INFORMATION TO USERS

This dissertation was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.

2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in “sectioning” the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again — beginning below the first row and continuing on until complete.

4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from “photographs” if essential to the understanding of the dissertation. Silver prints of “photographs” may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.

University Microfilms
300 North Zeib Road
Ann Arbor, Michigan 48106
A Xerox Education Company
DOCHERTY, Ethel Mae Hulda, 1937-
THE EFFECTS OF REDUCING AND MASKING THE
AUDITORY CUES ACCOMPANYING PERFORMANCE OF
SELECT GROSS MOTOR TASKS ON THE PERFORMANCE
OF THOSE TASKS.

The Ohio State University, Ph.D., 1972
Education, physical

University Microfilms, A XEROX Company, Ann Arbor, Michigan
THE EFFECTS OF REDUCING AND MASKING THE AUDITORY CUES ACCOMPANYING PERFORMANCE OF SELECT GROSS MOTOR TASKS ON THE PERFORMANCE OF THOSE TASKS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Ethel Mae Hulda Docherty, B.S., M.S.

The Ohio State University
1972

Approved by

[Signature]

Margaret A. Mard
Adviser
School of Physical Education
ACKNOWLEDGEMENTS

The writer wishes to express sincere gratitude to her adviser, Dr. Margaret Mordy, for her constructive suggestions and encouragement in the development of this study.

Appreciation is extended to Dr. Seymour Kleiman for serving on the reading committee; to Dr. Dolyte Kornis for serving on the reading committee and for providing assistance and guidance in the selection and use of the proper statistical procedures; and to Dr. John Hendrix, tennis instructor and professional, for offering expert advice.

This study could not have been completed without the efforts of Dr. Salvatore Marco and his assistant, Mr. William Patterson, from the Mechanical Engineering Department who provided valuable technical skill in the determination of the sound measurements used in this study.

The writer is especially indebted to the varsity tennis players from Upper Arlington High School and The Ohio State University who so willingly participated in the study and to their respective tennis coaches, Mr. Dick Fryman and Mr. John Daly.
VITA

September 26, 1937 . . . . Born - Detroit, Michigan

1960 . . . . . . . . . . B.S., Wayne State University, Detroit, Michigan


1961-1962 . . . . . . Teaching Assistant, Pennsylvania State University, University Park, Pennsylvania

1962 . . . . . . . . . . M.S., Pennsylvania State University

1962-1967 . . . . . . Instructor, Western Illinois University, Macomb, Illinois

1967-1968 . . . . . . Teaching Associate, The Ohio State University, Columbus, Ohio

1968-1972 . . . . . . Assistant Professor, Western Illinois University, Macomb, Illinois

1972 . . . . . . . . . . Graduate student, The Ohio State University, Columbus, Ohio

FIELDS OF STUDY

Major Field: Physical Education

Minor Field: Developmental Psychology
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENT</td>
<td>ii</td>
</tr>
<tr>
<td>VITA</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
</tbody>
</table>

## Chapter I. INTRODUCTION

- Statement of the Problem
- Hypothesis
- Basic Assumptions
- Delimitations of the Study
- Weaknesses
- Significance of the Study
- Definition of Terms
- Organization of the Remainder of the Study

## Chapter II. RELATED LITERATURE

- Perception and the Highly Skilled Performer
- Feedback and Performance
- Decreased and Masked Auditory Feedback
- Other Related Literature
- Summary

## Chapter III. PROCEDURES

- Design of the Study
- Pilot Study
- Selection of Subjects
- Experimental and Control Conditions
- Experimental Apparatus
  - Attenuating Earmuff
  - Attenuating Headset
  - Modified Earmuff
  - White Noise Recording
  - Tape Recorder Back Pack
- Gross Motor Tasks
- Wall Rally Task
- Game-like Task

iv
## TABLE OF CONTENTS—Continued

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Response Questionnaires</td>
<td></td>
</tr>
<tr>
<td>Administration of the Task Conditions</td>
<td></td>
</tr>
<tr>
<td>Wall Rally Task</td>
<td></td>
</tr>
<tr>
<td>Game-like Task</td>
<td></td>
</tr>
<tr>
<td>Reliability and Validity of the Wall Rally Task</td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
</tr>
<tr>
<td>Validity</td>
<td></td>
</tr>
<tr>
<td>Important Controls</td>
<td></td>
</tr>
<tr>
<td>Weight of Tennis Balls</td>
<td></td>
</tr>
<tr>
<td>Tennis Equipment</td>
<td></td>
</tr>
<tr>
<td>Wall Rally Task Administrators</td>
<td></td>
</tr>
</tbody>
</table>

### IV. ANALYSIS OF DATA ........................................ 52

| Performance of the Wall Rally Task                                    |      |
| Determination of Reliability and Validity: Wall Rally Task             |      |
| Reliability                                                            |      |
| Validity                                                               |      |
| Qualitative Analysis of Subject Response Questionnaires                |      |
| Wall Rally Task                                                        |      |
| Preliminary (Normal) Sound Session                                    |      |
| Control (Normal) Sound Session                                         |      |
| Reducing Sound Session                                                 |      |
| Masking Sound Session                                                  |      |
| Game-like Task                                                         |      |
| Control (Normal) Sound Session                                         |      |
| Reducing Sound Session                                                 |      |
| Masking Sound Session                                                  |      |
| Brief Summary of the Analysis of Data                                  |      |

### V. SUMMARY AND CONCLUSIONS ................................ 116

| Conclusions                                                            |      |
| Recommendations for Further Study                                     |      |

### APPENDICES

| A. INFORMATION SHEET—CONSENT FORM                                     | 125 |
| B. INSTRUCTIONS FOR PERFORMANCE OF WALL RALLY TASK                    | 129 |
| C. SCORE SHEET                                                         | 132 |
# TABLE OF CONTENTS—Continued

## APPENDICES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D. SUBJECT RESPONSE QUESTIONNAIRES - Wall Rally Task</strong></td>
<td>134</td>
</tr>
<tr>
<td>Preliminary Normal Sound Session</td>
<td></td>
</tr>
<tr>
<td>Control Sound Session</td>
<td></td>
</tr>
<tr>
<td>Reducing Sound Session</td>
<td></td>
</tr>
<tr>
<td>Masking Sound Session</td>
<td></td>
</tr>
<tr>
<td><strong>E. SUBJECT RESPONSE QUESTIONNAIRES - Game-like Task</strong></td>
<td>142</td>
</tr>
<tr>
<td>Control Sound Session</td>
<td></td>
</tr>
<tr>
<td>Reducing Sound Session</td>
<td></td>
</tr>
<tr>
<td>Masking Sound Session</td>
<td></td>
</tr>
<tr>
<td><strong>F. QUALITATIVE RESPONSES TO SUBJECT RESPONSE QUESTIONNAIRE</strong></td>
<td>149</td>
</tr>
<tr>
<td>Preliminary Normal Sound Session</td>
<td></td>
</tr>
<tr>
<td><strong>G. SKILL RATING FORM</strong></td>
<td>156</td>
</tr>
<tr>
<td><strong>H. AUTHORIZATION FOR A MINOR TO SERVE AS A SUBJECT IN RESEARCH</strong></td>
<td>160</td>
</tr>
<tr>
<td>Consent to Serve as a Subject in Research</td>
<td></td>
</tr>
<tr>
<td><strong>I. PHOTOGRAPHS OF EXPERIMENTAL APPARATUS</strong></td>
<td>164</td>
</tr>
<tr>
<td><strong>BIBLIOGRAPHY</strong></td>
<td>171</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Age, Educational Level, Number of Years Played Tennis, and Highest Recognition Received</td>
<td>32</td>
</tr>
<tr>
<td>3.</td>
<td>Analysis of Variance of Number of Successful Hits for Order and Sound Conditions During the Performance Sessions</td>
<td>55</td>
</tr>
<tr>
<td>4.</td>
<td>Analysis of Variance of Accuracy for Order and Sound Conditions During the Performance Sessions</td>
<td>56</td>
</tr>
<tr>
<td>5.</td>
<td>Analysis of Variance of Total Scores (Number of Successful Hits Plus Accuracy) for Order and Sound Conditions During the Performance Sessions</td>
<td>57</td>
</tr>
<tr>
<td>6.</td>
<td>Analysis of Variance of Accuracy/Number of Successful Hits Ratio for Order and Sound Conditions During the Performance Sessions</td>
<td>58</td>
</tr>
<tr>
<td>7.</td>
<td>Estimate of the Reliability Coefficient for the Number of Successful Hits</td>
<td>60</td>
</tr>
<tr>
<td>8.</td>
<td>Estimate of the Reliability Coefficient for Accuracy Scores</td>
<td>60</td>
</tr>
<tr>
<td>9.</td>
<td>Estimate of the Reliability Coefficient for the Total Scores (Accuracy Plus Number of Successful Hits)</td>
<td>61</td>
</tr>
<tr>
<td>10.</td>
<td>Estimate of the Reliability Coefficient for the Accuracy/Number of Successful Hits Ratio</td>
<td>61</td>
</tr>
<tr>
<td>11.</td>
<td>Composite of Reliability Coefficients for the Performance Measures Used in This Study</td>
<td>62</td>
</tr>
<tr>
<td>12.</td>
<td>Composite of Validity Coefficients for the Wall Rally Performance Measures and Skill Rating Form Evaluation</td>
<td>63</td>
</tr>
<tr>
<td>13.</td>
<td>Composite of Validity Coefficients for the Wall Rally Performance Measures and Judges' Performance Rank Order</td>
<td>64</td>
</tr>
<tr>
<td>14.</td>
<td>Subjects' Responses to Control Sound Session Questionnaire - Wall Rally Task</td>
<td>70</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>15. Subjects' Responses to Reducing Sound Session Questionnaire - Wall Rally Task</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>16. Subjects' Responses to Masking Sound Session Questionnaire - Wall Rally Task</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>17. Subjects' Responses to Control Sound Session Questionnaire - Game-like Task</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>18. Subjects' Responses to Reducing Sound Session Questionnaire - Game-like Task</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>19. Subjects' Responses to Masking Sound Session Questionnaire - Game-like Task</td>
<td>105</td>
<td></td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Target Lay-out for the Wall Rally Task</td>
<td>41</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

A noted psychologist, Clarence Ragsdale wrote:

Often tho object of motor activity is to do work on an object, person, or material or to produce some other effect in the external world. This fact requires the use of appropriate sense organs to keep the total body activity properly related to the environmental circumstances.1

In addition, he commented that

We have muscles and use them in motor learning; we have kinesthetic sense organs, eyes, ears and skin senses and we use them all; ...; we have thinking processes and use them. We collect data about action from all available sources and use them in learning motor activities as fully as our individual intelligence permits!2

In motor learning and skill performance man moves in his environment; in order to move efficiently, man must rely on his senses, especially those of vision, kinesthesia and hearing to one degree or another, depending on the demands of the motor task, for perception of cues to determine what to do and how to do it. Bartlett states that it is the "... operations of the special


2Ibid., p. 71.
senses, and especially those of the distance receptors [eyes and ears] . . . "3 which provide information to then be interpreted and affected so that the performer in order to move with skill is " . . . in touch with demands which come from the outside world."4

Physical educators have shown an interest in the roles the various senses play in sport activities. As a result, imroads have been made toward a better understanding of the visual and kinesthetic areas in sport performance but little understanding has been acknowledged in regard to the importance of the auditory sense in such performance.

Several reasons for the lack of research studies in the area of auditory perception and its relation to skill learning and performance have been cited by Sage. He reports that it is very difficult to measure this dimension of perception; the standards for sound localization performance are inadequate; and lastly, the presumption that auditory perception plays a minor role in sports motor performance has affected this lack of research.5

Sage may be quite correct in his observations but, nonetheless, steps must be taken to aid in the determination, as fully as possible, of all variables affecting performance. This, then, would

4Ibid., p. 31.
include the variables in terms of the auditory sense.

Substantial research has been conducted in the auditory mode related to the effects of verbalization, either that which is given by the teacher through instruction to students or by the students, themselves, as they are in the process of learning and performing fine and gross motor skills. Some of these studies have been reviewed in writings by Robichaux, Lockhart, Knapp, and Singer.

In the same mode but related to auditory stimuli cues inherent in motor tasks and the effects these cues may have on skill learning and performance, there is almost a total lack of information. And yet such sound cues are very prominent in many of our sport activities. Often a "whishing" sound heard during the execution of a forehand drive or a serve in tennis and a similar sound accompanying an overhead clear in badminton are indicative of a well executed stroke. In baseball the crack of a bat provides information to the outfielder as to his movement needs to meet the situation.


The development of the aluminum bat has resulted in a change in the sound of the bat as it makes contact with the pitched ball, thus many players have had to relearn or readjust to the relevant auditory cues associated with this aspect of the game in order to maintain seemingly their previous efficiency. The sound of the basketball rebounding from the floor surface during a dribble may assist the player in locating the ball without need to sight the ball directly. These sounds in one way or another may affect an individual's performance, especially the performance of a skilled player who is more inclined to be cognizant of these sounds.

As Sage points out, these sounds "... combined with visual information provide a more precise representation of events in space."\(^{10}\) Barsch states that "one of audition's major services is to alert the visual mode to inspect detail for relevance."\(^{11}\)

On a survival basis, Barsch holds the view that sound processing goes through a basic sequence which is "... alert—scan—localize. The alerting characteristic sensitizes the auditory mechanism to a state of readiness—the scanning potential permits a survey for survival values and the localizing process enables the individual to have awareness of distance to signal whatever adjutiv mechanisms may be required."\(^{12}\)

\(^{10}\)Sage, op. cit., p. 186.


\(^{12}\)Ibid., p. 231.
This view may be applied to the early stages of motor skill learning and performance when the individual is aware of the sounds in his task performance but is not yet able at this stage to use them effectively in executing his movements. On the other hand, the skilled player has proceeded beyond this basic stage by

"... a perceptive-cognitive transduction of sound into information and evaluation of such information in movement terms so ... the auditory system can ... fulfill its share of the adaptive process. Consequently, localization of sound must lead to discrimination, differentiation and eventual classification. Sound must be processed through the cognitive sequence of sensitivity-perception-symbolization-conceptualization and abstraction ... for movement efficiency."\(^\text{13}\)

The skilled performer has automatized his movements to the point of efficiency so that he can focus on the pertinent cues in the situation display or the demands of the task. He is cognizant of the significant cues and the appropriate responses attendant to these cues.\(^\text{14}\) He knows, for instance in tennis, when and where to move in response to the pertinent cues associated with his opponent's response and perhaps his own. Whether or not the skilled player in the sport of tennis, assuming he has processed all potential cues accompanying his performance and that of his opponent is not known. Conjecture by tennis experts, though, has provided some insight to the possible importance of such sounds.

\(^\text{13}\)Ibid., p. 232.

The writer corresponded with several well known tennis coaches to ascertain their opinions regarding the relevance of sound cues inherent in the sport on the player's performance. The general consensus was that an experienced player does use auditory cues in playing the game, but probably is not aware of this use. They too indicated that when the sound cues are lessened or obliterated by some extraneous noise, the effects are felt by a decrease in the ability to judge the pace of an opponent's shot, by a decrease in the ability to react quickly in response to that shot, and there is a tendency for a player's concentration to be easily broken. 15, 16, 17

Along this line, Murphy relates some anecdotal evidence relative to the perception of auditory cues. He states:

I recall a group of us trying to play doubles indoors, in the University of Chicago Fieldhouse, while a basketball game was in progress at the other end of the building. None of the four of us enjoyed playing at all because of the distracting background noise but also because none of us was able to play well because we couldn't judge the speed of the ball as well as we thought we should. After only 3 or 4 games, we agreed, unanimously to quit playing. In discussing things after we had quit, we all felt that the inability to hear the ball well decreased our efficiency on the court and made play unpleasant. 18


16 Letter from Bill Murphy, Tennis Coach, Illinois State University, Normal, Illinois, April 10, 1972.

17 Letter from Chet Murphy, Tennis Coach, University of California, Berkeley, California, May 12, 1972.

18 Bill Murphy, loc. cit.
From what has been stated, the auditory sense is of importance to the efficiency of movement. Also, there is indication that the aspect of audition which involves the use of sound cues accompanying performance in a sport, particularly tennis, does have some relevance to the player's ability to play the game well. How much relevance these cues provide, no one seems to really know, and therefore needs to be explored.

To determine this relevancy, the auditory cues can be restricted by means of reducing and masking so that the individual is forced to use other sense modalities (visual, proprioceptive, and tactile) to receive stimuli for transposing into information that may assist him in his performance. The effects on his performance will determine whether auditory cues are, in fact, of value.

THE PROBLEM

Statement of the Problem

During the performance of a game of tennis, a skilled player receives auditory cues from the ball hitting an opponent's racket, hitting his own racket, and rebounding off the court surface. How significant are these cues to a player in determining his performance?

The purpose of this study was to determine the importance of auditory cues accompanying the performance of a select gross motor task incorporating skills similar to those used in the sport of tennis.

---

rallying a ball against the wall with a forehand drive, a backhand drive, or volley, upon the performance of that task at the skilled performer level. More specifically, the study attempted to

1) determine if a reduction in the intensity of the sound cues would affect a skilled player's performance of a tennis wall rally task.

2) determine if a total blockage or masking of the sound cues by white noise would affect a skilled player's performance of a tennis wall rally task.

Sub-problems included: (1) the development of an accuracy target for use in the wall rally task and the determination of its reliability and validity, (2) the construction of a series of questionnaires to assist in the collecting of subjective data which may have pertinence to the main purpose of the study, and (3) the administration of a game-like task performed under the reduced and masked sound conditions plus a control (normal) sound condition and distribution of appropriate questionnaires to gather additional subjective data pertaining to a task more closely related to an actual game of tennis.

Hypothesis

The hypothesis was that the normal auditory cues which are inherent in the wall rally task do not enhance the performance of that task at the skilled performer level. More specifically:

1) there would be no decrement in the efficiency of the performance of the wall rally task measured by number of successful hits and accuracy points scores when the intensity of the auditory cues were reduced.
2) there would be no decrement in the efficiency of the performance of the wall rally task as measured by the number of successful hits and accuracy points scores when the auditory cues were masked with white noise.

