to be suitable.
11. The player smiles weakly and occasionally "apologetically".
12. Stiff arm vibrato.
13. The player's thoughts are in advance of the movements all the time, but the stiffness of the movements prevents realization of the thoughts.
14. An attempt is made to correct notes out of tune. Follow - in connection with slightly out of tune notes is lacking. This makes one suspect that the player is not listening for "pure" intonation.

Greatest Deficiencies:
Stiff playing position, lack of elbow movement, lack of preparatory phase, lack of fundamental balances, too much fingertip pressure, lack of initial glissando.

Participant No 2 (TG).

1. The shoulder pad is relatively high, causing the violin to tip considerably toward the bowing arm. The playing position does not appear to be completely balanced. In the Flesch exercise the violin appears occasionally to move sideways with the hand. The shoulder is raised.
2. Shifting movements are jerky.
3. The upper arm moves a bit, but not actively enough to follow the movement of the hand. Not too much fingertip pressure, but arm balance is lacking: no attempt made to find it.
4. No preparatory phase movement visible. The shifts are carried out by sliding the final finger as quickly as possible (also in slow shifts) in the direction of the final note. Intonation is extremely uneven, which is also caused by the fact that the strings are struck quickly and without control by the fingers. The relationship between thought and finger action seems to be very sporadic. Instrument and player are not one.
5. No initial glissando. Shifts are carried out without exception with hurried end glissando.
6. The movement of the wrist is quite flowing.
7. No finger action in the preparatory phase (preparatory phase lacking).
8. The thumb appears to be quite relaxed and also relatively active.
9. The fourth finger strikes the string with no curvature. The angle of fall of the other fingers appears natural: there is effective movement of the elbow playing both the G- and E-strings.
10. The distance of the fingers above the strings is not always controlled. The fourth finger is often extended rigidly.
11. The player adopts a carefree facial expression, and attacks difficulties "with a smile on his lips." Out of tune notes do not appear to bother him.
12. Rather limp, relaxes hand vibrato.
13. Poor concentration. Thoughts are not always leading movements.
14. Not much attention paid to the correction of notes out of tune. Sometimes they are corrected, sometimes not. The follow-through is thus randomly present.

Greatest Deficiencies:
The upper arm is passive, the violin follows the movement of the left hand toward the bowing arm, the preparatory phase of shifts is completely lacking, initial glissando is lacking, no attempt is made to establish sensitive contact between the fingertips and the fingerboard. Overall careless playing.

Participant No 3 (TG).

1. The shoulder pad is rather high, the violin and the player's head are held steeply angled. The player appears to be stuck to the violin, and dangles it.

2. A lot of jerking. Broken movements.
3. The upper arm sometimes makes a barely observable movement, but is usually completely immobile. Most of the activity is in the fingers only. The arm is tense and lifeless. The shifting movement is not integrated. There is no balance in the arm; there is too much fingertip pressure.
4. There is no preparatory phase: the shifts take place as sudden

jerks. The shifts are not balanced, the violin dangles badly. The fingers of the left hand clutch the fingerboard. The entire left hand appears rigid.

5. Initial glissando not used consciously. Rushes into the final position as quickly as possible, resulting in imprecise, uncontrolled end glissandos.
6. The wrist bends, but is not elastic.
7. Preparatory phase lacking.
8. The thumb appears to be quite mobile,but functions post factum: it flexes enough so that the hand can open and move sideways from under the violin.
9. The fingers fall very upright onto the fingerboard on both G and E-string. (Typical phenomenon when the player clutches the fingerboard).
10. Fingers are at a suitable distance from the strings.
11. Occasionally the facial expression expresses confusion. Otherwise the face is calm.
12. Stiff arm vibrato (it appears, however, to be quite functional and produces a pleasing tone).
13. Thoughts are in advance of the movements, but since they are unclear, the orders given are uncertain.
14. An attempt is made at follow-through, but the stiffness of the hand and the slow reaction time usually prevent it from being carried out.
15. Intonation is for the most part below standard.

Greatest Deficiencies:
The muscles are tensed, the playing position forced.The timing of shifts is deficient. The upper arm is frozen in place. The wrist is stiff. Initial glissando is not used at all.

Participant No 4 (CG).

1. The shoulder pad is very high.The neck of the violin is pointed excessively toward the right (from the player's point of view), toward the bowing arm. The playing position does not appear very natural. The player's body is "hunched"; it is "wrapped around" the violin.
2. Shifts are made with very quick jerks.
3. The upper arm is frozen in place. The lower arm moves from the elbow with a forced movement. The arm is not balanced evenly between the thumb and the shifting finger.The shifting movement is truncated.
4. The preparatory phase makes its appearance as a balance-seeking movement of the thumb slightly before the shift. Otherwise there is no conscious use made of a preparatory movement.
5. No initial glissando is seen. When the rapid, jerky shifts are completely successful, a very short end glissando is heard (and seen).
6. The wrist is elastic and supple. Many of the shifts are carried out successfully with the help of efficient wrist technique.
7. The thumb carries out a preparatory movement as mentioned. The other fingers do not participate in the preparatory phase. The fingers appear, however, to be in sensitive contact with the strings.
8. The thumb is active and relaxed. The cooperation between it and the fingers seems to be good.
9. The angle at which the fingers strike the strings is natural.
10. The distance of the fingers above the strings is at all times minimal.

11. The facial expression is calm.
12. The vibrato is a relaxed and natural hand vibrato that produces an elegant sound.
13. For the most part thought directs the movements, but there is a certain amount of randomness about them.
14. The player attempts to correct notes out of tune, but is not always able to do so due to deficient balance. Follow-through rather fumbling.
15. Although the upper arm does not move and the timing of shifts is deficient, intonation is for the most part quite tolerable. The reason for this would seem to be the efficient use of the wrist and the thumb.

Greatest Deficiencies:
The playing position is unnatural. The upper arm is immobile. There is no use made of a preparatory phase. There is too much fingertip pressure, the hand dangling from the violin. Fundamental balances are not tended to. No initial glissando. Random follow-through.

Participant No 5 (TG).

1. The playing position seems natural.
2. The movement looks natural and flows smoothly. The shifts are for the most part quick, but are controlled quite well. The thumb is extremely elastic: the hand moves quickly to the side of and onto the top of the violin.
3. The upper arm functions quite independently. It makes no preparatory movement, but moves sidewise simultaneously with the rest of the arm during shifts. The shifting movement is integrated. Balance of the arm appears to continue during the shift.
4. There appears to be a tendency in the hand to move into the final position before the shift is carried out. The thumb prepares the beginning of the shift.
5. Initial glissando is not used systematically. The shifts are quick sweeps along the string: usually no glissando appears. If a glissando is seen (and heard), it is usually a short end glissando.
6. The wrist functions elastically and controlled,not too loosely.
7. The thumb makes a preparatory movement. It clearly releases the neck of the violin before downward shifts.The remaining fingers do not take part in the preparatory phase.
8. See points 6 and 7.
9. The angle at which the fingers strike the strings appears natural. The fingers strike the fingerboard perhaps a bit too steeply.
10. The fingers are kept close to the strings at all times.
11. The facial expression is determined. Small grimaces occur occasionally.
12. The vibrato is a natural and beautiful hand vibrato in the lower positions. It becomes an arm vibrato in the higher positions.
13. The thoughts direct the movements constantly. The movements are clearly conceived of beforehand.
14. Out of tune notes are corrected quickly. There is clear follow-through.
15. Intonation is quite good. The shifts are for the most part successful. Even though the preparatory phase is somewhat deficient, there is good balance through the shifts.

Greatest Deficiencies:
The upper arm makes no preparatory movement. There is no initial glissando.

Participant No 6 (TG).

1. The head is tipped a bit toward the bowing arm side. The neck of the violin is also pointed quite far toward the right (as seen by the player). The body is "hunched".
2. Some shifts are sudden jerks, other are smooth.
3. The upper arm is immobile. The shifts are carried out by means of an efficient movement of the wrist which is followed by movement of the lower arm. The movement is thus deficient, but functions rather well, because arm balance appears to be effective and the thumb is extremely relaxed.
4. There is preparation:the thumb seeks balance before the shifts. The preparatory phase is, however, very short, nor is it made use of.
5. Both initial and end glissando can be seen, but they are used randomly.
6. The wrist is extremely elastic. It occupies a central position in shifts.
7. As has been mentioned, the thumb makes a preparatory movement in both upward and downward shifts. The first and second fingers also try to move at quite an early stage in upward shifts. In downward shifts the thumb lags and is the last to assume the new position.
8. The thumb is extremely active and complements the movements of the other fingers well.
9. The angle at which the fingers strike the strings is completely natural with the exception of the high positions on the G - where the third and fourth fingers are not able to fall naturally onto the strings.
10. The fingers are held at a suitable distance from the strings.
11. The facial expression is calm and unchanging during the performance.
12. Beautiful hand vibrato. Its movement appears, however, to disturb the preparatory phase of the shift or to block its execution.
13. The thoughts do not direct the movements one hundred procent. Occasional lapses occur.
14. There is follow-through, even though it is not absolutely conscious.
15. Intonation is generally of good quality, even though small faults occur.

Greatest Deficiencies:
The movement is not integrated: the upper arm is immobile. There is no conscious use of initial glissando. Jerkiness appears in the shifts. The preparatory movement of the final finger is weak, nor is it conscious.

Participant No 7 (TG).

1. The shoulder pad is noticeably high.The player's head is tipped considerably toward the bowing arm side. The playing position does not appear to be very natural, but may nevertheless be in balance.
2. Even though the execution phase of the shift is carried out

very quickly, the movement is nevertheless relatively smooth due to the preparatory phase.The shifting movement is energetic and purposeful.

3. The upper arm does not move sideways during the shifts. Arm balance is taken care of quite well, even though it appears that the thumb presses too tightly against the fingerboard in the higher positions.
4. Clear preparatory phases are present and enough time is devoted to them.
5. Both short initial and end glissandos occur, but are not made conscious use of.
6. The wrist flexes energetically. It appears to be a bit too tense.
7. The final finger usually makes a clear preparatory movement before moving into the final position: it starts to move in advance of the shift.
8. The thumb does not make any preparatory movement, but supports the hand immediately when the execution phase of the shift begins. The thumb is active, but perhaps a bit too tense.
9. The fingers strike the strings at a natural angle.
10. The fingers remain close to the strings.
11. The facial expression is serious and does not change during the performance.
12. Stiff, narrow arm vibrato.
13. Even though the shifts are restless, energetic thinking clearly directs the movements.
14. The player is able to correct bad intonation very quickly. Relatively well- controlled timing, wrist and thumb action,plus good balance during the shifts guarantee that the intonation is relatively well controlled even though it is not yet of professional level.