Basic Assumptions

In the conduct of the study, the writer assumed: (1) that all subjects were highly skilled in the sport of tennis; (2) that the experimental apparatus worn by the subjects would not in and of itself hinder their performances—any changes that may have occurred in their performances were due to the experimental conditions only; (3) that the subjects, being highly skilled and practiced in the performance of the wall rally task would not be susceptible to learning during the course of the experimental sessions; and (4) that the subjects were sufficiently motivated so that their performances primarily reflected their attention to the demands of the task and the relevant cues associated with this task and its performance.

Delimitations of the Study

1. The study was limited to eighteen experienced male tennis players. During the conduct of the study Spring Quarter, 1972, seven of the subjects were members of the varsity tennis team at The Ohio State University; the remaining eleven subjects were members of the Upper Arlington High School varsity tennis team.

2. All subjects possessed hearing capabilities within the "normal" range as measured by means of an audiometer.
3. The wall rally task was performed indoors at The French Fieldhouse on the campus of The Ohio State University in order to avoid an unpredictable weather factor.

4. The game-like task was performed in groups of two, i.e., in the style of a singles game.

5. Any inferences derived from the results of the study must be applied only with reference to the experimental conditions and procedures inherent in the study and to the population sampled.

**Weaknesses**

The reader should consider the following factors as possible weaknesses in the study:

1. The number of subjects was limited by the necessary qualification required for the study, i.e., being a skilled performer in the sport of tennis and currently a member of a varsity tennis team.

2. The measuring instrument, specifically the wall rally task, was performed against a semi-rough cement block wall.

3. The background noise emanating from the large arena adjacent to the varsity tennis court inside The French Fieldhouse, although not intense, was not the same for all subjects because of the variety of activities that tended to take place in that area.

4. The subjects wore experimental apparatus throughout each performance session; the wearing of such apparatus is not consistent to playing the game of tennis.

5. The skill evaluation of each subject's performance by three expert judges for use in determining validity of the wall rally
task was completed during one afternoon session. The subjects played several games of tennis, either singles or doubles, but did not participate in a competitive situation where a win record was important. Thus, the subjects may not have performed to their optimum level.

Significance of the Study

The major reason for the undertaking of this study was to ascertain if auditory cues which occur in the process of performing a specific gross motor task play an important role in the determination of a skilled player's performance of that task. If a significant difference is found in the performance resulting from reducing and/or masking the auditory cues, it is hoped that these results might influence physical educators toward giving greater consideration to the potential use of such cues in the teaching of physical education activity classes and in the coaching of sport teams.

Knapp states:

One of the most important factors . . . in . . . skilled performance is the ability to select and pay attention to the right signals and to ignore irrelevant stimuli. Meredith has said that "the job of the instructor should not primarily be to persuade his pupil to make certain movements, but rather first to identify, and then to communicate the information which determines the control of these movements".20

Therefore, any knowledge regarding cues which are perceived and subsequently used by skilled individuals in the performance of motor tasks should provide valuable information to the physical educator because he is concerned with the development of optimal skill

20Knapp, op. cit., pp. 138-139.
learning and performance. He should deem it important to assist his students at all levels toward a greater awareness of these cues and to stress their informational aspects. For the beginning student, especially, the learning process may be more efficiently advanced by assisting him toward attending to these important cues during the initial stage of learning and performance so that the tendency to concentrate on many irrelevant cues, characteristic of this stage, may possibly be curtailed.

In addition, a study of this nature might create an atmosphere conducive to the development of critical questioning which might lead to the instigation of additional research designs to further the scanty information that is presently available regarding the role of auditory cues inherent in sport performance.

DEFINITION OF TERMS

Decibel: The unit of measure for sound intensity or physical energy of sound as it travels through a medium. It is the logarithm of the ratio of the sound energy to a reference point; the reference point generally used is the power necessary for a pure tone of 1000 cycles per second to be just audible.\(^2\)

Normal auditory cues: The sounds in the immediate context of the performance of the select gross motor tasks.

Masked auditory cues: The use of irrelevant stimuli (white noise) to conceal the normal auditory cues.

Performance: A series of observable movements of relatively short-term which are purposefully directed toward the execution of a motor task.\textsuperscript{21}

Reduced auditory cues: The intensity of the auditory cues is lowered approximately eight decibels from its normal standard by means of blocking the ear passages with attenuating earmuffs.

Skilled performer: An individual who has learned to execute consistently the movements in a gross motor task with a minimum amount of effort. His behavior has integrated to a point whereby "extraneous movements have been omitted, and the performance is executed with increasing speed and accuracy, a decrease in errors, or perhaps the ability to apply greater force."\textsuperscript{22} In this study the skilled performer is ranked as a varsity tennis player.

ORGANIZATION OF THE REMAINDER OF THE STUDY

Chapter II presents the literature related to the study. Chapter III presents the procedures used in conducting the investigation. The data and analysis are presented in Chapter IV. In Chapter V, the summary, conclusions, and recommendations for further study are presented. All material relevant to the investigation is appended. The bibliography follows.


\textsuperscript{23}Ibid., p. 10.
CHAPTER II

RELATED LITERATURE

Upon completing a survey of the literature which might have bearing on the present study the writer found a paucity of research relating audition, in terms of inherent task sounds, to the performance of gross motor skills. Therefore an attempt is made to present a review of select literature to construct background for the development of the present study. The writer categorized the review of literature in the following way: Perception and the Highly Skilled Performer; Feedback and Performance; Decreased and Masked Feedback; and Other Related Literature.

Perception and the Highly Skilled Performer

This study was primarily concerned with the importance of auditory cues accompanying the performance of a task upon that performance. A cue is information which enables one to make a response and hopefully a correct one. The information is received through the complex process of perception. Fellows defines perception as "... the process by means of which an organism receives and analyses sensory information." Berelson and Steiner define perception as "the more complex process by which people select, organize, and interpret

stimulation into a meaningful and coherent picture. . ."\(^2\)

The possibilities for stimuli input are infinite and as a result there must be active participation by the organism in determining what stimuli will actually reach the receptors and in turn which of these will be at the awareness level. The process is selective in that it determines those stimuli which become a part of experience. The basis of the selection depends on three factors:

... the nature of the stimuli involved; previous experience or learning as it affects the observer's expectations (what he is prepared or "set" to see [hear]); and the motives in play at the time. . . . in short, what the observer wants or needs to see [hear] and not to see [hear].\(^3\)

Fellows amplifies this selective process which he considers to be the main characteristic of attention by indicating that it has three effects. "That is, attending to a stimulus magnifies its influence. Second, attention also serves to reduce the influence of competing stimuli."\(^4\) And thirdly, "... attention also operates to isolate certain characteristics of input."\(^5\) The selection process does not change or alter in any way the basic input, but this input is eventually "... supplemented and transformed by the existing characteristics of the perceptual system"\(^6\) which provides the environmental information used for determination of responses.

\(^3\)Ibid., p. 100.
\(^4\)Fellows, op.cit., p. 5.
\(^5\)Ibid., p. 6.
\(^6\)Loc. cit.
In that this study deals with highly skilled tennis players, Lawther places this perceptual process in the perspective of skilled performers in physical education and sport by stating:

The highly skilled performer keeps his attention directed toward cues for succeeding acts while turning present activity over to the custody of automatism. . . . The highly skilled adult integrates movements automatically in terms of cue perception. He looks ahead to discover when and where to perform certain acts. He learns to tie significant cues to appropriate responses. He also is learning many fine discriminatory recognitions. With experience and prompt action-results, he gradually refines and abbreviates his cue recognitions. Much of the learning at the high skill levels in this refinement is perceptual discrimination.?

Lawther further states:

Another factor in cue recognition is the progress in learning to perceive with greatly abbreviated cues. The high-level performer catches many cues from brief peripheral view which, as a beginner, he could only recognize by direct focus and a longer look. One learns to recognize these greatly abbreviated cues by innumerable practices in high skill-level competition.®

Lawther tends to put emphasis on visual perception and seems to negate the auditory cues which may be involved in the various performances of the highly skilled. This may be due to the general assumption that vision is the more important sense for perception. Although earlier, he did indicate in collaboration with Cooper that "the advanced student of motor skills should learn to take advantage of cues from as many of his senses as practicable in order to refine his cue perception."9

---

8Ibid., p. 42.
Feedback and Performance

Once the performer selects the correct cues from his environmental situation in this study from the total perspective of a tennis wall rally task and game-like task situations, decisions are made on the basis of those cues, and actions or responses are initiated and then controlled by feedback. Thus, feedback may be considered in terms of cues, but cues which result from the performer's own actions, Bilodeau stated: "Many authors treat feedback as if it were a cue, a command, a signal, or a bit of information in regard to the correctness of a particular past or future response. The subject learns to use the feedback and learns to execute responses more adequately.

... As a cuing variable, feedback acts upon already learned hierarchies of habits and serves as a selector.

Research indicates that feedback may affect performance in several ways; it may be motivating, regulating, and/or reinforcing. Adams briefly discussed the relation of regulating and reinforcing feedback to learning and performance. He concluded that the reinforcing stimuli of feedback affect learning whereas the regulating stimuli

---


12 Ibid., pp. 235-237.

13 Adams, op. cit., p. 186.

affect performance. He stated that "these regulatory stimuli change continuously as a function of the continuous responses in the motor sequence, and singly or in combination they can inform S [subject] through any sense modality about the rate, acceleration, amount, extent, and direction of movements."\(^{15}\)

According to Annett and Kay, feedback may be of two types: intrinsic and augmented. Intrinsic feedback is that information which is inherent in the task and is a result of the performer's own actions. Augmented feedback, on the other hand, is information supplemental to the task performance; i.e., the teacher may present additional information to the performer about his performance which is not contained in the task.\(^{16}\) In this study the auditory cues inherent in the performance of the gross motor tasks are of concern and are considered intrinsic feedback; i.e., they occur as the result of contact between ball and racket which is initiated by the performer.

Miller refers to feedback in terms of arrival time in relation to the performance. Action feedback provides cues or signals which tell the performer what he is doing at the moment or what he should do as he continues his performance. This type of feedback enables adjustments to be made as the task is being executed. Learning feedback offers cues about the completed performance, i.e., information about what has been done. A comparison is then generally made between the

\(^{15}\)Adams, \textit{loc. cit.} \\

performance and a model performance in order to determine what should be done during succeeding performances. 17, 18

The tennis wall rally task offers auditory feedback at the time the ball contacts the racket; it is an almost instantaneous sound and it occurs near the end of a ballistic response therefore no adjustment can be made during the performance on the basis of the sound. The cues that are received from the sound are in terms of learning feedback. The sound may tell the performer how much force he applied to the ball, whether the ball hit the center or periphery of the racket strings, etc.; this information may indicate to the performer how he should modify his next performance.

The reception of feedback does occur through a variety of modalities which can be classified into two general categories: internal feedback and external feedback. Internal feedback is received primarily by means of proprioceptors which provide information relative to the action of the body. External feedback is received by the sense organs of vision, hearing, touch, smell, and taste. These sense organs are stimulated by sources in the environment and provide information regarding conditions outside of the body, e.g., in playing a game of tennis, in order to make use of the auditory cues they must be received by the hearing mechanism for them to be incorporated in future responses.

Billodeau and Billodeau have concluded that "studies of feedback

17 Ibid., p. 75.
or knowledge of results . . . show it to be the strongest, most
important variable controlling performance and learning.\textsuperscript{19,20}

It has been shown that with feedback, progressive improvement occurs.
When feedback is not present, there is no improvement and when feedback
is withdrawn, deterioration takes place.\textsuperscript{21} Annett and Kay remark
that the use of feedback or knowledge of results is quite varied and
the removal of such feedback may have different consequences depending
upon this use. They state that two such consequences are:

(a) In these cases where the operator is carrying out a
series of well practiced responses removal of knowledge
of results will not lead to a sudden fall off in
performance. Conversely where a response is not well
known the fall off will be greater.

(b) Where a subject is using knowledge of results as
action feedback the fall off will be more dramatic
than where he had been using it as learning feedback.\textsuperscript{22}

Decreased and Masked Auditory Feedback

An investigation most closely related to the concerns of this
study was completed by Kriebel. She attempted to determine the
effects of reducing, masking, and delaying the sound inherent in a
modified table tennis task on the learning and performance of that
task. The subjects practiced the table tennis task on three separate
occasions under normal task conditions. During the fourth session or

\textsuperscript{19Edward A, Bilodeau and Ina McD, Bilodeau, "Motor Skills Learn-
ing," \textit{Annual Review of Psychology}, editor Paul Farnsworth, (Palo Alto,

\textsuperscript{20Ina McD, Bilodeau, "Information Feedback," \textit{Principles of
Skill Acquisition}, editor Edward A, Bilodeau, (New York: Academic

\textsuperscript{21Bilodeau and Bilodeau, "Motor Skills Learning," \textit{loc. cit.}

\textsuperscript{22Annett and Kay, \textit{ibid.}, p. 78.}
test session the subjects experienced the normal condition in addition to the three experimental conditions. She concluded that the reduced, masked, or delayed sounds of the table tennis ball hitting the table and paddle did not have any detrimental effect on performance.\(^{23}\)

Diehl and Siebel thought it reasonable to suppose that a typist utilized auditory and visual cues to maintain rhythm and to detect certain kinds of errors because of the constant availability of such feedback. To determine whether or not this supposition was correct, typists performed under normal typing conditions, under normal conditions but with vision blocked; under normal conditions with the sounds of the typewriter masked by noise fed via earphones to the typists; and under a combination of blocked vision and masked sound. The performances measured in terms of speed and accuracy showed only small differences and suggest that the presence or absence of visual and/or auditory feedback plays a relatively unimportant role in a speed typing situation.\(^{21}\)

In studies of decreased sensory feedback, Laszlo reduced the kinesthetic, tactile, visual and auditory senses during the performance of keytapping. With only kinesthetic sense reduced the subjects were able to reach 89.5 per cent of their normal performance but when all four senses were reduced the performance dropped to 40.9 per cent of


normal. It is interesting to note that even when all feedback
cannels were blocked there was still some competence remaining in
the performance.  

Chase, like Lasslo, investigated the influence of sensory
feedback reduction on the motor task of keytapping. He decreased four
sense modalities: auditory, visual, proprioceptive and tactile.
Auditory noise was used to decrease auditory feedback, visual feed­
back was reduced by screening the hand while tapping, vibratory
stimuli on the arm hindered proprioceptive feedback, and the tactile
feedback was curtailed by the injection of xylocaine to the tapping
finger. During the experiments each of the sense modalities were
examined separately; decreases in performance were found only when
the auditory and proprioceptive feedback were reduced.

Other Related Literature

Whiting points out that few studies have been done on reaction
time relating to ball skills; therefore the importance of reaction
time in such activity for the most part is unknown. This importance
seems to be especially obscured in relation to the auditory modality
and sport performance. And yet, empirical observation particularly in

25Judith L. Lasslo, "Training of Fast Tapping with Reduction
of Kinaesthetic, Tactile, Visual and Auditory Sensations," The
Quarterly Journal of Experimental Psychology, XIX (November, 1967),
pp. 344-349.

26R. A. Chase, at al., "Studies on Sensory Feedback: II,
Sensory Feedback Influences on Keypounding Motor Tasks," The Quarterly

27H. T. A. Whiting, Acquiring Ball Skill (Philadelphia: Lea
the sport of tennis seems to indicate that sound does play an important part in a player reacting to his opponent's shot. One observer commented, "I think we have all learned to react to the sound of his hit, as well as to the sight of it and when the sound is obliterated, it affects reaction time or speed of response." Murphy believes that a skilled player uses sound to increase or speed up his reaction time.

In a well documented report by Teichner regarding simple reaction time, he states "... there is no evidence available that indicates whether or not RT varies according to the receptor system stimulated." He bases this conclusion on the failure of most studies to use proper measurements for purposes of comparison. Teichner does concede and offers to speculate on the research by stating that in the literature of visual and auditory reaction, the evidence is almost universal that reaction time to sound stimuli is faster. The presentation of visual and auditory stimuli together yields a shorter reaction time than the reaction to either modality alone.

28 Chet Murphy, loc. cit.
29 Bill Murphy, loc. cit.
31 Ibid.
32 Ibid., p. 131.
A more recent study by Colgate concurs with Teichner's speculation. He compared reaction and response time of individuals subjected to a visual stimulus, a neon light; an auditory stimulus, sound from an electric doorbell; and a tactile stimulus, an electric shock. The results of the study show that both reaction time and response time were lowest when the subject responded to the auditory stimulus.33

Children were tested on their ability to react to either visual, auditory or paired stimulation. Costa reported a longer reaction time for visual stimulation as compared to auditory stimulation, but the pairing of the two stimuli yielded shorter reaction time than either modalities alone.34

Summary

The reception of stimuli and ultimate use of this input depends on perception. The perceptual process selects, organizes and interprets cues for use in making responses in relation to the ongoing scene.

Responses are controlled by feedback which may play the role of motivator, regulator, and/or reinforcer. In skilled performance, the regulator role seems to be dominant. The regulatory stimuli singly or in combination may provide information to the performer through any sense modality, including the auditory sense, about


rate, acceleration, amount, extent, and direction of movements.

In this study the auditory cues, as feedback, inherent in the performance of the gross motor tasks may be classified in several ways:

1. The auditory cues are external feedback in that they are received by the sense organ of hearing which is stimulated by sources in the environment and provide information regarding the conditions outside the body.

2. The auditory cues are intrinsic feedback in that the information is inherent in the performance task and is a result of the performer's own action.

3. The auditory cues are learning feedback in that they offer cues about the completed performance and may indicate to the performer how he should modify his next performance.

Feedback has a variety of uses and the removal of feedback may have different consequences depending on its use. In general, where the performer is well skilled and the input is learning feedback the removal of such feedback will not cause a fall-off in performance as dramatic as when the performer is relatively new to the task and the feedback is action feedback.

Kriobel found that the reduction of auditory cues inherent in a table tennis task performance did not cause a detriment in performance. However, studies by Laszlo and Chase which investigated the influence of auditory feedback in keytapping tasks found decreases in performance.
The studies of masked auditory feedback suggest that the presence or absence of auditory feedback plays a relatively unimportant role in performance as reported by Kriebel and Diehl and Siebel.