Greatest Deficiencies:
The playing position is not entirely natural. There is excessive tension in the arm (cf. vibrato, wrist). The preparatory movement of the final finger is not carried through. The upper arm does not move sideways. There is excessive fingertip pressure.

Participant No 8 (CG).

1. The playing position is balanced; the head is held erect, the angle of the violin appears adequate. The shoulder pad is high, but the player has long limbs.
2. The shifting movement is quite controlled and smooth, and not jerky.
3. The upper arm functions together with the rest of the arm: it moves both sideways and vertically. The movement is integrated. The thumb flexes freely. The upper arm adjusts balance during the shift.
4. There is a clear preparatory phase preceding the execution phase. The player's upper arm makes a slight movement to the side and the thumb begins to move under the neck of the violin just before the execution phase. The preparatory phase is, however, quite short.
5. The shifts are carried out quite quickly (both upward and downward) and end glissando is heard clearly (primarily in Flesch). Initial glissando is also present in the musical pieces, but the main type of glissando used is a clearly audible and visible initial glissando.

6. The flexing of the wrist during shifts is extremely elastic.
7. As has been observed, the thumb makes a preparatory movement before shifts. The fingers also make a preparatory movement in the direction of the final position.
8. The thumb is very active and relaxed and balances well the action of the fingers.
9. The angle at which the fingers strike the strings is natural.
10. The fingers are held at a suitable distance above the strings.
11. There is a faint smile on the face of the player, which remains unchanged during the performance.
12. The vibrato is a relaxed and quite wide, slightly floppy, hand vibrato.
13. The performance is as a whole controlled and well balanced. There is a calm tempo: seemingly controlled by a strongly personal imagination. Precise thought is in advance of the movements all the time.
14. A quick follow-through is present.
15. The intonation is excellent. The constant long end glissandos are disturbing.

Greatest Deficiencies:
The preparatory phase is short. The end glissandos are audible The final finger does not move close to the initial finger finger during the preparatory phase (no knowledge of how to shorten the extent of the shift). Initial glissando is lacking in Flesch.

Participant No 9 (CG).

1. The shoulder pad is very high. The violin is tipped at a steep angle. The neck of the violin is also pointed excessively toward the bowing arm. The playing position appears tense. The player raises the left shoulder.
2. The shifting movement alternately stops and jerks into motion. The shift is the fastest possible jerk at the last moment.
3. The upper arm moves (at slow tempos) just a shade sideways. There is nevertheless poor balance during shifts because there appears to be constant excess fingertip pressure. The wrist functions very stiffly.
4. The preparatory phase is almost non-existent.
5. An end glissando is seen and heard when the quick jerking shifting movement does not pull the final finger directly into the final note. No initial glissando at all is used.
6. Cf. point 3.
7. There is no action on the part of the fingers in the preparatory phase.
8. The thumb is passive. It gives way "grudgingly" a bit when the hand moves into a higher position. The thumb does not balance the action of the hand; the left hand dangles from the violin.
9. The angle at which the fingers strike the strings is natural.
10. The distance of the fingers above the strings is suitable.
11. The facial expression is funereal, interspersed with occasional grimaces.
12. Stiff arm vibrato is used.
13. The player appears to be quite at the mercy of the situation. There seems to be little conscious control of the hand movements. There is either a lack of conception of the shifts, or a lack of ability to concentrate on each one.
14. The player doesn’t bother (have time, care, know how?) to correct notes out of tune. There is no follow-through.

15. The intonation is consistently unsure and random.

Greatest Deficiencies:
Rather phlegmatic thought processes, stiff wrist, excessive fingertip pressure, lack of preparatory phase and follow -through, unnatural playing position (lack of balance).

Participant No 10 (TG).

1. The playing position appears to be natural. The shoulder pad is not too high.
2. The shifts are even at slow tempos usually as rapid jerks as possible. For this reason the movement is not smooth.
3. The upper arm plays an active role. The shifting movement is integrated, but there is no balance during the shifts: the player squeezes the fingerboard with his fingers and does not have time to decrease pressure during the shift. The violin also dangles badly.
4. There is a clearly visible preparatory phase: upper arm, thumb, wrist and the final finger all make preparatory movements. A fair amount of time is spent on this preparation.
5. Glissando is not used consciously. When the jerking movement does not bring the finger perfectly into the final note, an unconscious end glissando is seen and heard.
6. The wrist flexes well, but does not appear to be very free.
7. The thumb slides slightly under the neck of the violin (Flesch). The final finger begins a movement toward the final position.
8. The thumb is active, but does not balance the action of the fingers during shifts. Nor is it fully elastic.
9. The angle at which the fingers strike the strings is natural.
10. The distance of the fingers above the strings is suitable.
11. There is a faint smile on the face of the player, unchanging during the performance.
12. Vibrato: stiff arm vibrato. The thumb does not balance the considerable pressure of the fingers.
13. The concentration of the player is not total in Flesch. In the musical pieces the ability to listen ahead of time sharpens and intonation is clearly improved.
14. There is no follow-through present in Flesch.On the other hand, notes out of tune are corrected in the musical pieces.
15. Intonation is quite shaky in Flesch, but is rather good in the musical pieces.

Greatest Deficiencies:
Lack of balance in the left hand,dangling the violin,stiffness in the arm, lack of initial glissando, failure to decrease decrease fingertip pressure.Careless listening and performance in Flesch.

Participant No 11 (CG).

1. Rubber pillow for shoulder pad. The neck of the violin is pointed quite far toward the bowing arm. Playing position appears cramped.
2. Shifts are as rapid jerks as possible, merely flicks of the hand. The movement does not "flow",nor is it smooth, but rather falls apart.
3. The upper arm makes no preparatory movement, but rather follows

stiffly along after the hand.There appears to be no balance in the arm during shifts. The lower arm appears to be very tense, the same applies to the thumb. The overall movement is clumsy, not integrated.

4. No preparatory phase appears.
5. Glissando is not used (consciously) at all. If glissando does appear, it is an audible (and visible) end glissando finishing off an unsuccessful jump.
6. The wrist flexes, but stiffly. It is actually relatively sharply bent outwards all the time.
7. The fingers are not active when there should be a preparatory phase.
8. The thumb flexes just enough to allow the hand to move sideways during shifts to higher positions. The thumb makes no sort of preparatory movement, nor does it balance the pressure of the fingers. The violin dangles precipitously.
9. Since the arm does not move sufficiently to the side in higher positions or rise high enough, the third and fourth fingers are forced to strike the strings at too flat an angle.
10. The third and fourth fingers rise quite high above the strings and they are struck forcibly onto the strings.
11. The player's face is expressionless. Not a tremble appears on it despite many notes out of tune.
12. The vibrato is a stiff arm vibrato.
13. It appears that the shifts are performed mechanically (and perhaps a little nonchalantly). There can hardly be any concentrated listening to the intervals in advance.
14. The player doesn't bother (have time, know how?) to correct out- of- tune notes. There is thus no follow-through.
15. Intonation is across the board random. The playing is characterized by uncertainty in the treatment of intervals.

Greatest Deficiencies:
Lack of a strong controlling imagination, lack of preparatory phase and follow - through, stiffness of arm and thumb, jerkiness of shifting movement. The performance contains many of the cardinal sins of shifting technique.

Participant No 12 (TG).

1. The playing position is natural. The shoulder pad is a rubber pillow.
2. The shifting movement upward is relatively smooth and preparation is present. In downward shifts balance disappears during the shift.
3. The upper arm is active, making a small preparatory movement. Since the violin is clutched strongly, there is a poor basis for the fundamental balances.
4. There is a clearly visible preparatory phase: upper arm, thumb, wrist and final finger prepare to shift. Sufficient time is set aside for the shift, but the actual shifting movement is clumsy due to poor balance in the arm.
5. There is no conscious use of glissando. When the rather quick execution phase is not successful, a short end glissando is heard and seen.
6. The wrist functions relatively elastically.
7. The fingers clearly move toward the final position during the preparatory phase.
8. The thumb is elastic and actively moves under the neck of the violin. It does not, however, function properly in balancing

the pressure of the fingers.
9. The angle at which the fingers strike the strings is natural.
10. The fingers are held at a suitable distance above the strings.
11. The facial expression is sensitive and serious. Notes clearly out of tune cause slight grimacing.
12. The vibrato is a rather unusual relatively relaxed combination of hand and arm vibrato in which the rotation around the axel of the lower arm can be seen.
13. The conception of the sound is clearly strong and the player's powers of concentration excellent.
14. An attempt is made to correct notes out of tune quickly.
15. Intonation is for the most part good, but accidents occur relatively often.

Greatest Deficiencies:
There is a lack of balance in the arm, especially in downward shifts. Initial glissando is lacking. Excessive fingertip pressure.

Participant No 13 (TG).

1. The playing position is in general natural, but the neck of the violin is pointed rather far to the right (toward the bowing arm).
2. Shifting movements are very even and also quite smooth.
3. The upper arm is squeezed tightly into one position. Balance (which is deficient) is achieved with the aid of the lower arm and fingers. The fingers clutch the fingerboard tightly.
4. A short preparatory phase is seen in the shifting of the hand to the side and in the attempt of the final finger to move in the direction of the final position before upward shifts. There is no such reaction of the final finger before downward shifts.
5. The shifts are not jerking movements. They are controlled through the execution phase. Initial glissando is not employed, but all the more end glissando is present, especially in upward shifts.
6. The wrist flexes somewhat, but does not appear to be elastic.
7. Cf. point 4.
8. The thumb makes no preparatory movement. It gives way sufficiently to allow the hand to move sideways during upward shifts. The thumb does not function to balance the other fingers, but rather to stabilize the grip.
9. The fingers strike the strings even in the higher positions very vertically. When playing on the G-string, the elbow is turned very strongly toward the bowing arm side of the violin.
10. The fingers are held at a suitable height above the strings.
11. The player is serious. There is no change of facial expression during the performance.
12. The vibrato is (surprisingly) principally a hand vibrato.
13. The clarity of the player's imagination seems to be very strong. Both concentration and listening in advance are excellent.
14. An attempt is made to correct notes out of tune quickly. There is thus clearly discernible follow-through.
15. Intonation is excellent at times. In general, however,excessive use of end glissando ruins the impression. In quick shifts and downward shifts the intonation is considerably weaker.

Greatest Deficiencies:
The tenseness and immobility of the upper arm, excessive

fingertip pressure, lack of initial glissando, loss of balance during downward shifts.

Participant No 14 (CG).

1. The violin is held relatively far toward the sternum. The playing position appears to be natural.
2. The shifting movement is smooth and produces a rather imperceptile shift. Balance is taken care of for the most part by a very actively functioning thumb that also balances out the considerable pressure exerted by the fingers against the fingerboard.
3. The upper arm is not active, but rather follows along after the rest of the arm. There is a barely perceptible movement of the upper arm.Its immobility is compensated for with very efficient use of the wrist and thumb.
4. A preparatory phase is clearly visible in the movement of both the thumb and the final finger. A suitable amount of time is devoted to it.
5. Initial glissando is not used consciously, but appears in short flashes. Shifts including both short initial and end glissando are made good use of. The long glissandos that can be heard and seen are, however, end glissandos.
6. The wrist is extremely flexible but perhaps still not very elastic.
7. The fingers appear to lean in the direction of the final position during the preparatory phase.
8. The thumb is extremely elastic. It balances the hand in advance and makes preparation for the establishment of balance in the final position.
9. The angle at which the fingers strike the strings is natural because of the activity of the wrist: it flexes continuously in the necessary direction. The upper arm does not very actively control the action of the elbow, but is locked into one position. Even when playing on the E-string it is turned sharply toward the bowing arm: therefore the wrist has to bend under the neck of the violin to allow for a favorable finger angle.
10. The distance of the fingers above the string is natural.
11. When a distinctly out of tune note is heard, the player smiles wryly.
12. Vibrato is principally arm vibrato. The wrist is, however, not immobile.
13. The player's conception of the intervals seems to be very strong. There is exceptionally good concentration.
14. Quick correction of out- of- tune notes is part of the shift, and also usually is successful. Follow-through is clearly noticeable.
15. Intonation is on the whole excellent, but not total. Accidents occur.

Greatest Deficiencies:
The shifting movement is not integrated: the upper arm does not function freely: the fingers squeeze the fingerboard unnecessarily. Initial glissando is not made use of. End glissando in downward shifts is heard and seen excessively.

Participant No 15 (TG).

1. The playing position is very natural. The neck of the violin is held far enough to the left (from the player's point of view).
2. The shifting movement is calm and steady. The presence of a preparatory phase ensures the smoothness of the shift. Balance is almost always good throughout the shift.
3. The shifting movement appears to be integrated: the upper arm makes a clear preparatory movement; the same for the wrist, thumb and final finger.
4. Enough time is spent on the preparatory phase.
5. The shifts are not carried out jerkily. A well- nuanced initial glissando appears to used consistently, even though its use is not conscious. Short end glissandos appear frequently.
6. The wrist is elastic and fictions efficiently.
7. The fingers clearly move in the direction of the final position during the preparatory phase. Thus the shift is "shortened" in advance.
8. The thumb is elastic, but does not appear to be very active.
9. The angle at which the fingers strike the fingerboard is ideal.
10. The distance of the fingers above the strings is natural.
11. The player's facial expression is steady and calm and remains the same under all circumstances.
12. Vibrato is a broad arm vibrato into which wrist movement is integrated.
13. The player's imagination appears to be strong.
14. An attempt is made to correct out of tune notes, though not very quickly. There is follow-through.
15. Intonation is relatively good, although it rapidly weakens at faster tempos. Then the action of the upper arm stiffens and shifts are made only with the wrist and lower arm.

Greatest Deficiencies:
The fundamental balances are not always observed. The action of the thumb is weak.Conscious use of initial glissando is lacking. The violin dangles slightly: fingertip pressure is unnecessarily large.

Participant No 16 (CG).

1. The player has short arms, causing the neck of the violin to be pointed unusually far toward the bowing arm. The playing position appears to be a bit distorted, but it seems to serve the player well. Her head is tipped toward the bowing arm: the shoulder pad is perhaps too high.
2. The player seems to have adopted as a principle that the shifts should be carried out as quickly as possible. This gives a hurried air to the performances. The upward shifts are quite well integrated wholes. Balance is not achieved in downward shifts, and they are carried out jerkily.
3. The upper arm makes a clear preparatory movement before upward shifts. The shifting movement is integrated in upward shifts, but not in downward shifts: in which case the movement of the upper arm is uncertain.
4. Preparation occurs and sufficient time is devoted to it.
5. The principal type of glissando used in upward shifts is end glissando.
   It is heard and seen in downward shifts when the quick flash of the final finger does not succeed in finding the final note. Initial glissando does not put in an appearance even at slow

tempos.

6. The player's wrist is very elastic and it functions actively. It moves to the side during the preparatory phase.
7. In upward shifts the final finger approaches the initial finger during the preparatory phase.
8. The thumb is relaxed and alive. It moves somewhat under the neck of the violin in the preparatory phase (upward shifts). The neck of the violin rests near the base of the thumb. An attempt is made to maintain this grip even in the high positions, and this causes the thumb to tense.
9. The third and fourth fingers strike the fingerboard quite flat in the higher positions.
10. The fingers are held a suitable distance above ths strings.
11. The businesslike expression on the face of the player does not change during the performance.
12. The vibrato is an arm vibrato that produces a beautiful sound.
13. It seems that the player relies more on pure deftness than on complete concentration. The conceptions of intervals is, however,clear. Concentration could be still more unconditional.
14. No time is taken to pay attention to follow-through. (What is done, is done, it's time to get on with things!)
15. If the clearly heard and seen end glissandos are forgotten, the intonation is good when the shifts are successful.

Greatest Deficiencies:
The fingers strike the fingerboard rapidly no matter what the tempo is. The shifts are hurried and are not kept under control throughout. Initial glissando is lacking, end glissando is too prominent. Balance in the arm disappears during downward shifts. There is no preparation before downward shifts. Follow-through is neglected.

Participant No 17 (TG).

1. The neck of the violin is pointed relatively far toward the bowing arm due to the shoulder pad (the player has long arms). Nevertheless the neck of the violin dangles down. The player raises the left shoulder.
2. The shifts are sudden jerks. The movement is not smooth.
3. There is a hint of preparation on the part of the upper arm before upward shifts. The upper arm is, however, frozen quite solidly into one basic position. No care is taken to preserve balance during shifts.
4. A scant subconscious preparatory phase is present before upward shifts. There is no conscious preparatory phase.
5. No initial glissando is employed. A short end glissando is heard and seen at the end of shifts (which are carried out as quickly as possible) when the jerking movement has not successfully brought the finger to the final note.
6. The wrist flexes, but is stiff.
7. The fingers make no preparatory movements.
8. The thumb moves quickly under the neck of the violin during the execution phase of upward shifts, but makes no preparatory movement.
9. The fingers strike the strings very flat: the elbow remains under the violin even when playing on the G-string. The fingers squeeze the fingerboard. The violin dangles.
10. The distance of the fingers from the strings is suitable.
11. The player's facial expression is serious and does not change during the performance.

12. The vibrato is a very stiff arm vibrato.
13. Concentration seems to be good, but the values of notes are shortened arbitrarily and the tempos are hurried. This leads one to doubt the presence of imaginative precision and strength.
14. Even at slow tempos the shifts are carried out so rapidly that there is no change for any follow-through to take place.
15. The intonation is better at quick tempos than at slow tempos. This is typical for shifts played stiffly and quickly. The intonation is characterized by randomness, which, however - taking into consideration the stiff technique employed - is surprisingly good.

Greatest Deficiencies:
Greatly tensed muscles,excessive fingertip pressure,immobulity of the upper arm. Almost total lack of preparatory phase,jerky shifts,lack of follow-through. Lack of initial glissando. Lack of balance during the shifts.

Participant No 18 (CG).

1. The violin is held exceptionally vertically, i.e., the belly turned toward the bowing arm. It is perhaps partially due to the fact that the player raises the left shoulder. The position does not appear to be natural. There is too much playing room on the bowing arm side.
2. The shifting movement is not smooth:the shifts are sudden jerks independent of the tempo.
3. The shifting movement is extremely truncated: both the upper arm and also (what is more unusual) the lower arm are completely immobile. The entire arm is held rigidly toward the bowing arm no matter what string is being played on, and that position is held constantly.
4. Small but clear preparatory movements are made by the thumb and wrist.
5. Hints of initial glissando are heard and seen (again surprisingly) in downward shifts. Therefore downward shifts are carried out quite successfully. There is, however, usually short end glissando which appears when the final finger does not make direct contact with the final note.
6. The capacity for wrist movement is limited: it does not flex sideways, but only in the direction of the strings. The hand is thus forced to work "cramped" and unnaturally. The wrist is active but stiff.
7. The final finger moves in the direction of the final position during the preparatory phase. This also takes place before downward shifts (rare in this experiment).
8. The thumb is very active and attempts to establish balance before the shift is carried out. The neck of the violin is held very near the base of the thumb. The thumb is the most supple part of the arm (!).
9. The fingers strike the strings quite flat. An attempt is made to correct the angle by bending the wrist because the upper arm is locked into place.
10. Primarily the third and fourth fingers are frequently held at too great a distance above the strings.
11. The player's facial expression is a "Mona Lisa smile" which does not change during the performance.
12. The vibrato is a stiff arm vibrato.
13. The ability to conceive of and listen to the music does not

seem to be highly developed since the overall impression is one of hastiness and bustle.

14. An occasional attempt is made to correct out- of- tune notes as well as possible. Follow-through thus occurs to some extent.
15. Intonation is random and uneven in quality. Intonation in successful shifts is quite good. At increased tempos the intonation improves (playing more quickly often loosens up the performance of stiff players).

Greatest Deficiencies:
The rigid staticness of the playing position. The immobility of the arm. Excessive muscular tension. Jerky shifts. Negligence in concentration.

Participant No 19 (CG).

1. The playing position appears to be natural, but the belly of the violin is tipped considerably toward the bowing arm side. The player raises the left shoulder slightly.
2. The shifting movement is very even and smooth. There is no jerkiness.
3. The shifting movement is not initiated smoothly from the upper arm, but is nevertheless well integrated: the upper arm follows the rest of the arm. Balance is maintained exceptionally skillfully during the shift.
4. An usually great amount of time is spent on the preparatory phase. Before downward shifts the hand moves slightly in the direction of the final position.
5. End glissando is employed systematically in shifts in both directions. Initial glissando does not occur.
6. The wrist is exceptionally elastic and active.It flexes supply.
7. The fingers make no preparatory movements.
8. The thumb is exceptionally elastic. It gives way easily when the hand moves sideways. It makes, however, no preparatory movement. The smoothness of the shift is based on controlled balance and the use of end glissando. The thumb balances the pressure of the fingers.
9. The angle at which the fingers strike the strings is natural.
10. The distance of the fingers above the strings is suitable.
11. There is a calm smile on the face of the player. If the final note is clearly out of tune she purses her lips slightly.
12. The vibrato is a somewhat stiff, slow arm vibrato.
13. The concentration of the player is total. The goal of the realization of a strong conception of the music is striven for with great determination.
14. Out- of- tune notes are corrected quickly. Follow-through is clearly present.
15. Intonation is controlled and, overall, pleasing to the ear. (Slight) misuse of end glissando weakens somewhat the overall excellent impression.