As to the relationship between auditory stimuli and reaction, the literature seems to support the view that reaction time to auditory stimuli is faster than to visual stimuli. The presentation of visual and auditory stimuli simultaneously tends to yield a shorter reaction time than when either modality is presented alone.

In general, auditory cues do seem to facilitate performance, but this facilitation depends on the type of task being performed and the skill level of the performer.
CHAPTER III

PROCEDURES

During the Spring Quarter of 1972, this study was conducted to investigate the importance of auditory cues inherent in select gross motor tasks which are similar to those skills encountered in a game of tennis.

Eighteen skilled players in the sport of tennis volunteered as subjects for this study. These subjects were either members of The Ohio State University or the Upper Arlington High School varsity tennis teams.

Each of the subjects performed a tennis wall rally task and a tennis game-like task under two experimental conditions and a control condition. One experimental condition consisted of performing the skill tasks with the auditory cues, i.e., the sound of the ball hitting the racket face, hitting the target wall, and rebounding from the court surface, masked by white noise so that these sound cues could not be heard by the subject and consequently not used in the performance of the tasks. And the second experimental condition reduced the intensity of the sound cues appreciably from the level the subject would have been exposed to had he been in a normal situation. The control condition permitted the subject to hear the sound cues as he would normally.
An accuracy score and a number of successful hits score were the measurements used in the statistical analysis of the tennis wall rally task to determine significance of the experimental conditions. In addition, questionnaires were developed for both the wall rally task and the game-like task for the purpose of securing additional information which may be pertinent to the understanding of the use skilled subjects make of inherent sound cues accompanying their performances of the select gross motor tasks.

The tennis wall rally task was performed at the French Fieldhouse on the campus of The Ohio State University using a side wall adjacent to the indoor tennis court. The game-like task was performed either on the French Fieldhouse tennis court or on the outdoor varsity courts at either The Ohio State University or Upper Arlington High School.

Design of the Study

The study was composed of two gross motor tasks: (1) the primary task, a wall rally measured by accuracy points and number of successful hits and for additional data a questionnaire was administered at all sessions (preliminary, experimental, and control); and (2) the secondary task, a game-like session used to secure subjective information from the subjects regarding their performances under the experimental and control sound conditions.

The wall rally task was administered on four occasions. The first session was to familiarize the subjects with the task and to determine its reliability and validity. The second, third, and fourth
sessions were experienced under the experimental and control conditions. There were six possible orders in which the conditions could be performed; each subject was randomly assigned to an order and controlled so that each order contained three subjects. This format was a repeated measures design with the repeated measures being the treatment conditions.

For the game-like task the subjects paired-off so that the task could be likened to a singles game situation. This task was administered on an appointment basis suitable to the paired subjects and took only one session to complete.

Pilot Study

A pilot study was conducted during the second week in April to determine the appropriateness of the proposed procedures. Nine male students enrolled in either one of two intermediate tennis classes volunteered as subjects for this preliminary study. The information gleaned from the results suggested several changes. The pilot study ascertained equipment and its subsequent modification in addition to certain procedures. Equipment modification was needed in the means by which the back pack was to be attached to the subject, in the modified earmuff to reduce echo in the ear domes, and in the intensity level of the white noise used for the masking condition. The procedures determined included the length of time for each trial in the performance of the rally task and for each performance in the game-like situation; the amount of time sufficient for rest between trials; the means by which the rally task would be started and stopped;
the best location for the scorer to observe the target and subject
and yet not disturb the subject during his performance; the most
workable method to record scores; a practical format for the response
questionnaires in order to gain the greatest amount of information
from the subjects; and the number of balls needed.

Selection of Subjects

One of the prerequisites to the participation in this study was
skill in the sport of tennis. To obtain such skilled subjects the
respective tennis coaches at The Ohio State University and Upper Arlington
High School were contacted and informed of the study proposal. In
turn, each coach was asked as to the possibility of securing the
assistance of players on his tennis team; positive replies were received.
To assist in disseminating information describing what was to be
expected of the prospective subjects, an Information Sheet—Consent
Form\(^1\) was developed and distributed to the players. Those players who
were interested in taking part in the study filled in the consent form
with name, address and phone number and returned it to the writer.
This information was later used to contact each subject personally for
the purpose of reaffirming his scheduled appointments.

The tennis players who volunteered to take part in the study
were subjected to a second prerequisite which was that they possess no
gross hearing problem. To determine this, two hearing test sessions,
one at The Ohio State University and the other at Upper Arlington High
School, were held at a time and place convenient for the subjects.
Each subject attended only one test session at which time he was given

\(^1\)Information Sheet—Consent Form (See Appendix A, p. 125).
a hearing test measured by an audiometer and administered by a graduate student from the Speech and Hearing Department at The Ohio State University. All the volunteers passed this criterion. Also, at this time, each subject scheduled an appointment that was most convenient for him to take part in the study sessions.

Thus, eighteen male high school and university students between the ages of sixteen and twenty-two volunteered as subjects. The subjects were experienced in the sport of tennis and during the conduct of the study were rated as varsity tennis players at their respective school. Eleven subjects were members of the Upper Arlington High School tennis team and seven subjects were members of The Ohio State University tennis team.

Table 1 presents background data on each subject. This data includes the subject's age, educational level, number of years he has played tennis, and the highest recognition he has received for his participation in the sport of tennis.

**Experimental and Control Sound Conditions**

The subjects experienced as close as possible the exact situations under all conditions with the exception of the experimental (sound) variable.

The experimental conditions were designed to reduce or mask the auditory cues inherent in the performance of the wall rally task and the game-like task.

During the reducing condition, the subjects wore an attenuating earmuff that reduced the sound cue input by approximately six to eight
<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Educational Level</th>
<th>Number of Years Played Tennis</th>
<th>Highest Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>16</td>
<td>High School Junior</td>
<td>7</td>
<td>Whetstone Invitational - All City</td>
</tr>
<tr>
<td>B</td>
<td>17</td>
<td>High School Junior</td>
<td>3</td>
<td>All City Toledo - First Team</td>
</tr>
<tr>
<td>C</td>
<td>17</td>
<td>High School Junior</td>
<td>5</td>
<td>Michigan Regional-Tournament - Runner-up</td>
</tr>
<tr>
<td>D</td>
<td>16</td>
<td>High School Senior</td>
<td>8</td>
<td>Ohio State High School Tournament Doubles Runner-up</td>
</tr>
<tr>
<td>E</td>
<td>17</td>
<td>High School Senior</td>
<td>9</td>
<td>Ohio State High School Tournament Doubles Champion</td>
</tr>
<tr>
<td>F</td>
<td>18</td>
<td>High School Senior</td>
<td>5</td>
<td>Club Champion</td>
</tr>
<tr>
<td>G</td>
<td>18</td>
<td>High School Junior</td>
<td>5</td>
<td>Ohio State High School Tournament Doubles Runner-up</td>
</tr>
<tr>
<td>H</td>
<td>17</td>
<td>High School Senior</td>
<td>10</td>
<td>Ohio State High School Tournament Doubles Champion</td>
</tr>
<tr>
<td>I</td>
<td>18</td>
<td>High School Senior</td>
<td>9</td>
<td>Ohio State High School Tournament Singles Champion</td>
</tr>
<tr>
<td>J</td>
<td>17</td>
<td>High School Senior</td>
<td>7</td>
<td>Ohio State High School Tournament Doubles Champion</td>
</tr>
<tr>
<td>K</td>
<td>17</td>
<td>High School Senior</td>
<td>6</td>
<td>Scioto Club Tournament Runner-up</td>
</tr>
<tr>
<td>Subject</td>
<td>Age</td>
<td>Educational Level</td>
<td>Number of Years Played Tennis</td>
<td>Highest Recognition</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>-------------------------</td>
<td>------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>L</td>
<td>18</td>
<td>University Freshman</td>
<td>5</td>
<td>Ohio State High School Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Doubles Runner-up</td>
</tr>
<tr>
<td>M</td>
<td>22</td>
<td>University Senior</td>
<td>10</td>
<td>Cleveland Open Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Doubles Runner-up</td>
</tr>
<tr>
<td>N</td>
<td>22</td>
<td>University Senior</td>
<td>15</td>
<td>Western Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Singles Runner-up</td>
</tr>
<tr>
<td>O</td>
<td>19</td>
<td>University Sophomore</td>
<td>8</td>
<td>South Euclid-Lyndhurst Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Singles Champion</td>
</tr>
<tr>
<td>P</td>
<td>20</td>
<td>University Sophomore</td>
<td>8</td>
<td>Ohio Valley Invitational Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Doubles Champion</td>
</tr>
<tr>
<td>Q</td>
<td>20</td>
<td>University Junior</td>
<td>6</td>
<td>Ohio State High School Tournament</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Singles Runner-up</td>
</tr>
<tr>
<td>R</td>
<td>18</td>
<td>University Freshman</td>
<td>8</td>
<td>High School Distinction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Host Valuable Player Award</td>
</tr>
</tbody>
</table>
decibels. Although the subjects could hear the sound cues, they were reduced appreciably from their normal level.

During the masking condition, the subjects wore an attenuating headset through which white noise of a sufficient intensity was transmitted to mask all sound cues relating to his task performance. As a result, the subjects were not able to use the sound cues to assist them in their performance but, rather, were forced to rely on other sense modalities, especially the visual and proprioceptive senses.

During the control condition, the subjects wore a modified earmuff that permitted the sound cues to be heard as in a normal environment. The modified earmuff was worn to ensure that the wearing of the experimental head equipment would not be a factor affecting performance results.

Experimental Apparatus

Attenuating Earmuff. The attenuating earmuff was a Straight-away Hearing Protector, Model 10A, recommended for use in areas where noise may be detrimental to one's hearing; for example, in farm work especially where large machinery is in operation and in areas around airport terminals where jet aircraft noise is quite intense. In this study, the attenuating earmuff was used for the purpose of reducing the normal sounds inherent in the select gross motor tasks performed by the subjects. The attenuating earmuff fit snugly over both ears with a headband force of approximately two to two and one-half pounds so as to make a seal between the muff and head. An elastic band was

---

2Attenuating Earmuff (See Appendix I, p. 166).
attached across the back of the earmuff to prevent it from slipping forward during the performance of the tasks.

The earmuff was pre-tested at the Worcester Polytechnic Institute, Worcester, Massachusetts by means of the subjective threshold shift method. This method is used to observe the difference that occurs in a subject's threshold of hearing with and without hearing protectors. For example, at a frequency of 125 Hertz an attenuation of 15 decibels occurred whereas, at a frequency of 250 Hertz the attenuation was 22 decibels when wearing the earmuff.

For this study, an attempt was made by the Mechanical Engineering Department to determine approximately how much reduction of the normal task sounds occurred when the attenuating earmuff was worn. This was done by the following means:

1. A tape recording was made of a skilled non-subject's task performance sounds, as he would normally hear them, on an Ampex 602 Professional Recorder. This was accomplished by placing an Ampex microphone, Model 803, at approximately ear height and three feet behind the individual to simulate as close as possible his input of the sounds.

2. A tape recording was made of the same skilled non-subject's task performance sounds but with the exception that the microphone was enclosed in a sound absorbing, foam cushioned, 8 inch steel cylinder. The head of the microphone was then covered by an attenuating earmuff to simulate the subject's hearing when wearing the same earmuff. The enclosed microphone was placed, as noted above, at ear height and three feet behind the individual to simulate as close as possible the performer's

---

3"Straightaway Ear Protectors," Form G 1 100, David Clark Incorporated, Worcester, Massachusetts, pp. 5-6.

input of the reduced sounds caused by wearing the attenuating earmuff.

3. A control sound, a pure tone, was recorded on a Brush Oscillograph, Model 13-5335-00. This control sound was composed of one microbar⁵ which measured 3.6 divisions at a sound pressure level of 74 decibels and a frequency of 250 Hertz. This measurement was then used as a scale to measure the sound pressure level of the previously recorded normal sounds and reduced sounds which, likewise, were recorded on the oscillograph.

4. After the sound pressure levels were determined for the normal and reduced sound conditions, these levels were compared to determine the approximate amount of reduction that occurred when the attenuating earmuff was worn. The approximate amount of attenuation that resulted was six to eight decibels. (It must be emphasized to the reader that this was a very crude estimate due to the method used and the unavailability of a more efficient method of measurement such as the use of an artificial ear.)

Attenuating Headset.⁶ The attenuating headset was a Clark/400 "Hybrid" headset/hearing protector. For this study the headset was used to transmit white noise from a tape recorder secured to the back side of the subject for the purpose of masking the normal sound cues inherent in the subject's performance. The headset was similar to the attenuating earmuff in that it had similar qualities of attenuation; headband force of between two and two and one-half pounds; and an elastic headband attached on the back side to prevent it from slipping forward when worn. The main distinction between the attenuating headset and the attenuating earmuff was that the former, in addition to reducing the task performance sound cues, was capable

⁵A microbar is defined as a unit of measurement.

⁶Attenuating Headset (See Appendix I, p. 166).
of transmitting pre-recorded sounds to the individual when properly assembled and worn.

Modified Earmuff. The modified earmuff was used as the control condition. The earmuff, prior to modification, was exactly the same as the attenuating earmuff with the same headband pressure and elastic band attached to the back side. In order to devise the control earmuff which permitted the sound cues to be heard as normally as possible, several modifications had to be made in an attenuating earmuff. First, the absorbent material inside the domes that fit over the ears was removed. Second, a large two by three inch oval opening was cut in the outermost part of each dome. And third, to minimize an echo in the domes evidenced by subjects in the pilot study, two rows of openings were drilled in the remaining intact portion of each dome.

White Noise Recording. A tape recording of white noise was made on the tape recorder used in this study (see below) from the sound emanating from a random noise generator. This sound was composed of the vibrations of many frequencies. This is analogous to the color white which consists of all colors. Much of the noise which we are exposed to in the environment is of a white noise nature.

To determine an approximation of the actual sound pressure level in decibels of the white noise transmitted via the attenuating headset when attached to the tape recorder, the following procedure was taken:

A one-half inch microphone surrounded by absorbent, sponge foam with a depth of four inches was attached to a Bruel &

---

7Modified Earmuff (See Appendix I, p. 166).
Kjaer Frequency Analyzer, Model 2107, with a narrowband A scale filter. One ear dome of the attenuating headset was placed over the microphone with slight pressure to make a seal with the surrounding foam. As the white noise was transmitted through the headset, the microphone picked up the sound and the frequency analyzer recorded the sound pressure level, which, in this situation, was measured at 84 decibels.

When the same procedure was followed but with a non-absorbent material surrounding the microphone a sound pressure level of 93.5 decibels was recorded.

The actual sound pressure level of the white noise heard by the subject, in order to mask the normal sounds inherent in the performance tasks, was somewhere between the two extremes of 84 and 93.5 decibels.

Tape Recorder Back Pack. A Wollensak mini cassette tape recorder was the power source used to replay the white noise recording to the subject via the attenuating headset during the administration of the experimental masking condition. The volume control of the tape recorder was pre-set and secured in place by an adhesive tape to prevent its being accidentally disturbed.

The tape recorder, weighing 1.6 pounds with batteries, was inserted in a specially constructed case which was secured by means of a wide Army type belt at hip level on the back side of the subject. The belt was adjustable so that each subject could fit it to conform comfortably to his waist size.

After each day's session, the batteries used in the tape recorder were recharged overnight to insure proper functioning during the experimental masking condition. A two set supply of General Electric size AA perma-cell rechargeable nickel-cadmium batteries were the type used.

---

8 Tape Recorder Back Pack (See Appendix I, p. 166).
Gross Motor Tasks

Wall Rally Task. Ronning\(^9\) modified Dyer's Revised Backboard Test of Tennis Ability\(^10\) in an attempt to determine a more valid wall rally test for evaluating skill performance in tennis. He changed Dyer's test in two principal respects: 1) the restraining line was increased to thirty-five feet; and 2) the subjects performed the rally test for a period of one minute for three trials instead of the thirty second time period used by Dyer, also for three trials. Ronning had both beginning and varsity tennis players perform the test. He reported a reliability of .921 and a validity of .897 for the group of forty-two beginning tennis players and a validity of .970 for the group of eight varsity tennis players.

The successful completion of Ronning's modified tennis test is dependent upon hard hit drives which to a great extent are indicative of skilled performance. Thus it seemed fitting, in addition to other reasons, to use this test as the task performed by the skilled subjects in this study but with the condition of employing two additional revisions. The first revision was the extension of the performance time for each trial from one minute to three minutes. It was assumed that this additional length of time would provide for better measurement of any performance change due to the experimental conditions, if such occurred, because this longer time period would


out down the error penalty if a subject made a poor judgment during the rally.

Several experts in the area of tennis were consulted regarding the three minute time period because of the writer's concern pertaining to the possibility of a fatigue factor. They suggested that the three minute performance period should not cause undue fatigue and consequently affect performance because the skilled players having had considerable practice prior to the study should be in good physical condition apropos to tennis. The pilot study, although using intermediate players who, for the most part, had not played tennis since the previous summer, tended toward verifying the experts' opinion.

The second revision was the addition of a target on the rally wall for the purpose of determining an accuracy score to supplement the number of successful hits score. The writer hoped the two measurements would provide a more sophisticated test than would the use of only one measurement. Also, the writer wished to determine if the experimental conditions would affect one measure more so than the other.

The center of the target was situated eighteen inches above the upper edge of the line on the wall representing the top of the net. This center point was based on the assumption that most, if not all, of the strokes executed by the subjects would be ground strokes.

In this regard, Jones states:

\[ \text{Since no man in his right senses tries to make each drive touch the net band in passing, some kind of elevation must be given to the average shot.} \]

\[ \text{In men's play this safety margin over the net is likely to vary between 1 and 3 feet,} \ldots \ldots \]
These heights refer to normal, baseline line rally play.11

Thus, the target seemed to be in keeping with Jones' opinion and that of Dr. John Hendrix, former Ohio State Tennis Coach and tennis professional, who suggested that most drives executed by skilled players travel approximately eighteen inches above the net.12 The center of the target, then, was eighteen inches from the top of the net from which four concentric circles emanated with dimensions of one, two, three, and four feet; the respective point value for each dimension was five, four, three, and two points. Any ball hitting the wall area above the net line and within the wall boundaries surrounding the target, scored one point.

Figure 1: Target lay-out for the wall rally task


12Personal interview with Dr. John Hendrix, The Ohio State University, February 15, 1972.
For the wall rally task, each subject was required to stand behind a restraining line, which was thirty-five feet from the rally wall. He held two tennis balls in his non-racket hand and, when ready, initiated the ball for rally by dropping it into a designated area centered behind the restraining line. As the ball made contact with the wall, a one-tenth second stop watch was started. The subject continued to rally the ball against the wall using any type of ground stroke (drive permitting any number of bounces and/or volley) for three consecutive minutes. Each ball contact on the wall above the net line and within the wall boundaries, having been hit by the subject from behind the restraining line, scored one hit; accuracy points were scored dependent on where the ball made its contact on the wall. Balls hit short of the restraining line, hit below the net line or outside the wall boundaries did not score but could be contacted in order to continue the rally. Three trials of three minutes each were administered to each subject with a two minute rest period between each trial.

Upon completion of each performance of the rally task, under the conditions of this study, each subject completed a questionnaire regarding his experience.

This tennis wall rally task was selected as the primary performance task to measure the subject's achievement under the experimental and control sound conditions in this study for six reasons. First, the task provided several sound cues very similar to those encountered in a game of tennis. Second, the task was a gross motor
task which involved large muscles of the body. Most of our activities in physical education are of this nature. Third, the task consisted of movement components involved in an actual tennis game situation. And, tennis being a very popular sport, it was felt that a sufficient number of skilled players could be located to take part as subjects in the study. Fourth, since the study was concerned with performance, not learning, it was assumed that skilled tennis players have sufficiently practiced the skill so that the chance of learning to occur would be negligible. Fifth, the wall rally task permitted each subject to perform on an individual basis. Thus, the introduction of a second person, an opponent, was eliminated. And sixth, the task could be easily scored and not dependent on subjective evaluation.

**Game-like Task.** The purpose of the secondary task was to gather information regarding each subject's performance in a situation resembling, as close as possible, the sport of tennis. The subjects were requested to rally, as if participating against an opponent in an actual game, incorporating, when feasible, the various strokes generally executed in tennis. Either player could initiate the ball at any time. The main concern was to keep the ball in play as much as possible. This task was performed for fifteen minutes under each of the two experimental conditions plus the control condition. A five minute rest period was permitted after each rally performance at which time each subject was given a questionnaire to complete pertaining to his performance under his particular experimental condition.

This game-like task was selected, as opposed to the real game experience, for it offered more opportunity to contact the ball in the
limited time available. This provided the subject with potentially more information about his performance in order to respond adequately to the questionnaire.

**Subject Response Questionnaires.**

It was felt that there might be information important to the study beyond that which was obtained from the objective measures used during the subject's performance of the wall rally task. Also, a method was sought to glean information from the subjects regarding their performance of the game-like task. Therefore, the writer decided to develop appropriate questionnaires for each task performance, i.e., the wall rally and game-like tasks experienced by the subjects under the conditions of this study. As a result, questionnaires were constructed for the preliminary normal sound session (practice session), control (normal) sound session, reducing sound session, and masking sound session. Likewise, similar questionnaires were constructed for the game-like task with the exception that a preliminary normal sound session questionnaire was not needed, therefore was omitted.

For each questionnaire, a series of questions was posed to the subject; he was requested to provide his honest response. If he had comments to offer about any of his performances under the various treatments beyond the scope of the questionnaire, he was directed to note them in the space provided in the appropriate questionnaire.

---

13 Subject Response Questionnaire (See Appendices D and E, pp. 134 and 142).
Administration of the Task Conditions

The subjects were personally contacted by the writer to determine for each a suitable appointment time for four consecutive wall rally task performance sessions and one appointment for the game-like task session. The sessions for the rally task were approximately twenty-five minutes duration while the game-like session ran for a period of one hour. Special arrangements were made for any subject who was not able to attend a particular session. This occurred in only one instance when the subject could not make a late afternoon appointment and arranged to be tested at a more convenient time during the morning of his original appointment day.

Wall Rally Task. When each subject arrived for his first session, the writer briefly reviewed the purpose of the study, the four and one sessions arrangement and the type of equipment to be used during the sessions. Then the subject was given a copy of the wall rally instructions\(^1\) which he followed as it was read to him. Any questions that the subject asked, were answered, except those questions pertaining to the order in which he would receive the experimental and control condition sessions. The order of sessions was not known by the subject, except as he would become aware of it by the process of elimination. The writer emphasized to each subject the importance of performing as well as he could during each session.

At the beginning of each task session, the subjects were given a two minute practice period under the control condition; i.e., the

\(^{1}\)Instructions for Performance of Wall Rally Task (See Appendix B, p. 129).
modified earmuff and tape recorder back pack were worn; no scores were recorded. During the practice period, if any misunderstandings in the execution of the task were apparent, these were corrected prior to his performance in the task session. When the practice session was terminated, a two minute rest period occurred.

The first session was a preliminary normal session composed of three trials of three minutes each with a two minute inter-trial rest. The purpose of this session was to familiarize the subject with the task and its procedures and to record trial scores for use in the determination of task reliability and validity. The subject performed the task under the same circumstances as found in the control condition.

To begin the preliminary session, the subject readjusted, if necessary, the back pack and modified earmuff. He then situated himself in the rectangular box located behind the restraining line and opposite the target area on the wall. When the subject was ready, he visually observed the timer for the signal to begin which consisted of a nod of the head. The subject then dropped the ball and upon its contact with the racket the stop watch was started. The subject continued to rally the ball for three minutes; during this period the scorer recorded on a specially devised score sheet the point at which each ball made contact with the wall. At the completion of this time, a red tennis ball was thrown by the timer at the target in front of the subject to indicate cessation in play. Then the subject rested for two minutes with the experimental equipment remaining intact. The second and third

---

15Score Sheet (See Appendix C, p. 132).
trials followed the same procedure. Upon completion of the task session, the subjects were requested to indicate on one of their score sheets certain background information which included age, educational level, number of years he has played tennis and the highest recognition he has received in the sport.

The control task session was identical to the preliminary practice session, whereas the two experimental task sessions were administered in a similar fashion except for a variation in the sound condition under which the subjects had to perform.

The reducing sound session required the subject to wear an attenuating earmuff which the subject adjusted to his head. The earmuff caused a reduction in the intensity of the normal sound cues associated with the task performance. The procedure following the fitting of the attenuating earmuff was the same as in the control session.

For the masking sound session, the subject wore an attenuating headset which transmitted white noise to the subject from the tape recorder back pack; the white noise concealed the normal sound cues so that they were not heard during the task performance. Immediately prior to the beginning of the performance, the scorer switched the tape recorder to the on position. A pre-arranged pause in the tape recording of white noise permitted the scorer to return to the scoring table and allowed the subject ample time to align himself in the proper position. When the white noise sounded, the subject, timer, and scorer were ready and the timer's nod of the head initiated the subject's
performance. At the end of each trial, the white noise was switched off and the tape recording was rewound in preparation for the subsequent trial. As in the other sessions, during the rest periods, the equipment remained in its proper position on the subject.

At the completion of each of the wall rally task sessions, except for the preliminary session, the subjects were requested to respond to a questionnaire appropriate to the particular task session he had just finished. For the preliminary session, the questionnaire was completed prior to the subject's performance.

Game-like Task. This task was administered no later than one week after the subjects had participated in the wall rally task sessions. The subjects made appointments in groups of two, at a time most convenient for them. Generally these occurred in the late afternoon. Two subjects opposed one another in a situation very closely resembling a tennis game. They were informed that the task was to be performed under the same experimental conditions as previously experienced for the purpose of obtaining subjective information that might not have been experienced or expressed in the wall rally task performance.

To expedite the procedure for this task which was necessitated by the lack of time on the part of the subjects, the writer decided that two opposing subjects could perform under the same or different conditions during the rally period without biasing the data. For example, one subject performed under the masking sound condition while his opponent received the reducing sound condition. At the conclusion of
the play period both subjects rested and completed appropriate questionnaires. The normal sound condition occurred next for both subjects and then either the masking or reducing sound condition with appropriate questionnaires followed. The latter depended on what condition each subject received during the first period of play.

To begin the task, the subjects were instructed as follows:

Put the ball in play by any means you wish. Continue to rally the ball as you would in an actual competitive game. Use as many different strokes and strategies you can in order to outwit your opponent. The play time will be fifteen minutes for each condition with a five minute rest between conditions. During the rest period you will respond to a questionnaire pertaining to your experience.

Reliability and Validity of the Wall Rally Task

Due to the revisions made in Ronning's tennis wall test, which resulted in the wall rally task used in the present study, it was necessary to determine the reliability and validity of this revised task. The two correlation coefficients were found for the whole test (accuracy plus number of successful hits), accuracy score only, number of successful hits score only, and the ratio of accuracy/number of successful hits.

Reliability. The writer felt that two methods could be used to approach the determination of the reliability coefficient, i.e., the split-half method stepped up by the Spearman Brown Prophecy Formula to determine an estimate of the self-correlation of the whole task and the analysis of variance as described by Winer. The latter was

chosen primarily to stay in keeping with the analysis of variance used in other phases of the statistical analysis used in this study.

**Validity.** The validity of the task was determined by two methods, each using an independent criterion composed of a qualitative measure. The first independent criterion was a Skill Rating Form\(^\text{17}\) constructed by the writer for use in discriminating between levels of performance exhibited by the eighteen skilled subjects. Three experts in the area of tennis judged all players during a special afternoon session where all subjects, except subject Q, competed either in a singles or doubles game situation. The ratings of the three judges were summed for each subject and used to rank all subjects in order from one to eighteen (one being the top position). Likewise, the subjects were ranked from one to eighteen depending on their performances of the wall rally task. These rank orders were then correlated.

The determination of a second validity coefficient followed the same format as above, but the criterion measure was a simple all-around performance rank order of the subjects from best to least best player as evaluated by the same three experts who rated their form. This rank order was dissociated from the rating form. The wall rally task performance rank order and the all-around performance rank order were then correlated.

The second validity correlation coefficient was sought primarily because the writer found great difficulty in constructing the Skill Rating Form and was apprehensive as to its ability to

\(^{17}\text{Skill Rating Form (See Appendix G, p. 156).}\)
discriminate between levels of skilled performance as exhibited by the subjects.

Important Controls

Weight of Tennis Balls. Eighteen Wilson Championship tennis balls from newly opened pressurized cans were used in the study. Each ball at the beginning of the task sessions weighed between 57 and 60 grams as measured on an Edmunton Scientific Company Gram/Cunce Scale. The balls were examined after each day's use to check ball covering and weight quality. If the covering was beginning to show wear and/or if the weight of the ball was not within the pre-use grams range, then the balls were replaced.

Tennis Equipment. The subjects wore attire suitable for playing a game of tennis. In addition, all subjects were requested to use their own rackets. On two occasions this was not possible due to broken strings; rackets of similar style and quality were borrowed from teammates.

Wall Rally Task Administrators. Several women students from a beginning tennis class volunteered to time the trial sessions. Each timer was instructed to her duties and received practice in the use of the stop watch. The writer served as scorer for all sessions.
This chapter presents the statistical analysis of the data collected on eighteen skilled tennis players during the execution of a wall rally task (primary performance task) under three sound conditions. Each subject rallied against the wall for three trials of three minutes each while hearing normally the ball sounds accompanying his performance; while hearing these same sounds but reduced approximately eight decibels; and while hearing white noise which concealed all sounds, therefore inhibiting any input of those sounds. A preliminary performance was also administered under normal sound conditions for the purposes of practice and determination of reliability and validity of the wall rally task.

In addition, subjective data were gathered by means of subject response questionnaires distributed before the preliminary task session, at the completion of the wall rally condition sessions and the game-like task (secondary performance task) performances session. This data which could not be analyzed statistically, were categorized and summarized.

**Performance of the Wall Rally Task**

The mean scores, standard deviations, and standard error of the means for the measurement scores of number of successful hits,
accuracy, total score (number of successful hits plus accuracy), and accuracy/number of successful hits ratio under the three sound conditions (control, reduced, and masked) are presented in Table 2.

**TABLE 2**

MEAN SCORES, STANDARD DEVIATIONS, AND STANDARD ERROR OF THE MEANS FOR THE PERFORMANCE MEASURES UNDER THE EXPERIMENTAL SOUND CONDITIONS

<table>
<thead>
<tr>
<th>Performance Measures</th>
<th>Control</th>
<th>Reduced</th>
<th>Masked</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Successful Hits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>250.667</td>
<td>248.500</td>
<td>250.333</td>
</tr>
<tr>
<td>( SD )</td>
<td>31.284</td>
<td>31.155</td>
<td>32.523</td>
</tr>
<tr>
<td>( SE )</td>
<td>7.374</td>
<td>7.342</td>
<td>7.667</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>567.333</td>
<td>560.667</td>
<td>561.055</td>
</tr>
<tr>
<td>( SD )</td>
<td>113.971</td>
<td>100.267</td>
<td>125.698</td>
</tr>
<tr>
<td>( SE )</td>
<td>26.863</td>
<td>23.633</td>
<td>29.627</td>
</tr>
<tr>
<td><strong>Total Score</strong>(^*)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>818.000</td>
<td>809.167</td>
<td>811.389</td>
</tr>
<tr>
<td>( SD )</td>
<td>144.253</td>
<td>129.983</td>
<td>156.630</td>
</tr>
<tr>
<td>( SE )</td>
<td>34.001</td>
<td>30.637</td>
<td>36.918</td>
</tr>
<tr>
<td><strong>Accuracy/Number of Successful Hits Ratio</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>2.243</td>
<td>2.244</td>
<td>2.219</td>
</tr>
<tr>
<td>( SD )</td>
<td>.205</td>
<td>.167</td>
<td>.246</td>
</tr>
<tr>
<td>( SE )</td>
<td>.048</td>
<td>.039</td>
<td>.058</td>
</tr>
</tbody>
</table>

\(^*\)Total Score = number of successful hits score plus accuracy score

In comparing the mean scores under the three sound conditions for each of the performance measures, one finds that the mean scores for the reduced sound condition were somewhat lower on three of the performance measures. The mean score of a fourth measure, accuracy/
number of successful hits ratio, was slightly higher under the reduced sound condition as compared to either the control or masked sound condition.

Winer states that due to large differences in previous experience, people respond to the same treatment conditions with much variability. He suggests that this can be controlled by means of observing each of the subjects under all conditions. In this way each subject serves as his own control. In a design of this type a special kind of analysis of variance (F test) called repeated measures is used. The following analyses are based on a two factor design with repeated measures on one factor. Factor A was the order in which the sound conditions were received. There was a total of six possible orders with three subjects randomly assigned to each order. The second factor, B, was that of the sound conditions which contained three levels; this was the repeated measures factor.

This design was used to determine the significance of the main effects of order (A) and sound conditions (B), and in addition, the main effect of the interaction between order and sound conditions. The design will analyze the two task measurements (number of successful hits and accuracy) separately, then as these same two measurements are summed for a total score and as a ratio of accuracy over number of successful hits.

The analysis of variance of performance measured by number of successful hits in terms of the sound conditions and the order factors

---

1 Winer, op. cit., pp. 105-106.
is presented in Table 3. The main effect for factor A between subjects was non-significant indicating that performance was not affected by the position in which the sound conditions were received; i.e., it did not matter if a particular sound condition was first, second, or last in order of receipt.

**TABLE 3**

**ANALYSIS OF VARIANCE OF NUMBER OF SUCCESSFUL HITS FOR ORDER AND SOUND CONDITIONS DURING THE PERFORMANCE SESSIONS**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>49042.14</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order (A)</td>
<td>12107.26</td>
<td>5</td>
<td>2421.452</td>
<td>.7867</td>
</tr>
<tr>
<td>Subjects within order groups</td>
<td>36934.88</td>
<td>12</td>
<td>3077.907</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>2127.1913</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound Conditions (B)</td>
<td>49.00</td>
<td>2</td>
<td>24.50</td>
<td>.4744</td>
</tr>
<tr>
<td>A X B</td>
<td>838.6133</td>
<td>10</td>
<td>83.86133</td>
<td>1.6237</td>
</tr>
<tr>
<td>B X Subjects within order groups</td>
<td>1239.578</td>
<td>24</td>
<td>51.64908</td>
<td></td>
</tr>
</tbody>
</table>

The main effect of factor B within subjects was non-significant, as was the resultant interaction between A and B. The latter obtained F was 1.6237, although not significant, perhaps there was some interaction which tended to affect performance as indicated by the number of successful hits scored.
In Table 4, the order in which the subjects received the control, reducing, and masking sound conditions did not affect their performances as measured by accuracy scores. The Tabled F necessary for significance was 2.62; the obtained F was only .7022 at the .05 level. The main effect of sound conditions within subjects did not reach a level of importance. The order in which the sound conditions was received X the sound conditions interaction was far from being significant at the .05 level. The required F was 2.25 and the computed F was .6768.

**TABLE 4**

ANALYSIS OF VARIANCE OF ACCURACY FOR ORDER AND SOUND CONDITIONS DURING THE PERFORMANCE SESSIONS

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>612752.0</td>
<td>17</td>
<td>27739.41</td>
<td>0.7022</td>
</tr>
<tr>
<td>Order (A)</td>
<td>138697.1</td>
<td>5</td>
<td>27739.41</td>
<td>0.7022</td>
</tr>
<tr>
<td>Subjects within order groups</td>
<td>474054.9</td>
<td>12</td>
<td>39504.58</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>48078.4769</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound Conditions (B)</td>
<td>504,0369</td>
<td>2</td>
<td>252,0184</td>
<td>0.1630</td>
</tr>
<tr>
<td>A X B</td>
<td>10464.71</td>
<td>10</td>
<td>1046.471</td>
<td>0.6768</td>
</tr>
<tr>
<td>B X Subjects within order groups</td>
<td>37109.73</td>
<td>24</td>
<td>1546.239</td>
<td></td>
</tr>
</tbody>
</table>
The wall rally task performances measured by total scores, which is a combination of number of successful hits and accuracy, are analyzed in terms of sound conditions and the order in which these conditions were received. A summary of the analysis is located in Table 5.

The order, sound conditions and the interaction between the two factors were non-significant as measured by the combined scores on the wall rally task.