Greatest Deficiencies:
The upper arm makes no preparatory movement. The thumb and fingers make no preparatory movements. In place of initial glissando, end glissando is used systematically.

Participant No 20 (CG).

1. The playing position is very natural (the shoulder pad is not too high).
2. The shifts are quick, but not hasty. The entire movement seems smooth.
3. The upper arm is mobile, but does not make a preparatory movement. The arm moves as an integrated whole. The fundamental balances are skillfully handled.
4. The shift (especially the execution phase) is carried out precisely. The preparatory phase is not actually visible, but rather melts imperceptibly into the execution phase. Little time is devoted to preparation.
5. Initial glissando is not used consciously. The shifts are carried out with the help of a short, light end glissando. An attempt is made, however, to limit all the glissandos.
6. The wrist is very elastic. It flexes and moves beneath the side of the violin in upward shifts. In downward shifts a supple wrist movement is also made good use of.
7. The fingers make no preparatory movements.
8. The thumb is elastic and functions well in balancing the pressure of the fingers. It does not, however, make any preparation for the shift.
9. The angle at which the fingers strike the strings is natural.
10. The fingers remain at a suitable distance above the strings.
11. The player's facial expression is calm. Out- of- tune notes cause slight grimaces.
12. The vibrato is primarily an arm vibrato. Its frequency and amplitude produce a pleasing synthesis.
13. There is strong imaginative power, excellent concentration.
14. Follow-through is automatic and quick.
15. Intonation is very good with the exception of a few small errors. Small end glissandos can be heard, nor is balance during shifts always perfect.

Greatest Deficiencies:
The upper arm, the lower arm,the final finger and the thumb make no preparatory movements (the wrist does). There is no initial glissando. Balance is occasionally precarious, especially in downward shifts. The end glissandos differ too much from each other.

FINAL TRIAL (IT = Initial Trial)

Participant No 1 (CG).

1. Cf.initial trial (IT). Dangling perhaps less severe than in IT.
2. Cf.IT. The execution phase of the shift is, however, carried out precisely.
3. Cf.IT The upper arm does actually move somewhat, but after the fact.
4. Before upward shifts (Flesch) the final finger can be seen making a tiny movement in the direction of the final position (but there is no preparation). More time is spent on this than on the execution phase, which is a rapid jerk.
5. Cf. IT.
6. As in IT. In spite of its stiffness, the wrist flexes actively and is supple. It flexes, however, only in the direction of the strings, not at all sideways. The hand position is not natural

due to the lack of upper arm movement and lower arm rotation. The player is "cramped" when playing on the G-string.
7. Cf. point 4.
8. - 12. Cf. IT.
13. Concentration is excellent and there seems to be a clear conception of the music. There is no hustle and bustle.
14. As in IT.
15. The intonation is on the whole clearer than in the IT. Fingertip pressure seems to have decreased and the fundamental balances improved somewhat. This has probably been due to practice.

Greatest Deficiencies:
As in the IT, with, however, the difference that the general stiffness is now a degree less.

Participant No 2 (TG).

1. The playing position is more natural than in the IT: the player is more relaxed and does not now raise the left shoulder.
2. The shift is smooth and integrated. Preparation and execution calmly follow one after the other.
3. The upper arm makes a clear preparatory movement. It functions actively to lead the movement of the entire arm. Good balance during the shift.
4. The amounts of time spent on preparatory and execution phases are in the proper relationship.
5. Initial glissando has been learned. In long upward shifts, however, one still hears and sees too much glissando.
6. As in the IT.
7. The final finger moves during the preparatory phase as close as possible to the initial finger.
8. -11. As in IT.
12. The vibrato is relaxed, but occasionally "more determined" (= tighter) than in IT.
13. Concentration is excellent, the thoughts lead the movements, there is no randomness.
14. An attempt is made to correct notes out-of-tune. It seems, however, that the player does not master the ability to listen to Pythagorean tuning because he is occasionally content with slightly out of tune intervals.
15. Intonation is clear and excellent. Accidents do occasionally occur: the technical control of the arm movement is not yet perfect.

Greatest Deficiencies:
There is still no ability to achieve balance. The control of fingertip pressure during shifts is unfinished. The distances between the positions are not yet clear. (The participant did not have time to assimilate the instruction).

Participant No 3 (TG).

1. As in IT.
2. The shifting movement is quite smooth. Bad jerking does not occur.
3. The shifting movement is integrated: the upper arm makes a clear preparatory movement and leads the entire movement. The

fundamental balances are partly under control, but there is still a lot of wavering and insecurity.

4. There is the proper ratio between the durations of preparatory and execution phases.
5. Initial glissando is employed. However, excessively long end glissandos are still heard and seen in long upward shifts. It is, however, a controlled shifting movement.
6. The wrist is not entirely elastic, but it seems quite active.
7. The final finger approaches as closely as possible to the initial finger during the preparatory phase.
8. The thumb is active: it makes a clear preparatory movement (in upward shifts, but not as clearly in downward shifts). It attempts to balance the pressure of the fingers. Good balance is maintained quite often, but not always.
9. The fingers do not strike the strings as vertically as in IT.
10. As in IT.
11. The facial expression is calm. At the end of the performance there is a slight smile on the face of the player.
13. The player's approach to the music seems to be somewhat phlegmatic (cf. follow-through).
14. Follow-through is present, but it is carried out slowly. Many out- of- tune notes remain uncorrected due to the slowness of the player's reactions. It also seems that she is not able to hear intervals in accordance with the Pythagorean tuning system.
15. Intonation is for the most part quite good. There is still, however, a great deal of insecurity in the technical execution of movements and there is still a lack of sensitive contact with the violin. This causes random intonational difficulties.

Greatest Deficiencies:
Balance and contact with the violin is still unclarified. Muscular tension and an excessively high shoulder pad prevent a smooth performance. Follow-through is very slow.
(The participant had time to assimilate partially the instruction).

Participant No 4 (CG).

1. The player's posture is poor, the violin dangles and its neck is pointed too far toward the bowing arm.
2. Fingertip pressure is not lightened before shifts, nor is there any preparation. For this reason the shifts are imprecise jerking movements.
3. The upper arm is completely locked in place, devoid of the slightest movement. The wrist and an active thumb take care of the shifting. The fundamental balances are not controlled. The left hand dangles from the violin.
4. -10. Cf. IT.
11. The player's facial expression is very serious: his brow is furrowed !
12. As in IT.
13. The player listens with great concentration, but fails to play in accordance with Pythagorean tuning even when he plays (in his opinion) in tune.
14. As in IT.
15. Intonation is rather random. Not much attention is paid to how the shifts are carried out: que sera,sera!

Greatest Deficiencies: as in IT.

Participant No 5 (TG).

1. The playing position is natural.
2. The shifts are calm and completely smooth.
3. The upper arm makes a clear preparatory movement, the direction of which is both to the side and up (in upwards shifts). Balance is excellent , the shifting movement is integrated.
4. Adequate time is used on the preparatory phase.
5. Initial glissando is employed, also a combination of initial and end glissando.
6. The wrist is extremely elastic and active.
7. The final finger moves as closely as possible to the initial finger during the preparatory phase.
8. The thumb makes a preparatory movement and functions actively in balancing the pressure between the fingertip and the fingerboard.
9. -14 as in IT.
15. Intonation is under control although a few accidents occur.

Greatest Deficiencies:
End glissando is heard and seen too often in long upward shifts. The extent of the shifts are not always clear. Fingertip feeling and fundamental balances are still not perfect.
(The participant had time to assimilate the instruction).

Participant No 6 (TG).

1. The neck of the violin is pointed too far toward the bowing arm side. The player is "wound" around the violin: the body is "hunched", the playing position does not appear to be free. These errors are even more prominent in the sitting position.
2. The shifts are carried out calmly; on the other hand, the shifting movement does not "flow"; it is impeded.
3. The shifting movement is integrated: the upper arm functions actively, although to a limited degree. The fundamental balances are not under control. The violin is dangled badly especially in the high positions. When playing on the G-string the upper arm remains too far under the violin.
4. The preparatory phase is perhaps emphasized too much. It does not flow smoothly into the execution phase.
5. Both initial and end glissandos are present. Fingertip pressure is regulated well enough so that the glissandos do not offend the ear.
6. As in IT.
7. The final finger moves "orthodoxly" right next to the initial finger during the preparatory phase. Thereafter, however, the movement stops for an instant before execution is carried out.
8. The thumb also makes a preparatory movement before both upward and downward shifts. It is extremely active. The neck of the violin rests, however, near the base of the thumb: this prevents the thumb from performing its balancing role in the different positions.
9. The third and fourth fingers are prevented from striking the G -string naturally by deficient elbow movement.
10. As in IT.
11. The facial expression is a bit anxious.
12. As in IT. When the player uses vibrato, the entire violin wobbles and shakes.
13. -14. As in IT. In the piece played in sitting position (Flesch)

the player did not have time to tend to follow-through.

15. While playing in sitting position intonation is shaky. It improves considerably in standing position (Flesch) and is then excellent. In the musical pieces the intonation is clearly weaker in the higher positions, where the player has obvious difficulties with balance. This is due to a) the playing position, b) inability to balance pressures by raising and rotating the upper arm.

Greatest Deficiencies:
Makes impression of insecurity, fear of shifting (?). Inadvantageous playing positions. The use of the upper arm only partially taken advantage of. Exaggeration of the preparatory phase and failure to integrate it into the whole movement. Movements do not yet function automatically.
Tension in the thumb and excessive fingertip pressure in the high positions.
(The participant has not assimilated the instruction material. This disturbs the natural performance of shifts).

Participant No 7 (TG).

1. -2. As in IT.
3. The upper arm makes a clear preparatory movement both sideways and vertically. The shift is smooth and clear. The upper arm takes good care of the fundamental balances in the higher positions.
4. The duration of the preparatory phase stands in natural proportion to the duration of the execution phase.
5. An attempt is made to make use of initial glissando.
6. As in IT.
7. The final finger moves up right next to the initial finger during the preparatory phase.
8. The thumb makes a small preparatory movement and then relaxes and allows the hand to move sideways (in upward shifts).
9. -12. As in IT.
13. A determined pattern of thought directs the entire performance.
14. As in IT.
15. Intonation is from beginning to end controlled and excellent. However, small accidents still occur.

Greatest Deficiencies:
Fine regulation of the fundamental balances is lacking, there is excessive tension in the arm, the fingers squeeze the fingerboard unnecessarily hard.
(The participant has had time to assimilate the instruction).

Participant No 8 (CG).