**TABLE 5**

ANALYSIS OF VARIANCE OF TOTAL SCORES (NUMBER OF SUCCESSFUL HITS PLUS ACCURACY) FOR ORDER AND SOUND CONDITIONS DURING THE PERFORMANCE SESSIONS

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>995410.3</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order (A)</td>
<td>229495.7</td>
<td>5</td>
<td>45899.15</td>
<td>.7191</td>
</tr>
<tr>
<td>Subjects within order groups</td>
<td>765914.6</td>
<td>12</td>
<td>63826.21</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>63382.6669</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound Conditions (B)</td>
<td>760.0369</td>
<td>2</td>
<td>380.0183</td>
<td>.1919</td>
</tr>
<tr>
<td>A X B</td>
<td>15105.15</td>
<td>10</td>
<td>1510.515</td>
<td>.7629</td>
</tr>
<tr>
<td>B X Subjects within order groups</td>
<td>47517.48</td>
<td>24</td>
<td>1979.895</td>
<td></td>
</tr>
</tbody>
</table>
Table 6 summarizes the analysis of variance of performance in terms of the ratio, accuracy over number of successful hits, measurement. The value of F required for significance at the 5 percent level for between subjects effect was 2.62. The computed F ratio was .7063, too low for the determination of any significance. The within subjects B factor required an F value of 3.40 for significance; the obtained F was .2674, indicating that the performance measurements of accuracy over number of successful hits made during the three sound conditions were not significantly different.

**TABLE 6**

ANALYSIS OF VARIANCE OF ACCURACY/NUMBER OF SUCCESSFUL HITS RATIO FOR ORDER AND SOUND CONDITIONS DURING THE PERFORMANCE SESSIONS

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>1.7980332</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order (A)</td>
<td>.4088212</td>
<td>5</td>
<td>.08176422</td>
<td>0.7063</td>
</tr>
<tr>
<td>Subjects within order groups</td>
<td>1.389212</td>
<td>12</td>
<td>.1157676</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>.43062903</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound Conditions (B)</td>
<td>.00751587</td>
<td>2</td>
<td>.003757935</td>
<td>0.2674</td>
</tr>
<tr>
<td>A X B</td>
<td>.08584684</td>
<td>10</td>
<td>.008584682</td>
<td>0.6109</td>
</tr>
<tr>
<td>B X Subjects within order groups</td>
<td>.33726632</td>
<td>24</td>
<td>.01405263</td>
<td></td>
</tr>
</tbody>
</table>
The interaction of factors A and B was found to be non-significant; i.e., the subjects performed the same way no matter what order the sound conditions were received. The obtained F was .6109, while the value of F required for significance was 2.25.

Determination of Reliability and Validity: Wall Rally Task

Revisions (increase in performance time and the addition of an accuracy target) were made on a wall rally test devised by Ronning which resulted in the wall rally task performed in this study. Due to these revisions, the coefficients of reliability and validity were determined for this task. Correlations were computed for each task measurement, number of successful hits and accuracy; for the total score or sum of the two measurements; and for the accuracy/number of successful hits ratio.

In relation to interpreting the coefficients of correlation that follow, Guilford states, "Always, the coefficient of correlation is purely relative to the circumstances under which it was obtained and should be interpreted in the light of those circumstances, very rarely, certainly, in any absolute sense." In addition, he remarks that in practice reliability coefficients are expected to be in the .80 to .98 range; and for validity coefficients the range is between .00 and .80.

---

2 Ronning, loc. cit.


4 Ibid., p. 146.
Reliability. The analysis of variance, as defined by Winer, was used to estimate the reliability of each of the task performance measures. The three trials of the preliminary performance session were the data to be analyzed. In Table 7 is located the estimate of reliability for the number of successful hits recorded for the three performance trials.

TABLE 7

ESTIMATE OF THE RELIABILITY COEFFICIENT FOR THE NUMBER OF SUCCESSFUL HITS

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>5477.64771</td>
<td>17</td>
<td>322.21436</td>
<td>.906</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>1087.93285</td>
<td>36</td>
<td>30.2203</td>
<td></td>
</tr>
</tbody>
</table>

The reliability coefficient for the accuracy scores is presented in Table 8.

TABLE 8

ESTIMATE OF THE RELIABILITY COEFFICIENT FOR THE ACCURACY SCORES

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>63610.75307</td>
<td>17</td>
<td>3741.80884</td>
<td>.918</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>11078.21044</td>
<td>36</td>
<td>307.72807</td>
<td></td>
</tr>
</tbody>
</table>

The reliability coefficient for the total scores, sum of the number of successful hits and accuracy scores, is found in Table 9.

**TABLE 9**

**ESTIMATE OF THE RELIABILITY COEFFICIENT FOR THE TOTAL SCORES (ACCURACY PLUS NUMBER OF SUCCESSFUL HITS)**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>104,303.31535</td>
<td>17</td>
<td>6,135.48828</td>
<td>.923</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>17,005.08312</td>
<td>36</td>
<td>472.36198</td>
<td></td>
</tr>
</tbody>
</table>

Table 10 presents the reliability coefficient of correlation for the accuracy/number of successful hits ratio.

**TABLE 10**

**ESTIMATE OF THE RELIABILITY COEFFICIENT FOR THE ACCURACY/NUMBER OF SUCCESSFUL HITS Ratio**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>1.72358</td>
<td>17</td>
<td>.10139</td>
<td>.754</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>.89795</td>
<td>36</td>
<td>.02494</td>
<td></td>
</tr>
</tbody>
</table>

As noted in Table 11, page 62, which contains a composite of the four reliability coefficients, three correlations were reasonably high when compared to the .80 to .98 range suggested by Guilford.6

---

6Guilford, loc. cit.
The one correlation which was quite low was for the ratio, accuracy/number of successful hits; the computed correlation was only .754. There was a tendency for the accuracy points to increase to a greater extent than number of successful hits scored.

**TABLE II**

**COMPOSITE OF RELIABILITY COEFFICIENTS FOR THE PERFORMANCE MEASURES USED IN THIS STUDY**

<table>
<thead>
<tr>
<th>Measures</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of successful hits</td>
<td>.906</td>
</tr>
<tr>
<td>Accuracy scores</td>
<td>.918</td>
</tr>
<tr>
<td>Number of successful hits plus accuracy</td>
<td>.923</td>
</tr>
<tr>
<td>Accuracy/number of successful hits ratio</td>
<td>.754</td>
</tr>
</tbody>
</table>

**Validity.** The validity was determined by a special correlation, the Spearman’s rank-difference correlation method. Guilford states that the rank difference method "... is almost as good an estimation of correlation as the Pearson r." In addition, this method is frequently used when the number of pairs is less than 30. This study was composed of only eighteen pairs of scores.

Two sets of basic correlations were done on the data or the measures recorded for the wall rally task. The first set of validity correlation coefficients was computed by using a qualitative criterion.

7 Ibid., p. 288.
8 Ibid., p. 235.
which was a Skill Rating Form. Three experts in the sport of tennis completed a form for each subject. The three resultant evaluations per subject were summed. On the basis of this total the subjects were then ranked from best (lowest summation) to least best (highest summation). This same procedure was followed for the three preliminary performance session trials, except that the highest sum of scores was best and the lowest sum of scores was least best. On this basis, the obtained correlations were negative. Table 12 contains the computed correlations.

TABLE 12

COMPOSITE OF VALIDITY COEFFICIENTS FOR THE WALL RALLY PERFORMANCE MEASURES AND SKILL RATING FORM EVALUATION

<table>
<thead>
<tr>
<th>Measures</th>
<th>rho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of successful hits</td>
<td>-.770</td>
</tr>
<tr>
<td>Accuracy scores</td>
<td>-.753</td>
</tr>
<tr>
<td>Number of successful hits plus accuracy</td>
<td>-.775</td>
</tr>
<tr>
<td>Accuracy/number of successful hits ratio</td>
<td>-.553</td>
</tr>
</tbody>
</table>

The second set of validity correlation coefficients was computed by using a different qualitative criterion than the one used for the computations of the preceding correlations. This present criterion was a simple subjective ranking of the subject's performance in relation to the other seventeen subjects. The same three experts who did the previous evaluation also did the rank
order, which was dissociated from the Skill Rating Form. The criteria for determining a player's rank rested on each individual judge by virtue of his expertise in the sport of tennis.

Each subject's three rankings were summed; in turn, this sum was then ranked in comparison with the sums of all the other subjects from best (lowest sum) to least best (highest sum). This performance rank was then correlated with the subject's rank position in the preliminary performance session trials. Because of the inverse nature of the sums used in the rank order and in the performance rank, the coefficients of correlation were negative. Table 13 presents the validity correlation coefficients for the task measures and performance rank order.

TABLE 13

COMPOSITE OF VALIDITY COEFFICIENTS FOR THE WALL RALLY PERFORMANCE MEASURES AND JUDGES' PERFORMANCE RANK ORDER

<table>
<thead>
<tr>
<th>Measures</th>
<th>rho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of successful hits</td>
<td>-.851</td>
</tr>
<tr>
<td>Accuracy scores</td>
<td>-.805</td>
</tr>
<tr>
<td>Number of successful hits plus accuracy scores</td>
<td>-.845</td>
</tr>
<tr>
<td>Accuracy/number of successful hits ratio</td>
<td>-.580</td>
</tr>
</tbody>
</table>

The writer's suspicion mentioned earlier in the study regarding the possible inability of the Skill Rating Form to discriminate between levels of performance seems to have been borne out, to a degree,
in the correlation coefficients. The judges' simple rank ordering
of the subjects' performances was superior to the rank order devised
by means of the Skill Rating Form. The greatest discrepancy was
between the number of successful hits measure where the rho was -0.851
for performance rank order and a -0.770 for the Skill Rating Form
evaluation rank. This is a rather wide discrepancy.

The tennis experts, as judges, did find the Skill Rating Form
difficult to use in the evaluation of the subjects. The problem seemed
to stem from the basic descriptions of performance from which the
judges selected to characterize the subjects' performances under a
particular category. These descriptions were not always applicable
to the performance of a skilled tennis player, especially those
descriptions depicting poor performance; they tended to exemplify
more the performance of a beginning or intermediate tennis player.
The judges more frequently than not selected the first three descrip-
tions; the latter two were almost non-working.

On the basis of the computed reliability and validity correla-
tions two measures would be equally appropriate for measuring skill
performance in the wall rally task, i.e., the number of successful hits
measure and the total score measure (number of successful hits plus
accuracy score). The computed reliability for the former measure was
0.906 and the validity was -0.851. For the latter measure the reliability
was 0.923 and the validity was -0.845. The validity correlations were
based on the performance rank order.
QUALITATIVE ANALYSIS OF SUBJECT RESPONSE QUESTIONNAIRES

The writer felt that the subjects could contribute additional information about their performances under the various conditions of the study beyond the objective scores recorded for the wall rally performance. Often times what the subject believes and feels has more meaning or at least contributes toward greater insight into a situation than what mere scores may provide. Thus questionnaires were developed to serve this purpose for both the wall rally task and the game-like task. A qualitative analysis of the responses follows.

Wall Rally Task

Preliminary (Normal) Sound Session. To summarize, the questions attempted to ferret out the subjects' opinions about the experimental conditions prior to their performing in the study. The unedited responses of each subject to the various questions can be found in Appendix F.

Question 1. In general, the opinion presented was positive in that fourteen or 77 per cent of the subjects indicated that hearing the various sound cues would be an asset to their performance of the wall rally task. Four subjects replied negatively; and of these four, two seemed to have misinterpreted the question.

For the most part, the subjects felt the sounds of the ball hitting the racket face, hitting the target wall, and rebounding from the floor would present cues to supplement visual perception. These cues would assist in the judging of the timing or speed of the ball.
And, more specifically, the sound of the ball hitting the racket would provide information about how well the stroke was executed, i.e., how "solid" the ball made contact with the racket. Of the two subjects who replied "no" to the question, one felt that he did not really notice noise (ball sounds) and the other suggested that he watched the ball closely so that he did not need to hear the ball sounds to make a judgment about the ball.

**Question 2.** The influence of reduced sound cues as causing a detrimental effect on performance was aptly stated by subject M. His response was that "the reduced sound level will decrease the amount of information received by my ears. This reduction should make judgment of the ball's location and velocity more difficult." Subject R responded to the opposite by stating, "Do not really notice the noise." Numerically, fourteen subjects indicated reduced sound cues would cause a negative effect; two subjects felt that such cues would not affect their performances; and the remaining two subjects were not sure.

**Question 3.** This question was interested in determining whether or not the white noise, even though masking the inherent task sounds, would affect the subjects' performances. The general opinion made-up of fourteen responses indicated that the hearing of white noise would affect performance. The main response was that the incoming noise would make concentrating more difficult and that with the elimination of the ball sounds used for setting a rhythm, timing would be disturbed. Several subjects within this group who felt that white noise would disrupt their performances tended to add that as
they became accustomed to the noise, the disruption would diminish. The four subjects who indicated no effect responses suggested that the white noise would not be any more distracting to them, due to their ability to concentrate, than other noises they have been subjected to, which were loud enough to "drown out" the ordinary occurring sounds exhibited in play.

Question 4. The majority of subjects (thirteen) stated that the absence of sound cues would cause a decrement in their performances. The reasons were primarily the same as presented in Question 3. It was felt that the decrement would occur in concentration, a vital factor in a competitive game of tennis, and in the ability to time stroke execution. Of the remaining subjects, one felt that his concentration would not be affected, two felt that perhaps the absence of sounds might offer assistance to them in their attempts to concentrate, and a fourth subject was ambivalent in his feelings. He suggested that the absence of sounds would "hurt" because he was not accustomed to not hearing them and, on the other hand, he felt it would "help" him to "think better." The one remaining subject did not respond to this question.

In summary, the general consensus of the subjects, prior to experiencing the sound conditions of this study, seemed to indicate that sounds may be important in the execution of the wall rally task. They suggested that the main areas in which the sound cues may be important included: (1) concentration; (2) judgment of ball speed; and (3) information perceived about the task.
Control (Normal) Sound Session. This questionnaire attempted to determine how the subjects during their performances may have responded to and used the normal sounds of the ball as it made contact with the various surfaces (racket strings, wall, and floor) inherent in the task. Table 14, pages 70-72, presents a composite of the subjects' responses.

Question 1. The sounds heard when performing the task were either pleasing to the subjects or were not of any consequence; i.e., the hearing of the sounds evoked an indifferent feeling which was neither favorable or unfavorable. This latter feeling may be a result of the subjects not being able to give the sounds a qualitative connotation; too, perhaps, they have been so accustomed to hearing the sounds that they actually had no feelings one way or another. Appropos to this statement is Subject D's comment, "Just what I'm used to." Seven subjects checked that the sounds were pleasing, whereas ten subjects checked the indifferent response. It is interesting to note that one subject checked both pleasing and indifferent; there was no reason given. Two subjects felt that the sounds were stimulating; i.e., the sounds urged them on in their performances as a type of motivator.

Question 2. What influence might the sound cues have on a subject's performance? The opinions were varied with all possible responses being checked by at least four subjects. Subject C was the only one who checked all positive items; he felt the sounds contributed reinforcement, increased his attention and helped him to
### Questionnaire—Wall Rally Task

#### Table 14

**Subjects' Responses to Control Sound Session**

<table>
<thead>
<tr>
<th>Reseponses:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. pleasing</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>38.9</td>
</tr>
<tr>
<td>b. stimulating</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>c. indifferent</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>d. frustrating</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>e. distracting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>f. other comments:</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.1</td>
</tr>
</tbody>
</table>

<p>| <strong>Question II</strong> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| a. provides reinforcement |   | x | x | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   | 7     | 38.9 |
| b. increases attention | x | x | x | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   | 7     | 38.9 |
| c. facilitates concentration | x | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   | 4     | 22.2 |
| d. no general influence | x |   |   |   |   |   |   | x | x |   |   |   |   |   |   |   |   |   | 4     | 22.2 |
| e. other comments: |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0     | 0.0  |</p>
<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. indicated a good or poor stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>17</td>
<td>94.4</td>
</tr>
<tr>
<td>b. indicated where ball hit on racket face</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>9</td>
<td>50.0</td>
</tr>
<tr>
<td>c. indicated direction ball would take</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>d. indicated power of the stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>12</td>
<td>66.6</td>
</tr>
<tr>
<td>e. indicated application of spin</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>f. provided no information</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>g. other comments:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>QUESTION IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. force of hit</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>15</td>
<td>83.3</td>
</tr>
<tr>
<td>b. speed of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>c. direction of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>d. timing of reaction</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3</td>
<td>16.6</td>
</tr>
<tr>
<td>e. rhythm of stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>f. provided no information</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>g. other comments:</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>RESPONSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td>%</td>
</tr>
<tr>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>QUESTION V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>a. speed of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>b. direction of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>c. timing of reaction</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>d. rhythm of stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>e. provided no information</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>f. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>QUESTION VI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>a. sound of the ball hitting the racket face</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>b. sound of the ball hitting the target wall</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>c. sound of the ball rebounding off the court surface</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>QUESTION VII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>a. sound of the ball hitting the racket face</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>b. sound of the ball hitting the target wall</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>c. sound of the ball rebounding off the court surface</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
concentrate better. Item a, provides reinforcement, and item b, increases attention, both received seven check marks. Four subjects felt that concentration was facilitated. It seemed peculiar to the writer that another four subjects indicated that the sound cues had no general influence on their performances. In comparing these subjects' responses to those they made to a similar but differently structured question in the preliminary questionnaire, three of them had at this time presented an opposite view. Subject R was the only one consistent with his first response that he does not notice the noise (ball sounds) and therefore any influence of the sound on his performance was not apparent to him.

Question 3. Sound of the ball hitting the racket face does seem to provide certain kinds of information to the subjects. At the top of the list as to such information was the recognition of whether the stroke was well executed or not; seventeen subjects agreed on this point. Twelve subjects felt that they could determine the power of their stroke by means of sound heard at ball contact. Approximately 50 per cent of the subjects knew by sound where the ball hit on the racket face and 44 per cent did perceive that the ball had spin. No doubt this latter information is more difficult to determine. Subjects I and Q were the only two who felt that they received all the listed items of information from this one sound and were the only two who perceived the direction the ball would take by the sound of contact on the racket face. The sound of the ball hitting the racket face was received and perceived by all subjects as a source of some type of
information; some subjects perceived more than others but not a single one checked item f, provided no information.

**Question 4.** What kinds of information can be perceived when the ball hits the rally wall? To a certain extent this sound is as Subject Q points out, "... somewhat like the ball hitting the opponent's racket face." This sound, too, offers potential information to the subjects; all subjects received some positive input from this sound. The most substantial cue received was the force of the hit; it is possible that the more forceful the hit the louder and more firm the sound at the wall. Approximately 84 per cent of the group checked this item. Eleven subjects felt the speed of ball return could be determined by this sound. One would be inclined to think that speed of ball return would have a strong relationship to the determination of reaction time and if the former can be assisted by ball sound why is it that only three subjects perceived information that would aid them in timing their reaction?

**Question 5.** One other sound which may provide some cues is that of the ball hitting the court surface. Not all subjects could perceive information from this sound; three indicated that it did not provide any type of information. Speed of ball return was the most prominent cue perceived by ten subjects. Timing of reaction was the second important cue; it received eight responses. It is interesting to note that more subjects felt that timing of their reaction was based on court surface sound as opposed to wall sound. It is difficult to believe that one would use such a late cue to assist him in his
reaction; there just doesn't seem to be sufficient time to react and
then to move to the proper position in relation to this sound.
Direction of ball return and rhythm of stroke both received six
responses.

Question 6. What sound cue tends to be most important to the
execution of the rally task? The sound of the ball hitting the racket
face ranked number one with eleven votes. The sound of the ball
hitting the target wall and rebounding off the court surface each
received four check marks. Subject D responded twice by checking the
latter two sound cues.

Question 7. What sound cue ranks second in importance in the
execution of the rally task? Eleven subjects felt the sound of the
ball hitting the target wall provided the second best information.
The sound of the ball hitting the racket face received six second
place responses. And the ball rebounding off the court surface was
least recommended and was chosen by one subject.

Reducing Sound Session. Table 15, pages 76-78, presents the
subjects' responses to a series of questions attempting to determine
how the subjects related to a reduced sound condition while performing
the wall rally task.

Question 1. The subjects were asked to check the word(s) which
best expressed their feelings about hearing the sound cues when their
intensity was reduced. All proposed responses were checked by at
least three subjects. The highest number of responses was received
by the expressions labeled stimulating and indifferent, each of the
### TABLE 15

SUBJECTS' RESPONSES TO REDUCING SOUND SESSION
QUESTIONNAIRE—WALL RALLY TASK

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>b. stimulating</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>c. indifferent</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>d. frustrating</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>e. distracting</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>f. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>QUESTION II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increased reliance on</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. increased awareness of</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>the &quot;feel&quot; of the racket</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. increased strain to hear</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>the sounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>d. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
### TABLE 15—Continued

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUESTION III</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. tendency to hit harder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>b. no change in force</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>c. tendency to hit softer,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>50.0</td>
</tr>
<tr>
<td>more cautious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>QUESTION IV</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increase in ability to judge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ability to judge the speed</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>of the ball was not affected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. decrease in ability to judge</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>RESPONSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total %</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>QUESTION V</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. reaction time was slower</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 44.4</td>
<td></td>
</tr>
<tr>
<td>b. no change in reaction time</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 50.0</td>
<td></td>
</tr>
<tr>
<td>c. reaction time was faster</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>1 5.6</td>
<td></td>
</tr>
<tr>
<td>d. other comments:</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 11.1</td>
<td></td>
</tr>
<tr>
<td><strong>QUESTION VI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increase in ability to concentrate</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>11 61.1</td>
<td></td>
</tr>
<tr>
<td>b. no change in ability to concentrate</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>2 11.1</td>
<td></td>
</tr>
<tr>
<td>c. definite decrease in ability to concentrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>4 22.2</td>
<td></td>
</tr>
<tr>
<td>d. other comments:</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>8 44.4</td>
<td></td>
</tr>
</tbody>
</table>
two expressions received five checks. There does not seem to be an
all around general feeling regarding this condition, but instead one
that is quite diverse and individual to each subject.

Several subjects offered additional comments. Subject H found
it quite displeasing to not hear the sounds well. Subject I stated,
"Frustrating at first then I started to get use to it." Subject J was
inclined to move his focus from the target to the sound; he stated,
"Because of the reduced sound I tended to concentrate on the sound
rather than the target." And Subject N made a comment relating to a
skilled player's unconscious use of sound cues, he reported, "While I've
never before thought of listening to the sounds accompanying this
particular task, the reduction (not elimination) of them was very
annoying."

Question 2. When the sound cues were reduced did the subjects
strain to hear these sounds, did they depend more on vision and/or did
they seem to be more aware of the "feel" of the racket? For the most
part 61.1 per cent of the subjects had a tendency to try harder to
hear the sound cues. Fewer than half of the subjects (44.4 per cent)
felt that they had a greater "feel" of the racket in their hands. This
same sensation was noted by a number of the intermediate players who
took part in the pilot study. A smaller number of subjects (33.3 per
cent) felt that they relied on vision to a greater extent under this
condition as compared to a normal situation. It does seem quite
appropriate that as the use of one sense modality is diminished a
greater use is made of the other modalities to make up for this loss.
This may be likened to the blind who tend to rely on hearing and
tactile awareness to a greater extent than the sighted to perceive the environmental scene.

Question 3. The question was posed, "When the sound cues were reduced, in what way was the application of force altered?" Only one subject stated he had a tendency to hit harder. Why only one? It would seem that a greater number of subjects would have this tendency in light of the fact that eleven subjects previously stated that they felt strained toward hearing the ball sounds. It would seem conducive to have hit harder to increase the ball force against the wall and thus increase the intensity of the sound received and therefore reduce strain. Then again, the subjects may have done this at a point in their rallying, but they may have found that the sound input did not change appreciably to be of any assistance. Fewer than half (44.4 percent) of the subjects felt that they had driven the ball with the same amount of force as when the sounds were heard normally. Fifty percent of the subjects tended toward hitting the ball softer and with more caution.

Question 4. What effect does the reduced sound condition have on a subject's ability to judge the speed of the ball? Items b and c were equally chosen by eight subjects. One group felt that its ability to judge ball speed was not affected, whereas the other group felt a decrease in this ability. For the former group, there may have been enough sound available to assist in making this judgment or because of a certain consistency of ball return involved in the performance of this task there may have been little need to continually make speed judgments. Two subjects noticed an increase in their ability to judge
the ball speed. These individuals may have focused more on the sound than they would do normally and as a result used these cues more diligently to assist in determining speed of the ball.

Question 5. In essence, this question attempted to ascertain the effect reduced sound cues may have had on the subjects' reaction to the oncoming ball. This question and the previous question (number 4) were very closely related and the respective responses were quite consistent. Nine subjects or 50 per cent indicated no change in reaction. A response showing a slower reaction time was made by eight individuals. The remaining one subject, B, felt that his reaction time to the approaching ball was faster than normal. This is in keeping with his increase in ability to concentrate better as noted in questions 4 and 6, respectively. Subject A clarifies his position, "No change in reaction time because you had to use eyes more and concentrate more on getting the racket back."

Question 6. This question received eight comments. They were equally split between positive and negative remarks regarding the ability to concentrate as a result of the reduction of sound cues. Each of the four subjects who noticed a decrease in his ability to concentrate remarked as follows:

Subject D -- "Got bored and uninterested -- not really want to hit."

Subject F -- "The reduction in sound bothered me as did the pack and head phones." In regard to the back pack and head phones, this comment is an opinion change because at the conclusion of the preliminary
performance session each subject was asked whether or not the wearing of the equipment was bothersome; each remarked to the effect that it was of seemingly no consequence. "Not really," was the general response. Additional comments include those that follow:

Subject H — "Decrease because it was frustrating."

Subject N — "The 'reduction' headset seemed to have all of the detriment, i.e., bulkiness, weight, reduction of sound so that one automatically tried to listen to the sounds (strain), without having the benefit of totally blocking out the auditory senses by overloading them thus enabling one to concentrate more fully on the visual aspects of the task."

On the other hand, eleven subjects responded that their ability to concentrate was increased. The following four comments may offer some insight as to why several of the subjects thought this occurred to them.

Subject E — "Very easy to concentrate when all noise was omitted."

Subject G — "I tried to concentrate more. Hard to do."

Subject I — "It made me think about hitting the ball more than before."

Subject J — "My ability to concentrate increased but I feel I was concentrating more on the sound of the ball."

The two remaining subjects did not notice any change in their ability to concentrate on the task.

Masking Sound Session. White noise was heard by the subjects in order to mask the sounds accompanying their performances of the wall
rally task. This questionnaire, as did the others, attempted to probe for additional information about the subjects' performances; this questionnaire in particular was concerned with the effect of the absence of sound cues on performance. See Table 16, pages 84-86, for a summary of the subjects' responses to this masking sound questionnaire.

Question 1. This first question attempted to determine how the subjects reacted when they initially heard the white noise. Subject H was the only individual who felt that the first experience was stimulating. The indifferent opinion which meant neither a favorable or unfavorable reaction was expressed by five subjects. The sound was frustrating to one person even though at this point he had not as yet attempted his performance. An equal number (eight) of subjects indicated the sound to be annoying and/or distracting. Four of these eight subjects expressed both responses. In summary, two-thirds of the subjects reported negative opinions about the white noise.

Question 2. In this question, the subjects were asked to indicate their feelings in regard to the experience of performing under the white noise condition. A total of three subjects had a positive reaction; of these three subjects, two found the experience to be pleasing and the third felt it was stimulating. The indifferent item was checked by five individuals. The remaining nine subjects regarded the experience to be a negative one; they considered it either annoying, frustrating, and/or distracting. Of this group, five subjects checked at least two or more of the negative opinions. Additional comments included the following:
<table>
<thead>
<tr>
<th>QUESTION I</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>b. stimulating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>c. indifferent</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>5</td>
<td>27.8</td>
</tr>
<tr>
<td>d. annoying</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>e. frustrating</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>f. distracting</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>g. other comments</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION II</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>b. stimulating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>c. indifferent</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>5</td>
<td>27.8</td>
</tr>
<tr>
<td>d. annoying</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>e. frustrating</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>3</td>
<td>16.6</td>
</tr>
<tr>
<td>f. distracting</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>g. other comments</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>16.6</td>
</tr>
<tr>
<td>RESPONSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td>%</td>
</tr>
<tr>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>QUESTION III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increased reliance on vision</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>61.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. increased awareness of the &quot;feel&quot; of the racket and ball contact</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>9</td>
<td>50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. increased strain in an attempt to hear the sound cues</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>5</td>
<td>27.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments:</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3</td>
<td>16.6</td>
</tr>
<tr>
<td>QUESTION IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. tendency to hit harder</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2</td>
<td>11.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. no change in force application</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>6</td>
<td>33.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. tendency to hit softer, more cautious</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>44.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments:</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>5</td>
<td>27.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 16—Continued

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increase in ability to judge the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 0.0</td>
</tr>
<tr>
<td>b. ability to judge the speed of the ball not affected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 50.0</td>
</tr>
<tr>
<td>c. decrease in ability to judge the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 44.4</td>
</tr>
<tr>
<td>d. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 11.1</td>
</tr>
</tbody>
</table>

### QUESTION VI

| QUESTION VI |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |
| a. reaction time seemed slower |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 8 44.4 |
| b. no noticeable change |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 9 50.0 |
| c. reaction seemed faster |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0 0.0 |
| d. other comments: |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 4 22.2 |

### QUESTION VII

| QUESTION VII |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |
| a. increase in ability to concentrate |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 6 33.3 |
| b. no change in ability to concentrate |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 4 22.2 |
| c. definite decrease in ability to concentrate |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 6 33.3 |
| d. other comments: |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3 16.6 |
Subject H — "Frustrating because I felt like I was never in position hitting the ball squarely."

Subject I — "I thought it was interesting; I don't think I could have played with it much longer. I [was] relieved to take the headset off."

Subject L — "I hate it."

Question 3. The subjects were asked if there was any increase in their reliance on vision; in their awareness of the "feel" of the racket and ball contact; or in the strain to hear the sound cues. Just over 61 per cent of the subjects indicated an increase in relying on vision; this is almost double the number of responses reported in a similar question but under the reduced sound condition. As the hearing modality is decreased there does seem to be some trend to relate more to vision than normally. Nine subjects felt an increased awareness of the "feel" of the racket when sound cues could not be heard. This number of responses is only one more than the number checking the same item but under the reduced condition. Strain to hear was mentioned by 27.7 per cent or five of the subjects; a large decrease in the number of responses when compared to the reduced sound experience. Several subjects commented as follows:

Subjects O and R did not notice any type of increase. Subject R stated, "Nothing really except I could not hear the sound of the ball anymore."

Subject N, who in passing, commented that he really enjoyed the white noise condition also remarked to this question. He stated, "The white noise increased concentration for me through the elimination
of all (or most) other extraneous factors."

Question 4. Under the masking condition, fewer than 50 percent of the subjects had a tendency to hit softer and with more caution. Six subjects saw no change in the force with which they hit the ball and only two subjects seemed to hit more forcefully. Five subjects made comments regarding this question; two of whom did not check any of the items.

Subject D -- "I was more apt to try to hit my weaker stroke (forehand) instead of relying on my stronger stroke, due to caution."

Subject H -- "Felt like I was hitting much easier."

Subject I -- "Tendency to concentrate more."

Subject K -- "Hard to tell without hearing the ball."

Subject N -- "There was a tendency to hit softer, but not more cautiously. Actually it was more pleasing, as well as being necessary, to 'feel' the ball on the racquet for a longer period of time."

(This subject seemed to have a great awareness of the "feel" of the racket in his hand while performing under this condition.)

Question 5. This question attempted to ascertain the subjects' ability to judge the speed of the ball while performing under the masking condition. Of the responses, no one suggested that he had, as a result of his experience, increased his ability to judge ball speed. Nine subjects saw no change in this ability; they seemed to maintain a status quo. Fewer than half (eight) of the subjects felt a decrease in the ability to judge ball speed. Two comments were made:

Subject H -- "Had trouble judging everything the ball was doing."

Subject I -- "Because this made me concentrate more. I feel
that it helped not judge the ball better but think about it more."

Question 6. The subjects characterized the speed with which they reacted to the ball, while not hearing any of the sounds associated with it, either by a decrease in reaction time (eight subjects) or by no noticeable change in reaction time (nine subjects). A faster reaction time was not evidenced by any subject during the absence of sound cues. Several subjects' comments follow:

Subject A -- "No noticeable change because had to rely on eyes more."

Subject D -- "Could not tell when ball had bad bounce."

Subject L -- "Only once or twice did I find myself reacting somewhat slower and I felt that this was due more to getting used to the white noise rather than it being a distraction."

Question 7. In comparing the subjects' responses to this question with their responses to a similar question under the reduced condition, absence of sound cues seemed to have less affect on ability to concentrate than did the reduced sound cues. An increase in concentration was noted by six subjects and a like number indicated a decrease. Four subjects indicated no change in ability to concentrate. Several comments were made:

Subject C -- "Absence of sound made me watch the ball more carefully, so concentration was better."

Subject J -- "At first it affect my concentration greatly but then I became used to it."

Subject P -- "Am not sure how it affected my concentration
exactly, but it was a distracting sound so odds are my concentration decreased a bit. Perhaps it should be the other way around, but I don't think so."

In summary, it might be pointed out for comparison purposes that only four subjects indicated that during the normal sound condition hearing the sound cues facilitated performance; and yet, when these cues were reduced or absent their importance seemed to increase as evidenced by the subjects' responses.

Game-like Task

Notice should be made that only seventeen subjects completed this portion of the study as compared to the original eighteen subjects who initially volunteered to participate in the study. One subject was not able to complete this task.

Control (Normal) Sound Session. This questionnaire tried to ascertain the value of normal sound cues when performing the game-like task. Table 17, pages 91-94, presents the subjects' responses to the questions which formed this questionnaire.

Question 1. What kinds of feelings do the subjects have while hearing the various sounds of the ball accompanying their performances of the game-like task? For the most part, feelings expressed were either indifferent (47.1 per cent) or had a positive orientation (47.1 per cent). This latter orientation included six responses which indicated a pleasing quality and two subjects felt the sounds offered them an exciting feeling. The sounds were distracting to one subject — rather an unusual response especially when these sounds are normal to
<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>6</td>
<td>35.3</td>
</tr>
<tr>
<td>a, pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>b, exciting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>c, indifferent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>d, frustrating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>e, distracting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>f, other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>QUESTION II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>9</td>
<td>52.9</td>
</tr>
<tr>
<td>a, provide reinforcement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>6</td>
<td>35.3</td>
</tr>
<tr>
<td>b, increase attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>c, facilitate concentration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>17.6</td>
</tr>
<tr>
<td>d, no general influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>e, other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>RESPONSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td>%</td>
</tr>
<tr>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-------</td>
<td>--</td>
</tr>
<tr>
<td>QUESTION III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. indicated a good or poor stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>12</td>
<td>70.6</td>
</tr>
<tr>
<td>b. indicated where ball hit on racket face</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>13</td>
<td>76.5</td>
</tr>
<tr>
<td>c. indicated direction ball would take</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>d. indicated power of the stroke</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>13</td>
<td>76.5</td>
</tr>
<tr>
<td>e. indicated application of spin</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>58.8</td>
</tr>
<tr>
<td>f. provided no information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>g. other comments</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>QUESTION IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. force of hit</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>11</td>
<td>64.7</td>
</tr>
<tr>
<td>b. speed of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>13</td>
<td>76.5</td>
</tr>
<tr>
<td>c. direction of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>23.5</td>
</tr>
<tr>
<td>d. amount of time available for reaction</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>e. application of spin and type</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>11</td>
<td>64.7</td>
</tr>
<tr>
<td>f. provided no information</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>g. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>RESPONSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>QUESTION V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>a. speed of ball return</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>b. direction of ball return</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>c. amount of time available for reaction</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>d. application of spin and type</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>e. provided no information</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>f. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>QUESTION VI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>a. sound of the ball hitting the face of your racket</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41.2</td>
<td></td>
</tr>
<tr>
<td>b. sound of the ball hitting the face of your opponent's racket</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47.1</td>
<td></td>
</tr>
<tr>
<td>c. sound of the ball rebounding off the court surface</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>d. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>SUBJECTS</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUESTION VII</td>
<td>a. sound of the ball hitting the face of your racket</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. sound of the ball hitting the face of your opponent's racket</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. sound of the ball rebounding off the court surface</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. other comments</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>11.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.2</td>
<td>29.4</td>
<td>17.6</td>
<td>11.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 17—Continued
the sport of tennis in which he has had ten years of experience.
Subject G did not check any response but did comment in the positive
vein. He wrote, "I [hear] them to play better."