1. The playing position is very well balanced.
2. The shift is extremely precise (Flesch). It is smooth and perfectly natural.
3. As in IT. The fundamental balances are perfectly controlled.
4. Sufficient time is spent on the preparatory phase.
5. As in IT. The end glissandos are perhaps lighter and less noticeable than in the IT.
6. -9. As in IT.
10. The fingers are at all times exemplarily as close to the strings as possible.

11. The facial expression is calm. When out- of- tune notes occur, the player flutters her eyelids !
12. As in IT.
13. The thought processes directing the movement seem to be very concentrated and strong.
14. As in IT.
15. Intonation is exceptionally well under control. In rapid passages (Flesch and Suk) mix-ups occur; it would seem that the player had not practiced Suk well enough.

Greatest Deficiencies:
Slip-ups in concentration at fast tempos (Flesch). End glissandos are occasionally heard too clearly.
(The participant's shifting technique is exceptionally free of errors).

Participant No 9 (CG).

1. As in IT.Now and then, however, the player lowers her shoulder. Then the playing position becomes more natural.
2. The player clutches the violin. The thumb squeezes the fingerboard opposite the first finger. Excessive fingertip pressure is not released before the shift. For this reason even successful shifts are more or less jerking movements (sometimes less so than in the IT). The shift is thus, in general, not smooth. There are, however, exceptions.
3. The upper arm sometimes moves a little, sometimes not at all. It is made use of stiffly and deficiently. (This is probably connected with the raising of the shoulder).
4. In the preparatory phase the wrist attempts to move in the direction of the side of the violin (in upward shifts). The final finger creeps toward the initial finger in upward shifts. The preparatory phase is short and is not made use of consciously.
5. As in IT.
6. The wrist is stiff, but shifts in the upper positions are made by means of its action. It does not flex sideways, but only in the direction of the strings.
7. Cf. point 4. The fingers are not in sensitive contact with the fingerboard.
8. The thumb does not give way willingly, and therefore supple shifts are impossible. The player demonstrates the cardinal sin, "the gorilla grip": the thumb and first finger squeeze the fingerboard tightly between them.
9. As in IT. In the upper position on the G-string the third and fourth fingers find themselves in difficulties because of the awkward angle at which they strike the strings.
10. As in IT.
11. As in IT. When a note is played sufficiently out of tune, a concerned smile appears on the player's face.
12. As in IT.
13. The player's powers of imagination would seem to be clear and she tries hard enough, but the stiffness of the performance plays tricks on her.
14. There is a certain amount of follow-through, but it is carried out slowly due to the deficient fundamental balances and the excessive squeezing in the grip.
15. In Paganini and Sarasate the intonation is surprisingly well under control. In the other pieces it is also a class better than in the IT. However, in Flesch it is fumbling.

Greatest Deficiencies:
Stiff upper arm, raised shoulder, rigid thumb, stiff wrist,the lack of initial glissando, the curtailing of the preparatory phase and follow-through, excessive fingertip pressure, the crying lack of fundamental balances.

Participant No 10 (TG).

1. As in IT.
2. The execution phases of the shifts are actually quick, but not jerking movements, because they are preceded by a controlled preparatory phase. The shifting movement is smooth.
3. The upper arm makes a clear preparatory movement and takes care of both elbow movement (sideways movement) and arm balance (vertical movement) in an exemplary manner. The fingers do not squeeze the fingerboard as much as in the IT.
4. As in IT. The balancing action of the upper arm is clearer than in the IT. The relationship between duration of preparatory phase and execution phase is good.
5. An attempt is made to make use of glissando. The use of initial glissando is still deficient. End glissando, which is the dominant form of glissando used, is, however, quick and light so it does not generally disturb intonation.
6. The wrist is elastic and functions more supply than in the IT.
7. The final finger moves as closely as possible to the initial finger during the preparatory phase.
8. The thumb assists capably in upward shifts. It appears to be active, nor does it hinder the balance establishing action of the upper arm.
9. As in IT. Excellent elbow movement.
10. -11. As in IT.
12. The vibrato actually appears to be stiff, but produces a beautiful sound.
13. The player listens with good concentration, even in Flesch. Thought directs the performance of shifts in an exemplary manner.
14. Follow-through is used in all the pieces.
15. Intonation is excellent in all the pieces.

Greatest Deficiencies:
Lack of initial glissando, mild tension in the arm, some excessive fingertip pressure. Still some loss of balance, especially in downward shifts.
(The participant has for the most part assimilated the instruction).

Participant No 11 (CG).

1. The neck of the violin is pointed quite far toward the bowing arm. There seems to be little room to bow especially when the player leaves the upper arm beneath the violin when playing on the G-string.
2. As in IT:
3. As in IT. The upper arm makes a tiny extra helping movement when playing on the G-string with the fourth finger in the upper positions (Flesch). There is no proper use of the fundamental balances at all.
4. A slight hint of preparation can be seen in the movement of the final finger in the direction of the final position.

5. Shifts in both directions are made with the help of unbalanced careless end glissandos.
6. As in IT. The wrist flexes stiffly only in the direction of the strings, not at all sideways (= complete lack of lower arm rotation).
7. Cf. point 4.
8. The thumb and first finger squeeze the neck and fingerboard. In the high positions the neck of the violin rests near the base of the thumb. Otherwise as in IT.
9. -10. As in IT.
11. The facial expression is tense, lips pressed tightly together. Whenever a finger slips entirely off the fingerboard, a light smile flashes across the lips.
12. As in IT.
13. Concentration and listening seem to be a degree better than in the IT.
14. A quick follow-through occurs in both Flesch and the other pieces.
15. Intonation is variable, quite random, but clearly better than in the IT. However, the lack of fundamental balances and integration of the shifting movement, plus excessive tension, make the achievement of excellent intonation impossible.

Greatest Deficiencies:
Excessive muscular tension, stiff thumb, excessive fingertip pressure, dangling of the violin. Complete immobility of the upper arm, stiffness of the wrist, almost complete lack of preparatory phase, lack of initial glissando, jerky execution phases of the shifts, total lack of balance.

Participant No 12 (TG).

1. As in IT.
2. As preparation for shifting, the player shortens the note preceding the shift and stops the shifting movement. Thus there is no smoothly integrated shift (Flesch). There is , however, no jerkiness.
3. The upper arm is extremely active in making a preparatory movement. Arm balance is fair. There is no consistent regulation of the pressure between thumb and fingers. Therefore the shifting movement is not integrated.
4. The preparatory phase is exaggerated and separated from the execution phase.
5. Initial glissando is consciously made use of, especially in downward shifts. Thus balance is maintained in them a degree better than in the IT. End glissandos are also used, especially in upward shifts. Reduction of pressure before shifting is not really successful.
6. As in IT.
7. The final finger moves as close as possible to the initial finger in the preparatory phase.
8. The thumb does not play an active enough role: it opens, but does not balance the action of the fingers. The thumb is, however, elastic. Balance appears to be achieved best in high positions, when the thumb is tenser (i.e.,when there is greater pressure on it), than in the low positions.
9. -14. As in IT.
15. A serious attempt is made to play in tune, to a great extent successfully. E.g., it is under good control in the Paganini. An inability to regulate pressures and balances prevent,

however, the player from consistently achieving excellent results.

Greatest Deficiencies:
Fragmentation of the shifting movement, separation of the preparatory phase from the whole. Inability to regulate pressure and maintain balance. The passivity of the thumb. (The participant did not have time to assimilate the instruction completely. He is going in the right direction, however. Attention should be paid to increasing the smoothness of the shifting movement).

Participant No 13 (TG).

1. As in IT.
2. As in IT. However,the shifting movement does not really "flow".
3. The upper arm makes a small, but clear, preparatory movement before both upward and downward shifts. The fundamental balances are under fair control. Finger pressure is a degree less than in the IT. The shifting movement has become better integrated then in the IT.
4. The relationship of the duration of the preparatory phase to the duration of the execution phase is correct.
5. Initial glissando is used without exception in downward shifts, end glissando in upward shifts.
6. As in IT. The flexibility of the wrist is deficient. It is completely inactive. It flexes reluctantly.
7. The final finger moves as close as possible to the initial finger in the preparatory phase.
8. The thumb is more relaxed and functions more effectively in balancing the pressure of the fingers than in the IT.
9. - 14. As in IT.
15. As in IT. In quick shifts both balance and intonation are under quite good control.

Greatest Deficiencies:
Fine regulation of fundamental balances is lacking, the thumb and wrist are passive, the fingers strike the strings too vertically, the upper arm does not lead the shifting movement actively enough, initial glissando is lacking in upward shifts. Fingertip pressure still seems to be a bit excessive. (The participant has for the most part had time to assimilate the instruction).

Participant No 14 (CG).

1. As in IT.
2. As in IT. There are occasionally shifts that are jerky and in which balance is not achieved.
3. - 12. As in IT.
13. Concentration is not in the same class as in the IT.
14 -15. As in IT.

Greatest Deficiencies:
The same as in the IT. The upper arm is locked into one position. Initial glissando is deficient. Symptoms of mild jerkiness occur. The fundamental balances are not always achieved in the final stages of shifts.

Participants No 15 (TG).

1. As in IT.
2. Fundamental balances are not achieved in the sitting position. They are under control in the standing position. The shifting movement is smooth and calm.
3. -4. As in IT.
5. Both initial and end glissando are used. Achieving balance during glissando in downward shifts does not always succeed.
6. As in IT.
7. The final finger moves next to the initial finger during the preparatory phase.
8. The thumb opens easily and is elastic. It appears to be more passive than the fingers.
9. -13. As in IT.
14. Follow-through is very quick and usually succeeds.
15. As in IT. At fast tempos (Flesch, Suk) the player partially loses control.

Greatest Deficiencies:
Lack of fundamental balances in both upward and downward shifts. "Freezing" of the shifting movement at fast tempos. Initial glissando only partially under control. Lack of fine regulation of fingertip pressure. Mild passivity of the thumb. (The participant has partially assimilated the instruction. Attention should be paid to achieving the fundamental balances).

Participant No 16 (CG).

1. As in IT.
2. As in IT. In downward shifts there is better balance than in the IT. The shifting movement is supple, quick, and "flows" smoothly.
3. As in IT. There is now fair balance: good in upward shifts, a little insecure in downward shifts.
4. - 12. As in IT.
13. There is good concentration and finger reaction is quick.
14. Follow-through is better taken care of than in the IT.
15. As in IT. On the whole intonation is sounder than in the IT.

Greatest Deficiencies:
The fingers do not participate in the preparatory phase.No use is made of initial glissando. Sometimes end glissando is too audible. The execution phase is often (at slow tempos) rushed, even though it is under control. Follow-through is neglected.

Participant No 17 (TG).

1. As in IT. The shoulder appears to stay down.
2. The shifts are not exactly jerky, but are clumsy because the fundamental balances are not under control. The shifting movement is not "flowing"; it is very inhibited.
3. The upper arm makes a clear preparatory movement before upward shifts. In downward shifts it "flops" back during the execution phase. An attempt is made to produce an integrated movement, but it is carried out very stiffly.
4. In upward shifts sufficient time is devoted to the preparatory phase.

5. End glissando is the only type of glissando used. Due to deficiencies in applying the fundamental balances, the performance is disturbed by the audible (and visible) end glissandos.
6. As in IT.
7. In upward shifts the final finger clearly moves close to the initial finger.
8. As in IT.The thumb is stiff and works only to a limited extent.
9. The angle at which the fingers strike the strings seems more natural than in the IT. The reason for this is the more active role performed by the upper arm. The violin is perhaps not dangled as much as in the IT.
10. The fingers almost touch the fingerboard all the time. They appear to be frozen into this position. The knuckles appear to be stiff: the player has difficulty moving the fingers in the direction of the string because the whole hand is locked into the same unchanging position.
11. -12. As in IT.
13. Concentration is good. There is less rushing and shortening of the value of notes than in the IT.
14. Follow-through is usual, and is very quick. The pattern of thought and finger reaction both appear to be rapid.
15. Intonation succeeds due to the use of end glissando and follow-through. The audible glissandos disturb the overall impression. Due to deficient fundamental balances and timing, the intonation could be characterized as "amateurish". It is often quite random.

Greatest Deficiencies:
The shifting movement does not "flow", but stops up. The muscles of the arm are stiff, there is no elasticity. Initial glissando is lacking. There is excessive fingertip pressure, the thumb is not relaxed. The upper arm does not move on a broad enough scale. The execution phase of the shift is a bit too quick. Fingertip pressure is excessive, and there is no knowledge of how to regulate it. End glissando is too audible. (The participant has had time to assimilate only a fraction of the instruction: a complete overhaul of the technical side of violin playing would be in order).

Participant No 18 (CG).

1. - 2. As in IT.
3. As in IT. No attempt is even made to achieve any of the fundamental balances.
4. As in IT.
5. As in IT. The shifts are carried out almost without exception by means of end glissando and random correction.
6. - 10. As in IT.
11. The player's facial expression is serious.
12. The vibrato used is a stiff arm vibrato.
13. It would seem that the player's interest in producing good intonation increases and decreases randomly. Energy is directed toward something other than listening to the music.
14. The continuous correction (Flesch) is disturbing. Too much is left to the follow-through.
15. The quality of intonation is very variable, as also in the IT.

Greatest Deficiencies:
Occasional lack of interest in intonation. The exclusion of

the upper arm from the shifting movement. Total lack of fundamental balances. Deficient use of initial glissando. Exaggerated, uncontrolled speed of the execution phase. The slightly unnatural position of the arm.

Participant No 19 (CG).

1. -2. As in IT.
3. As in IT. There are occasional lapses in the achievment of balance, but as a whole it is under control.
4. -6. As in IT.
7. Before upward shifts the final finger creeps slightly in the direction of the final position.
8. As in IT.
9. As in IT. When playing on the G-string in the high positions the fingers are too straight and they strike the strings at too flat an angle.
10. As in IT.
11. Judging by the facial expression, the player is not satisfied by the performance.
12. The vibrato is a stiff, but at the same time floppy arm vibrato.
13 - 14. As in IT.
15. At slow tempos the intonation is excellent, but the player loses control of the performance at fast tempos (Flesch, Suk) and the fundamental balances disappear.

Greatest Deficiencies:
The loss of fundamental balances is due to concentration difficulties. Lack of initial glissando. Lack of preparatory movements on the part of the thumb and fingers. Now and then excessively audible end glissandos occur and are especially disturbing in downward shifts. Lack of a preparatory movement on the part of the upper arm.

Participant No 20 (CG).

Did not participate in the final trial.

R E F E R E N C E S:

l'ABBÉ le fils,1761. Principles Du Violon,Paris.

AHONEN,J.,LAHTINEN, T.,SANDSTRÖM, M.,POGLIANI, G., WIRHED, R.,1988. The Structure, Functioning and Care of the Muscles of the Body. Gummerus Oy, Jyväskylä.

ALEXANDER, MATTHIAS, 1932. The Use of the Self: Its Conscious Direction in Relation to Diagnosis, Function and the Control of Reaction. New York: E.P.Dutton and Co.

ANNETT,J.,1985. Motor Learning: A Review. In H.HEUR,U. KLEINBECK, & K.SCHMIDT (Eds),Motor Behavior:Programming,Control,and Acquistion pp.189-212).Berlin:Springler Verlag.

APPLEBAUM, SAMUEL & SADA, 1972. The Way They Play, Book I. Paganini Publications, New York.

APPLEBAUM, SAMUEL & SADA, 1981. The Way They Play, Book IX.Paganini Publications, New York.

AUER,LEOPOLD,1921.Violin Playing as I Teach it. Stokes Company N.Y.

BLAGONADYOZHINA, L. V., 1940. Die psychologishe Analyse der Vorstellung des Melodiegehörs. Moscow.

BLUM, DAVID, 1977. Casals and the Art of Interpretation. Heinemann, London.

BOYDEN,DAVID,D.,1965.The History of Violin Playing from its Origins to 1761. Oxford University Press.

BUCK,PERCY, C.,1961.Psykologi for musikere.Harald Lyche & Co, Oslo.

CAMPAGNIOLI, BARTOLOMEO, 1797. Metodo per Violino, op. 21.Milano.

CHRISTINA, ROBERT W., 1985. Premotor and Motor Reaction Time As a Function of Response Complexity. Research Quarterly for Exercise and Sport Vol.56,no.4,pp.306-315.

CHRISTINA,ROBERT,W.,1986. Future Lines of Research,American Academy of Physical Education. Papers no.20,pp.26-41.

COOKE,J.,D. and DIGGLES, VIRGINIA, A., 1984. Rapid Error Correction During Human Arm Movements: Evidence for Central Monitoring. U of Western Ontario, U of Southern California. Journal of Motor Behavior, Vol.16 no.4,348-363.

CORRETTE,MICHEL, 1738. L'Ecole d'Orphee. Paris.

CORSER,T.,1974.Temporal Discrepancies in the Electromyografic Study of Rapid Movement. Ergonomics,17,389-400.

DALTON,DAVID, 1988. Playing the Viola. Conversations with William Primrose. New York.

EBERHARDT,SIEGFRIED, 1931.Hemmung und Herrschaft auf dem Griffbrett Hesse,Berlin.

EBERHARDT,SIEGFRIED, 1921.Paganinis Geigenhaltung. Verlag von Adolf Fürstner,Berlin.

EBERHARDT,SIEGFRIED, 1922. Die Lehre der organischen Geigenhaltung Adolph Fürstner,Berlin.

FLESCH, CARL, 1931. Das Klangproblem im Geigenspiel.Ries & Erler, Berlin.

FLESCH, CARL, 1924. The Art of Violin Playing, Book I. Carl Fisher N.Y.

FLESCH, CARL, 1930. The Art of Violin Playing, Book II. Carl Fisher N.Y.

GALAMIAN,IVAN,1962. Principles of Violin Playing and Teaching.Faber and Faber London. Second Edition,1965.

GARDNER,H.,1985. The Mind's New Science: A History of the Cognitive Revolution. New York. Basis Books.

GARAM,LAJOS, 1972. Fundamentals of Violin Playing. Fazer. Helsinki.

GARAM,LAJOS, 1984. Violin Teaching. Fazer.Helsinki.

GARAM,LAJOS, 1985. Masters of Violin. Hellas-Edition. Rajamäki.

GEMINIANI, FRANCESCO, 1751. The Art of Playing on the Violin. Facsimile Edition. Oxford University Press.

GOWITZKE, BARBARA, A., & MILNER, MORRIS, 1980. Understanding the Scientific Bases of Human Movement. Williams & Wilkins Company, Baltimore, U.S.A.

GREEN,O.C., 1937. Violin Performance with Reference to Temporal, Temporal, Natural and Pythagorean Intonation. Univ. of Iowa. Studies on the Psychologie of Music,IV. The Univ.Press,Iowa City.

HANDSCHIN,JACQUES, 1948. Der Toncharakter. Atlantis-Verlag, Zürich.

HATHAWAY, S., 1935. An Action Potential Study of Neuro-muscular Relations. Journal of Experimental Physiology, 18, 285-298.

HAVAS, KATO,1961.A New Approach to Violin Playing.Bosworth and Co., London.

HAVAS,KATO,1964.The Twelve Lesson Course. Bosworth and Co., London.

HAVAS,KATO,1973. Stage Fright. Bosworth and Co., London.

HAUCK,WERNER,1962. Kleiner Katechismus für den Geiger. Bärenreiter.

HAUCK,WERNER,1975. Vibrato on the Violin. Bosworth.

HEMAN, CHRISTINE, 1964. Intonation auf Streichinstrumenten. Bärenreiter,Basel.

HERRIGEL, EUGEN,1987. Zen and the Art of Arhery. Arkana Editions, London.

HOCHMUT,GERHARD ,1967. Biomechanic sportlicher Bewegungen.Wilhelm Limbert Verlag GMbH, Frankfurt Am Main.

HORN,ALFRED,1964.Die Technik des Violinspiels.Robert Lienau,Berlin.

IYENGAR, B.K.S.,1985. The Art of Yoga (foreword by Yehudi Menuhin). Unvin Paperbacks, Sydney, Boston.

JAHN, A., 1913. Die Grundlagen der natürlichen Bogenführung auf der Violine. Leipzig.

JAMPOLSKI, J. M., 1967. The Principles of Violin Fingering. Oxford Univ.Press.

JANKELEVITS, JURI, 1983. Pedagogical Heritage. Editions "Musica", Moskow.

JANSSON,LAURA,1982.The Psychological Preparation of Athletes.Otava, Keuruu.

KARMA, KAI, 1980. Principles of Statistical Description in the Behavioral Sciences. Otava, Helsinki.

KARMA - KOMULAINEN, 1984. Advanced Statistics for the Behavioral Sciences. Gaudeamus, Helsinki.

KARMA, KAI,1986. Principles of the Psychology of Music. Helsinki.

KARMA,KAI,1983.Principles of Methodology in the Behavioral Sciences Otava, Helsinki.

KLEMOLA,TIMO, 1988. Karate-do. Otava, Helsinki.

KLINGLER,K.,1921. Über die Grundlagen des Violinspiels. Breitkopf & Härtel, Leipzig.

KOCH - REBLING, KATHINKA, 1979. Violinspiel und Violinpëdagogik. Beiträde sowjetischer Autoren zum Instrumentalunterricht. Deutscher Verlag für Musik, Leipzig.