Question 2. In this task, what way were the sounds conducive
to influencing performance? In order of number of responses received,
item a, provides reinforcement, was the most general influence with 52.9
per cent of the subjects feeling this way. More than one-third (35.3
per cent) of the group experienced an increase in attention, whereas
only two subjects (11.8 per cent) indicated the sounds aided concen­
tration. No general influence was experienced by three subjects
(17.6 per cent). Two comments were made:

Subject L — "Keys play. No increase in attention or concen­
tration."
Subject N — "Really don't think about it."

Question 3. Every subject received some type of information
from the sound heard when the ball made contact with his racket while
executing the rally (game-like) against an opponent. Almost all items
which indicated a kind of information received anywhere from ten to
thirteen check marks. The one exception was item c which indicated the
direction the ball would take; only two subjects perceived such infor­
mation. This item may be more felt through proprioception, a feeling
of body part relationships.

Question 4. Each subject was asked to indicate the kinds of
information received when he could hear the ball strike his opponent's
racket. Speed of ball return seemed to be the most prevalent cue
perceived, with force of hit and application of spin running a close second. The percentage of subjects choosing each of the three responses were 76.5, 64.7, and 64.7, respectively. The timing of reaction was selected by eight subjects (47.1 per cent) and direction of ball return was selected by four subjects (23.5 per cent). Subject G was a lone individual when he indicated that the sound provided no information; this may have been done inadvertently because he had also checked two informational items.

Question 5. When the ball hit the court surface, the resulting sound tended to provide less information than either the sound of the ball contact against a player's own racket or the racket of his opponent. Nonetheless, twelve subjects did seem to benefit from this sound as opposed to five subjects who felt that the sound carried no information for them. The most valuable cue perceived from this sound was that which indicated the amount of time available for reaction.

Questions 6 and 7. Which sound cues, the ball hitting one's own racket, hitting the opponent's racket or hitting the court surface, ranked first and second in importance to receiving and ultimately stroking of the ball? The sound of the ball hitting the face of the opponent's racket was ranked first but only by a margin of one check mark over the sound of the ball hitting the face of one's own racket. The latter was chosen as ranking second in importance. Subject P did not choose to select any of the items. His feeling was clarified by his statement, "Sound has very little to do with it I think."

Reducing Sound Session. A tabulation of data from the reduced sound condition questionnaire is presented in Table 18, pages 97-100.
### TABLE 18
SUBJECTS' RESPONSES TO REDUCING SQUASH SESSION QUESTIONNAIRE—GAMES-LIKE TASK

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUESTION I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. pleasing</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>17.6</td>
</tr>
<tr>
<td>b. stimulating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>c. exciting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>d. indifferent</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>70.6</td>
</tr>
<tr>
<td>e. frustrating</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>f. distracting</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>g. other comments:</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>17.6</td>
</tr>
<tr>
<td><strong>QUESTION II</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increased reliance on vision</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>12</td>
<td>70.6</td>
</tr>
<tr>
<td>b. increased awareness of the &quot;feel&quot; of the racket</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>29.4</td>
</tr>
<tr>
<td>c. increased strain to hear the sounds</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>29.4</td>
</tr>
<tr>
<td>d. none of the above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>e. other comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE 18—Continued

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. tendency to hit harder</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>b. no change in force application</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>52.9</td>
</tr>
<tr>
<td>c. tendency to hit softer,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>more cautious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
</tbody>
</table>

| QUESTION IV                      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| a. increase in ability to        |   |   |   |   |   |   |   |   |   |   |   |   | x |   |   |   |   |   | 1     | 5.9  |
| judge the speed of the ball      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| b. ability to judge the          | x | x | x | x | x | x | x | x | x |   | 8     | 47.1 |
| speed of the ball was not        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| affected                         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| c. decrease in ability to        | x | x | x | x | x |   |   |   | x |   | 8     | 47.1 |
| judge the speed of the ball      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |       |   |
| d. other comments                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 1     | 5.9  |
### TABLE 18—Continued

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUESTION V</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. reaction time was slower</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>41.2</td>
</tr>
<tr>
<td>b. no change in reaction time</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>c. reaction time was faster</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>QUESTION VI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. difficulty in assessing the force of the hit</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>41.2</td>
</tr>
<tr>
<td>b. difficulty in assessing the application of spin</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>c. difficulty in assessing the direction of ball return</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>d. did not encounter any difficulty</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>52.9</td>
</tr>
<tr>
<td>e. other comments</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>SUBJECTS</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>F</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
<td>%</td>
</tr>
<tr>
<td>----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>QUESTION VII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increase in ability to concentrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>10</td>
<td>58.8</td>
</tr>
<tr>
<td>b. no change in ability to concentrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>c. definite decrease in ability to concentrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>d. other comments:</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>QUESTION VIII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3</td>
<td>17.6</td>
</tr>
<tr>
<td>b. no</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>14</td>
<td>82.4</td>
</tr>
<tr>
<td>c. indifferent</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Question 1. Of the items from which the subjects could choose to express their general feelings about reduced sound cues, item d, indifferent, was selected by the greatest percentage of subjects (70.6 per cent). No other item received more than three check marks. In general, the other responses included five subjects in some way favoring these sounds by finding them pleasing, stimulating or exciting. On the negative side were three responses expressing a feeling of frustration or distraction. Several subjects commented further:

Subject I — "I really couldn't wait to take the phones off." Whether this comment was due to the wearing of the attenuating earmuff, itself, or the reduced condition is not known.

Subject J — "[I] was able to concentrate more."

Subject M — "Felt like I was in a silent movie, e.g., 'Chaplin's Modern Times,' also felt like I was panting under water."

Question 2. The responses to this question inferred that a reduction of sound cues did force a greater reliance on the use of vision. Twelve subjects felt the use of vision to be more intense. Fifty per cent more subjects felt this type of increase during the game-like task as opposed to the wall rally task. Perhaps the complexity of the game-like task which included the uncertainty of ball strategy used by the opponent forced the subject to intensely watch the ball for cues previously associated with ball sounds in order to effectively participate when there was a reduction of these sounds. An increase in the awareness of the "feel" of the racket in hand was evidenced by five subjects and a like number expressed a tendency
toward straining to hear the sounds. Two subjects did not feel that they experienced any of the listed items.

Question 3. Under the reduced sound condition were the subjects hitting the ball harder or softer than normal? There seemingly was no tendency on the part of any subject to decrease the application of force which would have resulted in a softer, more cautious hit. Slightly more than half of the subjects (nine) stated that they did not change the amount of force applied to the ball and fewer than half (eight) did indicate a tendency to hit harder. The tendency to hit harder may be attributed to an attempt to make the sound more viable, more loud. Subject N, although he checked the hit harder response, commented, "I probably was not hitting harder, I was simply more aware of the hit."

Question 4. The reducing sound condition affected the subjects primarily in two ways. Eight subjects stated that their ability to judge ball speed was not hindered and a like number (eight) suggested that this ability may have decreased. Subject L was affected in a positive way for he felt that he was better able to judge the speed of the ball as a result of the reduced sound cues. Subject N felt that his ability to judge ball speed was not affected, although he did have slight difficulty at the beginning of the task, he stated, "Only once when [my] opponent put a great deal of spin on his serve was I fooled—and from then on I was able to recognize how he hit the spin so that I was ready for it."

Question 5. In essence, this question attempted to determine the characteristic which best exemplified the subjects' speed of reaction
to the oncoming ball when experiencing a reduction in ball sounds.

Fewer than half of the subjects (eight) seemed to react as they would in a normal situation. But seven subjects reported a slower reaction time. The opposite or a faster reaction time was expressed by two subjects.

Question 6. This question asked the subject to focus on his opponent's racket and examine what effect the reduced ball sound at that point had on being able to assess force of hit, application of ball spin and direction of ball return. Nine subjects didn't perceive having any difficulty in assessing the above items. Seven subjects felt that it was more difficult to assess the force of their opponents' hits and of this number two subjects had difficulty in determining whether or not spin was put on the ball and two subjects had difficulty in determining the direction of ball return. Subject D marked both items a and c as areas of difficulty. To a certain degree his problem may have been due to a difficulty in hearing the reduced sounds. He stated, "[I] could not hear really at all."

Question 7. The subjects were asked to respond to the question, "What effect did the reduction of sound cues have on your ability to concentrate?" There was a slight tendency toward an increase in ability to concentrate with 53.8 per cent of the group choosing this item. No change in this ability was mentioned by 47.1 per cent. These percentages may be slightly less due to the fact that one subject checked each of these items; he did not explain why. The reason for the increase in ability to concentrate could be due possibly to the attenuating earmuff not only reducing the sound cues accompanying the task but may have
lessened the input of other extraneous noises making the situation more advantageous for the subjects to focus on the task. Subject I reported that the condition "got distracting after awhile. Couldn't wait to take the earphones off."

Question 8. The last question inquired as to whether or not the game-like task was more difficult to perform under the reduced sound condition as compared to the wall rally task. The greatest percentage of subjects (82.4 per cent) felt that the game-like task was not more difficult to perform than the wall rally task while under the reduced sound condition.

Masking Sound Session. White noise was presented to the subjects for the purpose of masking or concealing all sounds that accompanied their performances and the performances of their opponents in the game-like task. This questionnaire attempted to ascertain the influences that this experimental sound condition may have had on the subjects' performances of the task. See Table 19, pages 105-109, for a summary of the subjects' responses.

Question 1. This first question was very similar to the one posed for the wall rally task under the same experimental condition; i.e., it asked the subjects to indicate their reactions to the white noise when it was initially heard. The general theme of the expressed reactions was negative and even somewhat more so than that which was expressed when the noise was heard under similar circumstances prior to the performance of the wall rally task. Item e, annoying, received the greatest number of check marks (twelve); item g, distracting, scored next highest with ten subjects responding; and item f, which indicated a frustrating...
| RESPONSES        | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | Total | %  |
| QUESTION I      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |     |    |
| a. pleasing     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   | 0.0 |
| b. stimulating  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   | 0.0 |
| c. exciting     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   | 0.0 |
| d. indifferent   |   |   |   | x |   |   |   | x |   |   | x |   |   |   |   |   |   |   | 3   | 17.6|
| e. annoying     |   |   |   |   | x | x | x | x | x |   |   | x | x | x | x |   |   |   | 12  | 70.6|
| f. frustrating  |   |   |   |   |   | x | x |   | x |   |   |   |   |   |   |   |   |   | 2   | 11.8|
| g. distracting  |   |   |   |   | x | x | x | x | x |   | x | x |   |   |   |   |   |   | 10  | 58.8|
| h. other comments|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | x |   |   | 2   | 11.8|

TABLE 19
SUBJECTS' RESPONSES TO MASKING SOUND SESSION
QUESTIONNAIRE—GAME-LIKE TASK
<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESPONSES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUESTION II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. stimulating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. exciting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. indifferent</td>
<td>0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. annoying</td>
<td>11</td>
<td>64.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. frustrating</td>
<td>6</td>
<td>35.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. distracting</td>
<td>9</td>
<td>52.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 19—Continued

<table>
<thead>
<tr>
<th>RESPONSES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increased reliance on vision</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>10 58.8</td>
</tr>
<tr>
<td>b. increased awareness of the &quot;feel&quot; of the racket and ball contact</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>8 47.1</td>
</tr>
<tr>
<td>c. increased strain in an attempt to hear the sound cues</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2 11.8</td>
</tr>
<tr>
<td>d. none of the above</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3 17.6</td>
</tr>
<tr>
<td>e. other comments</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2 11.8</td>
</tr>
<tr>
<td>QUESTION IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. tendency to hit harder</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3 17.6</td>
</tr>
<tr>
<td>b. no change in force application</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>12 70.6</td>
</tr>
<tr>
<td>c. tendency to hit softer, more cautious</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3 17.6</td>
</tr>
<tr>
<td>d. other comments</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1 5.9</td>
</tr>
<tr>
<td>RESPCNSES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>Total</td>
</tr>
<tr>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>--------</td>
</tr>
<tr>
<td>QUESTION V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. increase in ability to judge the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ability to judge the speed of the ball not affected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. decrease in ability to judge the speed of the ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUESTION VI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. reaction time seemed slower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. no noticeable change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. reaction time seemed faster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. other comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total: 0 0.0

Total: 5 29.4

Total: 12 70.6

Total: 9 52.9

Total: 7 41.2

Total: 1 5.9

Total: 0 0.0
### TABLE 19—Continued

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION VII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. difficulty in assessing the force of his hit</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>b. difficulty in assessing opponent's application of spin</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>c. difficulty in assessing the direction of ball return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>3</td>
</tr>
<tr>
<td>d. did not encounter any difficulty</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>6</td>
</tr>
<tr>
<td>e. other comments</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

| QUESTION VIII |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| a. increase in ability to concentrate | x |   |   |   |   |   |   |   |   | x | x | x | x | x | x | x | x | x | 4 | 23.5 |
| b. no change in ability to concentrate | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 4 | 23.5 |
| c. definite decrease in ability to concentrate | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 9 | 52.9 |
| d. other comments | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0 | 0.0  |

| QUESTION IX |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| a. Yes | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 8 | 47.1 |
| b. No | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 9 | 52.9 |
experience, was checked by two subjects. Only three subjects felt that the initial sound had not affected them one way or another. From these results it might be conjectured that the subjects did not relish the input of the white noise. Two comments were offered:

Subject G — "After awhile it got very annoying." This same subject marked two other items, indifferent and distracting. He seemed to be expressing his reaction beyond the initial orientation as requested.

Subject N — "Grew to enjoy it." In addition to this comment the subject marked the item denoting an indifferent feeling.

Question 2. The feelings of the subjects regarding the total experience under the masking condition were not appreciably different from their initial reactions represented in Question 1; they were essentially negative. The two noticeable changes included an increase from two to six the number of subjects who indicated the situation was frustrating and one individual (Subject N) thought the experience was exciting; he had a similar reaction while performing the wall rally task under the same condition.

Question 3. The masking of the sound cues seemed to increase the subjects reliance on vision. Some 58.18 per cent of the subjects responded to that item. Eight subjects, or 47.1 per cent, felt that they could better "feel" the racket and ball contact. Only two subjects thought they had strained to hear the sounds. The small number of subjects who responded in terms of strain may indicate that the other subjects weren't concerned with hearing the sounds or knew it was fruitless to attempt to hear them. Three subjects did not respond
to any of the proposed items. A comment was made by Subject J. He stated that he felt a "decrease awareness of the 'feel' of racket and judgment of the ball."

Question 4. Over 70.16 per cent of the subjects did not notice any change in the amount of force applied to the ball. On the other hand, three subjects perceived hitting harder and a like number had a tendency to hit softer, and more cautiously. Subject D responded that he hit both ways but "at different times; at first softer, then harder." It would seem that this subject was unsure and cautious during the beginning of the game-like task, but as he became accustomed to the task and its lack of sound cues he adjusted and maybe over adjusted to the point of hitting harder than normal.

Question 5. This question investigated the subjects' ability to judge the speed of the ball when sound was masked thus forcing the subjects to rely almost solely on vision. Out of the total of seventeen subjects five subjects did not notice any change in their attempts to judge ball speed. They claimed to have performed as if in a normal situation. Over twice that number did witness a negative change; i.e., twelve subjects felt their ability to judge the speed of the ball deteriorated when the sounds accompanying its movement were not heard. No subject developed an increase in this ability.

Question 6. The masking of ball sounds so that they were not heard does seem to cause some players to react more slowly to the oncoming ball; nine subjects experienced such a reaction. Seven subjects, though, reacted no differently under this condition as under a normal situation. One subject thought that he was able to move more quickly in response to the ball.
Question 7. Nine subjects encountered difficulty in assessing the force of the ball hit by their opponents. Two of these subjects encountered similar difficulty when attempting to determine if spin was applied to the ball by their opponents and perhaps what kind of spin was applied. The task of determining the direction of the ball return was difficult for only three subjects when the sounds were not heard. The large number of subjects who were able to assess ball direction might indicate that this kind of information may be better determined by vision. Slightly more than one-third or 35.3 per cent of the subjects encountered no difficulty in any of the categories. Subject B stated that he had more difficulty in assessing the "awareness of solidness of hit."

Question 8. Concentration is one of the most important factors associated with a well played game of tennis. With the absence of sound cues there is some indication that the ability to concentrate is lessened. Nine subjects reported less ability to concentrate. Several subjects (four) did not feel their ability to concentrate was affected. On the positive side, four subjects benefited from the lack of sound cues and were better able to maintain concentration. This is an interesting phenomena.

Question 9. Almost an equal number of subjects reported that they either had more difficulty or performed with about the same efficiency the game-like task as compared to the wall rally task. The game-like task was performed with greater difficulty by eight subjects when experiencing the white noise condition as compared to their wall rally task performances. The remaining nine subjects felt that they
performed both tasks under this experimental condition with about the same effectiveness.

**Brief Summary of the Analysis of Data**

The importance of auditory cues accompanying the performance of a wall rally task upon the performance of that task executed by skilled tennis players was statistically determined. The reliability and validity coefficients of the task were computed. In addition, subject response questionnaires were distributed to gather subjective data relating to the subjects' performances of the wall rally task and a game-like task under the sound conditions (control, reducing, and masking) administered during this study; this data was qualitatively analyzed.

No advantage was gained by the subjects while performing the wall rally task under one or the other of the three sound conditions; the performances of the task were quite similar.

The computed reliabilities of three of the performance measures (number of successful hits, accuracy scores, and total scores) were reasonably high with respective coefficients of .906, .918, and .923. The accuracy/number of successful hits ratio coefficient was quite low; the coefficient of reliability was .754.

The validity was computed two ways; i.e., two qualitative criterion measures were used to determine the validities of the four performance measures. One criterion was a skill rating form which was used by tennis experts to evaluate the tennis skill of each subject. The second criterion was a simple rank order of each subject's skill by the same three
experts noted above. The computed validity correlations of the performance measures were higher when the simple rank order was used as the criterion measure.