KOECKERT, G., 1909. Rationelle Violintechnik. Breitkopf & Härtel, Leipzig.

LOGAN, GENE,A. and McKINNEY, WAYNE, C.,1970. Kinesiology. Dubuque, Iowa. William C. Brown Co.

LOTTI,TUULA, 1988. Musicality and Music Education. Publications of the University of Helsinki Pedagogic Institute, no 119, Helsinki.

MASSARO,D.,1975.Experimental Psychology and Information Processing Chicago, Rand-McNally.

MENUHIN, YEHUDI, 1971. Violin (Six Lessons with Yehudi Menuhin) Faber Music ltd.London.

MEINEL,K.,1977. Bewegungslehre.Volk und Wissen. Berlin.

MOREHOUSE, L.E., and COOPER, J.M., 1950. Kinesiology. St.Louis.C.V. Mosby Co.New York.

MOREHOUSE,L.E.,and MILLER,A.T., 1959.Physiology of exercise.3rd ed. C.V.Mosby Co. New York.

MOSTRASS, K., 1953. Die Intonation auf der Violine. Hofmeister, Leipzig.

MOZART, LEOPOLD, 1756. Versuch einer gründlichen Violinschule. Augsburg. All quotations are from the English translation: A Treatise on the Fundamental Principles of Violin Playing. Translated by Edith Knocker. Second Edition. Oxford University Press,1951.

MUSASHI,MIYAMOTO, 1645. A Book of Five Rings. Translation published in Great Britain 1974.

NEUHAUS, HEINRICH, 1973. The Art of Playing the Piano. Finnish Edition.Kirjayhtymä, Helsinki.

NICKERSON,J., 1949. Intonation of Solo and Ensemble Performance of the same Melody.Journal of the Acoustical Soc. of America,Vol.21.

NORMAN, R.W., and & KOMI, P.V., 1979. Electromechanical Delay in Skeletal Muscle Render Normal Movement Conditions. Acta Physiologica Scandinavica, 106, 241-248.

OTAVA'S ENCYCLOPEDIA OF MUSIC 1-5, 1976-79. Otava, Keuruu.

PAROW,JULIUS, 1953. Funktionelle Atmungsterapie. Stuttgart.

ROLLAND, PAUL, 1974. The Teaching of Action in String Playing. Illinois' String Research Assosiates.

RATHBONE,JOSEPHINE,1949. Corrective Physical Education.Philadelphia W.B. Saunders Co.

REULEAUX, F.,1875. Theoretische Kinematik: Grundig einer Theorie des Maschinenwesens.I.F. Vieweg und Sohn. Braunschweig.

SCOTT,M. GLADYS, 1942. Analysis of Human Motion.F.S. Crafts and Co. New York.

SEASHORE,CARL,E.,1967. Psychology of Music. Dover Publications,Inc. New York.

SHEA,J.and ZIMNY,S. (in press). Knowledge Incorporation in Motor Representation. In O. Meijer & K. Roth (Eds), Motor Behavior: The Motor-Action Controversy. Amsterdam.

STARR, WILLIAM, 1976. The Suzuki Violinist. Kingston Ellis Press.

STEINHAUSEN,F.A.,1928.Die Physiologie der Bogenführung.Druck Verlag von Breitkopf & Härtel. Fünfte Auflage. Leipzig.

SUZUKI,SHINICHI, 1969. Nurtured by Love (Exposition press N.Y.).

SZENDE, OTTÓ, 1977. Handbuch des Geigenunterrichts. Musikverlag Friedrich Karl Sandvors. Düsseldorf.

SZENDE, OTTÓ, 1981. Zur Didaktik und Methodik der Instrumentalen Früherziehung. Universal edition.

SZENDE, OTTÓ-NEMESSURI, MIHÁLY, 1971. The Physiology of Violin . Playing. Académiai Kiadó, Budapest.

von TOBEL,RUDOLF, 1941/1945. Casals. Rotapfel Verlag, Zürich.

TRENDELENBURG,W., 1925. Die natürlichen Grundlagen der Kunst des Streihinstrumentenspiels. Springer. Berlin.

ULSAMER-WINOLD, HELGA, 1979. "Musical Aspects of Motion Analysis": Concepts in String Playing. Indiana University Press.

WELFORD,A.,1976. Motor Learning. Glenview. IL: Scott, Foresman.

YOSIKA,TOICHI, 1978. Zen. Hoikusha Publishing.

L I T T E R A T U R E:

ALLEN,DEBORAH,A.and ROBERT, E.,1979. The Repetition Effect in Time. Judgments is not a Function of the Intensity of the Stimulus Defining the Interval: Implications for an arousal Theory. U New York, Albany. Acta Psycologica, Vol.43 (3),169-176. Coden: APSOAZ ISS: 00016918. Journal Announcement: 6404.

ASHOFF,JÜRGEN,1984. Circadian Timing. New York Academy of Sciences Conference on Timing and Time Perception: Rhytmic Patterns and Music (1983, New York); Max-Planck Inst.für Verhaltensphysiologie Andechs,West Germany.Annals of the New York Academy of Sciencies, Vol. 423, 442 - 468. Coden: ANYAA 9. ISSN: 00778923. Journal Announcement: 7202.

BJÖRKMAN, ANJA, 1982. Psychological Preparedness. Valmennuskirjat OY,Vaasa.

BROWN,SCOTT,W., 1985. Time Perception and Attention: The Effecs of Prospective Versus Retrospective Paradigms and Task Demands on Perceived Duration. Perception & Psychophysics,Vol 38(2),115-124. Coden:PEPSBJ.ISSN:003115117. Journal Announcement:7311.

BUCK,LESLIE, 1982. Location Versus Distance in Determing Movement Accuracy Control Systems and Human Engineering Laboratory, National Research Council of Canada. Journal of Motor Behavior, Vol. 14 No 4, 287-300.

CAHOON,DELWIN and EDMONDS, ED, M.,1980. The Watched Pot still won't Boil: Expectancy as a Variable in Estimating the Passage of Time. Augusta Coll.Bulletin of the Psychonomic Society.Vol. 16(2), 115-116. Coden: BPNSBY. ISSN: 00905054. Journal Announcement: 6604.

CAPRA, FRITJOFF, 1976. The Tao of Physics. Shambhala Publications. Inc. Boston.

CRONBACH,LEE,J.,1984. Essential of Psychological Testing. Harper International Edition .

DANTO,ARTUR,C.,1986. Basic Actions. In White Alan R. The Philosophy of Action, pp.43-58; Oxford University Press.

DELAY,EUGENE,R.and RICHARDSON, MARYJO, A.,1981. Time Estimation in Humans: Effects of Ambient Illumination and Sex. Regiss Coll,co. Perceptual & Motor Skills. Vol. 53 (3), 747-750. Coden: PMOSAZ. ISSN: 00315125. Journal Annocounment: 6803.

DELONG, ALTON, J. 1981. Phenomenological Spacetime: Toward an Experimental Relativity. U. Tennessee, School of Architecture, Knoxville. Science, Vol.213(4508). Coden: SCIEAS. ISSN: 00368075. Journal Announcement: 6706.

DIESTEL,HANS,1912. Violintechnik und Geigenbau. C.F.Kahnt, Leipzig.

DUNHAM,PAUL and GLAD, HAROLD, 1985. Effect of Plane of Movement and Speed of Stimulus on Anticipatory Coincidence. Perceptual and Motor Skills, 61, 1191-1194.

ESKOLA, ANTTI, 1981. Research Methods in Sociology. Wsoy, Helsinki.

ESKOLA, JORMA, 1983. The Learning and Teaching of Motor Functions University of Jyväskylä, Teacher Training Institute Publication 9. ISBN 951-678-953-6; ISSN 0357-7570.

FLEURY, MICHELLE and BARD, CHANTAL, 1985. Age,Stimulus Velocity and Task Complexity as Determiners of Concident Timing Behavior. Physical Activity Sciences Laboratory, Laval U, Quebec, Canada G1K7P4. Journal of Human Movement Studies ,Vol.11, 305-317.

FRAISSE, PAUL, 1984. Perception and Estimation of Time. U Paris V. Lab de Psychologi Experimentale. Annual Review of Psychology.Vol. 35,1-36. Coden ARPSAC. ISSN:00664308. Journal Announcement: 7110.

GHEZ,C.,and VICARIO,D., 1987.The Control of Rapid Limb Movement in the Cat.Response Latency. Experimental Brain Research,33,173-189.

GRAVIT, RAGNAR, 1970. The Basis of Motor Control.Academic Press. London and New York.

HAESLER, ERICH, 1958. Der Mittelhandgriff am Geigenbogen. Haesler, Nordhorn.

HAWKING,STEPHEN, W.,1988. A Brief History of Time. Finnish Edition. Wsoy.

HOGAN,H. WAYNE.,1978. A Theoretical Reconciliation of Competing Views of Time Perception.Loyola U Los Angeles.American Journal of Psychology.Vol.91(3) 417-428. Coden: AJPCAA.ISSN:00029556.Journal Announcement:6305.

IVRY, RICHARD, B.,1986. Force and Timing Components of the Motor Program. Journal of Motor Behavior. Vol.18, No.4, pp.449-474.

KAMINSKI,T.and GENTILE,A.M.,1986. Joint Control Strategies and Hand Trajectories in Multijoint Pointing Movements. Journal of Motor Behavior.Vol.18, No.3, pp. 261-278.

KANDINSKY,WASSILY,1988. Art and Mind. Publisher OY Taide.(Art,Ltd.)

KETONEN, OIVA, 1980. On the Border. Thoughts about Human Destiny. Otava,Helsinki.

KOHL,ROBERT,M. and ROENKER,DANIEL,L., 1983. Mechanism Involvement During Skill Imagery. Department of Psyhology, Western Kentucky University.Journal of Motor Behavior.Vol.15 No 2, 179-190.

KRISHNAN,LILA and SAXENA, NEENLAKSH K., 1984. Perceived Time: Its Relationship with Locus of Control, Filled Versus Unfilled Time Intervals, and Perceiver's Sex. Indian Inst. of Technology Kanpur Journal of General Psychology, Vol.110(2), 275-281. Coden: JGPSAY.ISSN: 00221309. Journal Announcement: 7203.

KUSNETSOV,BORIS ,1987. Einstein. Progress. Moskova.

LAMMENRANTA,MARKUS, 1987. The Work of Art as Symbol. The Philosophy of Art of Nelson Goodmann. University of Helsinki, Institute of Letters and Arts. Helsinki.

LAMMENRANTA,MARKUS-HAAPALA, ARTO,1987.Art and Philosophy.Gaudeamus, Helsinki.

LEHTOVAARA,ARVO,1985. The Enigma of Human Existence.Otava,Helsinki.

LEVISTE,ROGER,1951. Rationelle Technik des Vibrato. Bosworth,Köln-Wien.

MACHAMER,PETER,K. and TURNBULL,ROBERT G., 1976. Motion and Time Space and Matter. Ohio State University Press.

MASIN,RONALD and KELEMEN, MARIA, 1982. Violin Technique:the Natural Way. Frits, Knuf Buren .

MAYER,LEONARD,B.,1956. Emotion and Meaning in Music. The University of Chicago Press .

MIETTINEN,REIJO,1987. Behind a Cognitive View of Learning State Publishing Central,Helsinki.

MIGNOTTI,A.,1956. Wie übt Man Sevciks Meisterwerke. Bosworth.

MILLER,DORIS,J.and NELSON,RICHARD,C.,1976. Biomechanics of Sport. Lea & Febiger. Philadelphia.

MOHAN, VIDHU and DEOL, RUBAL, 1983. Affect of Personality and Frequency of KR on Aquisition of Efficiency in Time Estimation. Panjak U, Chandigarh, India. Journal of Psychological Researches. Vol. 27 (2), 92-99. Coden: JPSRB8. ISSN: 00223972. Journal Announcement: 7203.

MORAVSIK,JULIUS M.E., 1974. Aristotle on Adequate Explanations. Synthese 28, 3-17. D. Reidel Publishing Company. Dordrecht-Holland.

NEWELL,K.M.and CARLTON, LES G.and MARY,J.,1982.The Relationship of Impulse to Response Timing Error. U Illinois Urbana-Champaign, U Houston Rice. Journal of Motor Behavior. Vol. 14 no 1. 24-45.

NIINILUOTO,ILKKA, 1984. Science, Philosophy and World-View. Otava, Helsinki.

NIINILUOTO,ILKKA,1984. Introduction to the Philosophy of Sciences. Otava,Helsinki.

NIINILUOTO,ILKKA-SAARINEN,ESA, 1984. 20th Century Philosophy. Wsoy, Helsinki.

OELMÜLLER,WILLI, 1982. Ästhetischer Schein. Schönig,München,Wien, Zürich.

ONO,AKIO, 1975. An Experimental Study of the Interrelations Between Time, Distance, and Subjective Speed: A Study of the Kappatau Effect. Osaka U, Japan. Journal de Psychologie Normale et Pathologigue, Vol. 72(3) 261-290. Coden: JPNPAA. ISSN: 00217956. Journal Announcement:6506. Language: French.

PETERS, MICHAEL, 1985. Performance of a Rubato Like Task: When Two Things cannot be done at the Same Time. U Guelp, Canada. Music Perception,Vol.2(4), 471-482.ISSN:07307829. Journal Announcement: 7308.

PLETTA,D.H. and FREDRICK,D.,1964. Engineering Mechanics,Statistics and Dynamics. The Ronald Press, New York.

ROIHA,EINO,1949. Introduction to the Psychology of Music. Gummerus, Jyväskylä.

ROUTILA,LAURI,OLAVI,1986. Developing a Science of Art. Clarion, Helsinki.

SAARINEN,ESA,1985. Survey of Western Philosophy from Sokrates to Marx. Wsoy, Helsinki.

SALMON,WESLEY,C., 1980. Space,Time and Motion. University Minnesota Press.

SHAFFER,HENRY,1984. Timing in Musical Performance. New York Academy of Sciences Conference on Timing and Time. Perception: Rhytmic patterns and music (New York). U. Exeter,England. Annals of the New York Academy of Sciences. Vol. 423, 420-428. Coden: ANYAA9 ISSN:00778923. Journal Announcement:7202.

SHAFFER,L.H.,1981. Performances of Chopin, Bach and Bartók: Studies in Motor Programming. Cognitive Psychology 13,326-376.

SINGER, ROBERT N., 1982. The Learning of Motor Skills. Macmillan Publishing Co., Inc. New York.

SLOBODA,J.A.,1985. The Musical Mind. The Cognitive Psychology of Music.Oxford Psychology Series.No.5.Oxford:Clarendon Press.

SMIRNOV,A.G.,and KONEVA,N.M., 1985. Estimation of Time Intervals Under the Static Muscular Lead. Leningrad State U,Ukhtomsky Inst. Inst. of Physiology, USSR. Zhurnal Vysshei Nervnoi Deyatel nosti, Vol.35 (1), 81-86. Coden: ZVNDAM. ISSN: 00444677.Journal Announcement:7303. Language: Russian.

SMOLL,FRANK L.and SCHUTZ, ROBERT W.,1982. Accuracy of Rhytmic Motor Behavior in Response to Preferred and Nonpreferred Tempos. U of Washington, Seattle, WA, USA, 98195 and U of British Columbia Vancouver, BC. Canada, V6T1W5. Journal Human Movement Studies, Vol. 123-138.

STERN, DANIEL N.,1985. The Interpersonal World of the Infant. Basic books, New York.

STERNBERG, SAUL and KNOLL, ROLAND ,L., 1984. Perception, Production and Imitation of Time Rations by Skilled Musicians.New York Academy of Sciences Conference on Timing and Time Perception: Bell Labs Murray Hill, New York.Annals of the New York Academy of Sciences, Vol.423,439-441. Coden: ANYAA 9.ISSN: 00778923. Journal Announcement:7202.

SURWILLO, WALTER W.,1982. Time Perception in Relation to Pulse Rate in Healthy Males. U Louisville School of Medicine.Journal of Psychology. Vol. 110(1), 101-106. Coden: JOPSAM. ISSN: 00223980 00223980. Journal Announcement:6803.

SUONPERÄ, MATTI,1982. Learning and Teaching Art (the CMS-Strategy). Publications of the University of Jyväskylä Pedagogic Institute, no 323. ISBN 951-678-760-6. ISSN 0448-0953.

SZIGETI,JOSZEF,1979. Szigeti on the violin. Dover Publications.

TIMOSCHENKO,S, and YOUNG,D.H., 1956. Engineering Mechanics. Ed.New York: Mc Graw-Hill Book Company.

TIPPS,R.STEVEN, 1980. Time Estimation of Auditory Patterns of Different Pitch Intervals. U Virginia, School of Education, Charlottesville.Perpetual & Motor Skills, Vol.51 (3,PT1) 695-698. Coden:PMOSAZ. ISSN:00315125.Journal Announcement:6701.

TOOLE,TONYA and CHRISTIAN, ROBERT W. and ANSON, J. GREGORY, 1982. Preselected Movement Accuracy as a Function of Movement Time, Distance and Velocity. Florida State U, Pennsylvia State U, Cumberland College of Health Sciences,Australia. Journal of Human Movement Studies 8,93-102.

TUNNER, WOLFGANG, 1984. Erlebnisintensität und Zeiterleben. Ludwig-Maximillians-U,München, Inst.für Psychologie. Gestalt Theory.Vol. 6(2) 111-117.ISSN: 0170057. Journal Announcement: 7206. Language: German.

TUOMELA,RAIMO, 1982. Explanation of Action. Contemporary Philosophy A New Survey. Vol. 3. pp.15-43. Martinus Nÿhoff Publishers. The Hague, Boston, London.

TSAO,YAO-CHUNG and WITTLIEB, ELKE and MILLER,BARBARA and WANG,TSAI-GUEY, 1983. Time Estimation of a Secondary Event. Rensselaer Polytechnic.Inst. Perceptual & Motor Skills,Vol.57 (3,PT2). 1051-1055. Coden: PMOSAZ. ISSN: 00315125. Journal Announcement: 7111.

VARPIO,YRJÖ,1982. Principles of Art Research. Wsoy, Helsinki.

Le VEAU,B.,1977.Biomechanics of Human Motion.W.B. Saunders Company, Philadelphia.

VORBERG, DIRK and HAMBURG, ROLF,1984. Timing of Two-Handed Rhythmic Performance.New York Academy of Sciences Conference of Timing and Time Perception: Rhytmic Patterns and Music (New York). Philippsa U Marburg,West Germany.Annals of the New York Academy of Sciences Vol.423,390-406. Coden:ANYAA9.ISSN:00778923.Journal Announcement: 7202.

WHITE,ALAN R.,1968. The Philosophy of Action. Oxford University Press.

WHONE, HERBERT, 1976. The Integrated Violinist. Camelot Press. Southhampton.

WHONE, HERBERT, 1980. The Simplicity of Playing the Violin. Victor Gollancz ltd. London.

WILLIAMS,L.R.T.,1985.Skill Acquisition in Timing a Movement Series. Motor Learning and Control Laboratory, Kinesiology Section, Section, Faculty of Physical Education,U of Otago,Box 56,Dunedin, New- Zealand. Journal of Motor Behavior .

WILLIAMS,L.R.T. and CHURCHMAN, P., 1986. Timing Accuracy,Precision and Rhytm in Serial Movement. Motor Learning and Control. Laboratory Kinesiology Department, U of Otago, Dunedin,New-Zealand. Journal of Human Movement Studies, Vol. 12, 35-49.

WINTER,DAVID A., 1979. Biomechanic of Human Movement. John Wiley & Sons. New York, Chichester, Brisbane, Toronto,Singapore.

von WRIGHT,GEORG,HENRIK,1971. Explanation and Understanding.Editor: Ted Honderich .

von WRIGHT, GEORG, HENRIK, 1985. Philosophical Investigations. Kirjayhtymä.Helsinki.

YOSIKO,DAN and NITZAN, DEVORA and GLICKSOHN,JOSEPH, 1983. The Influence of Task Difficulty and External Tempo on Subjective Time Estimation. Tel-Aviv U Ramat - Aiv, Israel.Perceptional & Psychophysics, Vol.34 (5), 451-456. Coden: PEPSBJ.ISSN:00315117. Journal Announcement: 7109.

ZAKAY,DAN and LOMRANZ, JACOB and KAZINZ, MARIK, 1984. Extraversion-Interversion and Time Perception. Tel-Aviv U, Ramat-Aviv, Israel. Personality & Individual Differences. Vol. 5(2),237-239. ISSN: 01918869. Journal Announcement: 7204.

ZAKAY, DAN and NITZAN, DEVORA and GLICKSON, JOSEPH, 1983. The Influence of Task Difficulty and External Tempo on Subjective Time Estimation.Journal article. Israel.

ZIMMERMAN,MARC L. and LEDBETTER, WILLIAM and BALL,STEVEN,E., 1979. Time Estimation as a Personality Indicator. Psychology: A Quaterly Journal of Human Behavior, Vol.16(1) 1-3.ISSN: 00333077. Journal Announcement: 6504.

VALTION PAINATUSKESKUS
1990 HELSINKI

ISBN 951-
ISSN 0787