Information gleaned from the subjects by means of subject response questionnaires indicated essentially that the subjects do seem to perceive, under normal conditions, valuable information from the various ball sounds associated with the wall rally and game-like tasks.

When the sounds were reduced there was a tendency toward a feeling of increased reliance on vision and a greater awareness of the "feel" of the racket and ball contact. In addition, judgment of speed, reaction time, and force assessment were either not affected or were affected negatively by the reduced sound condition. It is interesting to note that the subjects tended to hit harder or had no change in application of force under the reduced condition in the game-like task but under the same condition during the wall rally task the subjects either hit softer or had no change in application of force. The ability to concentrate was favorably assisted by the reduced sound input.

As in the reduced sound condition, the masked sound condition affected the subjects toward an increased reliance on vision and awareness of the "feel" of the racket and ball contact. During the rally task eight subjects tended to hit softer, whereas six subjects felt no change; while in the game-like task twelve subjects noticed no change in the force of their hits and the remaining subjects hit either softer or harder. A greater number of subjects during the game-like task
performance seemed to have more difficulty judging ball speed and maintaining concentration than during the wall rally task performance. During the performance of the wall rally task and the game-like task under the masked sound condition, reaction time was either not affected or was increased.
CHAPTER V

SUMMARY AND CONCLUSIONS

Physical educators have been concerned with the roles that the various sense organs play in sport activities. The visual and the kinesthetic senses have received the greater amount of attention by researchers as compared to the auditory sense. And yet, the auditory sense is used to a great extent in sport activities by virtue of the sound stimuli associated with these activities which impinge upon the auditory mechanism.

This study was an attempt to determine the importance of auditory cues accompanying the performance of a select gross motor task incorporating skills similar to those used in the sport of tennis, i.e., rallying a ball against the wall with a forehand drive, a backhand drive, or volley, upon the performance of that task at the skilled performer level. Sub-problems included were:

1. To develop an accuracy target for use in the wall rally task and to determine its reliability and validity.

2. To construct a series of subject response questionnaires to assist in obtaining subjective data relating to the performance of the wall rally task.

3. To administer a game-like task performed under the experimental and control sound conditions in order to collect additional
subjective data pertaining to a task more closely related to an actual

The importance of this study was stated in terms of possible

information about auditory cues used by skilled players which might

contribute to a better understanding of the use of such cues by sport

participants and their potential use by physical educators in the

teaching of physical education activities and in the coaching of

sport teams.

Eighteen varsity tennis players from either The Ohio State

University or the Upper Arlington High School teams volunteered to

participate in this study during the Spring Quarter, 1972.

To ascertain the importance of auditory cues inherent in a
tennis wall rally task upon the performance of that task, the sub­
jects performed under three sound conditions: (1) a control (normal)
sound condition; (2) a reduced sound condition; and (3) a masked sound
condition. During the control condition, the ball sounds were heard
in a fashion typical of a normal situation except that modified earmuffs,
which did not interfere with the sound cues, were worn. The reduced
sound condition was induced by the wearing of attenuating earmuffs;
this caused the input of the normal sound cues to be diminished by
approximately eight decibels. And the third sound condition masked the
sound cues by white noise so that the sound cues associated with the
task were not heard.

The wall rally task was administered on four separate occasions.
The first occasion was a preliminary session for the purpose of familiar­
izing the subjects to the task and to determine the reliability and
validity of the task. The remaining three sessions were experienced under the experimental and control sound conditions. Prior to performance the sound conditions were organized into six possible sequences or orders; the subjects were then randomly assigned to an order and controlled so that each order contained three subjects.

During the course of each wall rally performance an accuracy score and a number of successful hits score were recorded. At the end of each session a subject response questionnaire appropriate to the respective sound condition was completed except for the preliminary session where the questionnaire was completed prior to the performance.

The game-like task was administered within a week following the wall rally task. Essentially, the game-like tasks could be likened to a singles game situation with emphasis placed on the rally. Rotation of serve and scoring were not emphasized. During this one session the experimental and control sound conditions were experienced by each subject. To gather data about the performances of this task the subjects completed response questionnaires for each sound condition; these questionnaires were similar to those used for the wall rally task.

Upon completing the administration of the performance tasks, the data were compiled and either statistically or qualitatively analyzed. The analysis and interpretation of the data revealed the following:

1. The reducing of sound cues which accompany the performance of the wall rally task did not result in an inefficient performance and this was reflected by the various measures used to evaluate that
2. The masking of sound cues which accompany the performance of the wall rally task did not result in an inefficient performance and this was reflected by the various measures used to evaluate that performance.

Thus the hypothesis, as stated in Chapter I, that the normal auditory cues which accompany the performance of the wall rally task do not enhance the performance of that task at the skilled performer level was accepted.

3. The order in which the experimental and control sound conditions were received did not affect the efficiency of the wall rally task performances and this was reflected by the measures used to evaluate those performances.

4. There was no significant interaction between the three sound conditions and the order in which these sound conditions were received.

5. For the wall rally task the reliability correlation coefficients for three performance measures (number of successful hits, accuracy scores and number of successful hits plus accuracy scores) were reasonably high ranging from .906 to .923. The fourth measure, accuracy/number of successful hits ratio, had a low correlation in comparison to the suggested range for reliability.

6. For the wall rally task the validity correlation coefficients for three performance measures (number of successful hits, accuracy scores and number of successful hits plus accuracy scores) when correlated
with the Skill Rating Form evaluations ranged from .753 to .775. The measure, accuracy/number of successful hits ratio, was low with a coefficient of .558.

7. For the wall rally task the validity correlation coefficients for three performance measures (number of successful hits, accuracy scores and number of successful hits plus accuracy scores) when correlated with the judges' performance rank order ranged from .805 to .851. The fourth measure, accuracy/number of successful hits ratio, was low with a coefficient of .580.

8. Prior to any performance of the wall rally task, the general feeling expressed was that the ball sounds accompanying the execution of the task would be an asset to performance through the presentation of cues which would supplement visual perception. The sound cues would be most effective in the areas of concentration, judgment of ball speed and information perceived about the task.

9. During the performance of the wall rally task the normal sound cues seemed to influence performance by providing reinforcement and increasing attention. In addition, and perhaps more importantly, the sound cues did seem to provide various kinds of information to the subjects which did assist them in their performances. The ball sounds which provided the most cues were those when the ball hit the racket face and the target wall.

10. When the sound cues were reduced during the execution of the wall rally task, the subjects' responses were varied. There was a tendency to strain to hear the ball sounds and a tendency to concentrate more diligently on the task. The opinions of the subjects
were almost equally divided as to no change or a negative change regarding the effects due to the reduction of sound cues on force of hit, judgment of ball speed and reaction time.

11. During the execution of the wall rally task, there was a slight leaning toward disliking the experience under the masked sound condition. Without sound cues a tendency was evidenced toward an increased reliance on vision, a greater awareness of the "feel" of the racket during ball contact and a softer, more cautious hit. The opinions of the subjects were almost equally divided between no effect and a negative effect on ability to judge ball speed and reaction time resulting from the absence of ball sounds.

12. During the execution of the game-like task the normal sound cues influenced performance by providing reinforcement and increasing attention toward the task. Concentration was not generally facilitated. For the most part, information was perceived from the sounds of the ball hitting the player’s racket, hitting the opponent’s racket and rebounding from the court surface. The most viable sounds were those when the ball hit the face of the opponent’s racket and the face of the player’s own racket.

13. When the sound cues were reduced during the game-like task, the majority of subjects felt indifferent toward the input of these sounds. There was a general tendency toward an increase in the reliance on vision and a very slight tendency toward an increase in the ability to concentrate. Approximately half of the subjects felt that they hit the ball with the same amount of force as in a normal situation, whereas the other half felt that they tended to hit more forcefully.
Opinions were split as to the effects of the reduced sound condition on the ability to judge ball speed and ability to react to the oncoming ball. The subjects either felt that these abilities remained the same as in a normal situation or actually decreased in their efficiency. The subjects did not find it more difficult to perform the game-like task as compared to the wall rally task under the reduced sound condition.

14. The masking sound condition with the white noise input concealing the ball sounds was primarily annoying and distracting to the subjects during the execution of the game-like task. There was a tendency toward an increased reliance on vision and an increased awareness of the "feel" of the racket at ball contact. The majority of the subjects felt that the force they applied to the ball did not change under this condition, and they felt that there was a tendency toward a decrease in their ability to judge ball speed. Reaction time for slightly more than half of the subjects seemed to increase; a smaller number of subjects felt that there was no noticeable change in their ability to react to the oncoming ball. Slightly less than two-thirds of the subjects encountered difficulty in assessing various aspects of their opponents' actions on the ball, whereas one-third of the subjects did not encounter any noticeable difficulty. In regard to concentration, slightly more than half of the subjects felt a decrease in their ability to concentrate; the remaining subjects either felt an increase or no change in this ability. Approximately 50 per cent of the subjects had more difficulty performing the game-like task as compared to the wall rally task under the masked sound condition.
Conclusions

The following conclusions are offered on the basis of the evidence secured from this study.

The inherent sound cues associated with a wall rally task seem to have a relatively minor or unimportant effect on the performance of that task by highly skilled tennis players as measured by number of successful hits, accuracy score, total score and accuracy/number of successful hits ratio. This is suggested by the small magnitudes of the differences between sound condition (control, reducing, and masking) means.

On the basis of the qualitative data secured from the subject response questionnaires, the inherent sound cues in the performance of a wall rally task and a game-like task do seem to provide various kinds of information to highly skilled tennis players. The effects of reducing and masking these sound cues on the performances of the tasks seem dependent on the individual player.

Recommendations for Further Study

As a result of this study, the writer suggests the following areas for further research:

1. The writer arbitrarily selected the tennis related tasks for investigation of the importance of inherent auditory cues. It would seem profitable to determine what skills may actually be dependent on auditory cues for efficient performance to occur.

2. The subjects in this study were highly skilled, it would be interesting to determine the effect that reduction or absence of
sound cues accompanying task performance may have on the learning of a task by unskilled subjects.

3. The basic format of this study could be repeated but with emphasis placed on performance in actual games of tennis, i.e., participation in a round robin tournament.

4. A study of this nature might be explored for use with elementary children in their learning of various ball handling skills which have definite sounds associated with their execution.

5. It would be of interest to compare men and women to determine the effects that reduction and/or absence of auditory cues may have on their respective performances in high auditory dependent tasks.
APPENDIX A

INFORMATION SHEET--CONSENT FORM
Dear Student:

During the Spring Quarter of 1972, I will be conducting a study to investigate the importance of sound cues which accompany a skilled player's performance in the sport of tennis (e.g., the ball hitting the racket, hitting the target wall, and rebounding from the court surface).

A wall rally task for speed and accuracy will be the primary performance task. The task performance will be conducted on an individual basis and will be composed of four sessions of approximately twenty-five minutes per session. The secondary task will be a game-like performance consisting of rallying against an opponent. This task will be conducted as a small group session during one of your regularly scheduled practice periods or at a more convenient time by appointment. Each of these tasks will be performed under three conditions: 1) masking the sound cues by white noise (static) transmitted via an attenuating headset; 2) reducing the sound cues by wearing attenuating earmuffs; and 3) hearing the normal sound cues while wearing modified earmuffs.

The masking of the sound cues by white noise seemingly is the only means by which the cues can be totally concealed so that they cannot be heard. The Walsh-Healey Public Contracts Act has specified standardized safe limits in decibels for exposure to noise conditions in accordance with the length of time of the exposure. The white noise that will be received as a condition in this study will be received...
at the intensity level of between 84-93.5 decibels to conceal the intensity of the sound cues during the rally tasks which peak at approximately 84 decibels. This is considered to be a safe limit, especially, in conjunction with the short exposure time. The wall rally and game-like tasks will be performed on one occasion each under the white noise condition for a total time period of nine minutes and fifteen minutes, respectively. The Walsh-Healey Act specifies a permissible noise exposure of four hours per day at a sound level of 95 decibels.

In order to ascertain that all subjects possess hearing ability in the normal range, which is a requisite for this study, a hearing test will be administered. This test will be given during one of your regularly scheduled practice sessions and prior to actual participation in the study.

Due to the nature of this study and limited number of available skilled tennis players, I do need your full cooperation in order to conduct this investigation. If you are willing to serve as a subject in this study, please sign the consent form below.

Your consideration, assistance, and support will be greatly appreciated!

Most Sincerely,

Ethel Docherty
1112 Perry, Apt. A
Columbus, Ohio 43201

Phone: 299-6722
SUBJECT'S CONSENT:

I do hereby consent to serve as a subject in the above proposed procedure for the research study entitled "The Effects of Reducing and Masking the Auditory Cues Accompanying Performance of Select Gross Motor Tasks on the Performance of Those Tasks."

Name____________________________ Date____________________

Present Address____________________ Phone Number________________

Home Address____________________ Phone Number________________
APPENDIX B

INSTRUCTIONS FOR PERFORMANCE OF WALL RALLY TASK
INSTRUCTIONS FOR PERFORMANCE OF WALL RALLY TASK\textsuperscript{1,2}

The object of the task is to cause the ball to strike the center of the target on the wall as many times as you can during a three minute time limitation. When the timer gestures a "nod of the head" start the task immediately. The time trial will begin at the point when your racket contacts the first ball.

You will start the task with two tennis balls in your hand. Drop one ball and let it hit the floor once, then put it into play against the wall. Continue to play it to the wall until a red ball is seen which is thrown by the timer toward the target wall at the end of three minutes at which time you will stop.

There is no limit to the number of times the ball may bounce before you hit it. You may volley the ball. The ball need not touch the floor before you play it except at the start and when a new ball is being put into play. You may use any stroke or combination of strokes. You must play all balls from behind the restraining line. Any hits made while stepping on or over the restraining line will not count. You may cross the line to retrieve balls, but any hits made while in such a position do not count.

If for any reason you lose control of the ball in play, do not try to retrieve it; instead, use the other ball in your hand. If you lose control of the second ball, take two more balls from the container and put one in play as you did at the start.

\textsuperscript{1}Ronning, \textit{op. cit.}, pp. 41-42.

\textsuperscript{2}Dyer, \textit{op. cit.}, pp. 29-31.
Each ball striking the wall above the not line and within bounds of the wall space before the signal to stop is given counts as a hit. Each ball striking the target will be given an accuracy score; the respective point values from the center outward are 5, 4, 3, 2 and 1 point for the remaining area outside the target but within the wall boundary.

You will have three trials with a two minute rest between trials. The final task scores for number of hits and accuracy points will be their sums of the three trials.

Rally with as much speed and accuracy as possible!
APPENDIX D

SUBJECT RESPONSE QUESTIONNAIRES - WALL RALLY TASK

Preliminary Normal Sound Session
Control Sound Session
Reducing Sound Session
Masking Sound Session
SUBJECT RESPONSE QUESTIONNAIRE

Preliminary Normal Sound Session

Name __________________________

Date ______ Time ______

Directions: During the next three upcoming sessions, the wall rally task will be performed under three experimental conditions. At this time, I would like to pursue your feelings in anticipation of these sessions. Please offer your honest response to the questions posed below.

1. During the wall rally performance the sounds of the ball hitting the racket, hitting the target wall, and rebounding from the court surface will be received in a normal manner except that a modified earmuff, which will not block incoming sounds, will be worn as a control variable. Do you feel the hearing of these normal sound cues will be a factor in your performing the rally task as well as you can? _______ Why do you feel this way?

2. During the wall rally performance the sounds of the ball hitting the racket, hitting the target wall, and rebounding from the court surface will be received via an attenuating earmuff which will reduce the sound level of these cues. Do you feel the reduced sound cues will cause a decrement in your performance? _______ Why do you feel this way?

3. During the wall rally performance, white noise (static) will be transmitted via an attenuating headset masking (concealing) all sounds which would normally accompany the performance. Do you feel the incoming white noise will disturb your performance? _______ Why do you feel this way?

4. Do you feel the absence of sound cues will cause a decrement in your performance? _______ Why do you feel this way?
SUBJECT RESPONSE QUESTIONNAIRE

Control Sound Condition

Name_____________________
Date_____________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include additional responses.

I. When you heard the sounds of the ball hitting the racket face, hitting the target wall, and rebounding from the court surface, which of the following words best expresses your general feeling about these sounds?

- a. pleasing
- b. stimulating
- c. indifferent
- d. frustrating
- e. distracting
- f. other comments

II. When the various sounds of the ball were heard during the performance of the task, which of the following words best depicts their general influence on your performance?

- a. provides reinforcement
- b. increases attention
- c. facilitates concentration
- d. no general influence
- e. other comments

III. When you heard the sound of the ball hitting the face of the racket, what information did the sound provide you about your stroke?

- a. indicated a good or poor stroke
- b. indicated where ball hit on racket face
- c. indicated direction ball would take
- d. indicated power of the stroke
- e. indicated application of spin
- f. provided no information
- g. other comments
IV. When the ball hit the rally wall, what information did the resulting sound provide?

_____ a. force of hit
_____ b. speed of ball return
_____ c. direction of ball return
_____ d. timing of reaction
_____ e. rhythm of stroke
_____ f. provided no information
_____ g. other comments:

V. When the ball hit the court surface, what information did the resulting sound provide?

_____ a. speed of ball return
_____ b. direction of ball return
_____ c. timing of reaction
_____ d. rhythm of stroke
_____ e. provided no information
_____ f. other comments:

VI. Which of the sound cues tends to be most important to your successful execution of the rally task?

_____ a. sound of the ball hitting the racket face
_____ b. sound of the ball hitting the target wall
_____ c. sound of the ball rebounding off the court surface
_____ d. other comments:

VII. Which of the sound cues tends to rank second in importance to your successful execution of the rally task?

_____ a. sound of the ball hitting the racket face
_____ b. sound of the ball hitting the target wall
_____ c. sound of the ball rebounding off the court surface
_____ d. other comments:
SUBJECT RESPONSE QUESTIONNAIRE

Reducing Sound Condition

Name__________________

Date__________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include additional responses.

I. When you heard the reduced sounds of the ball hitting the face of the racket, hitting the target wall, and rebounding from the court surface, which of the following words best expresses your general feeling about these sounds?

_____ a. pleasing
_____ b. stimulating
_____ c. indifferent
_____ d. frustrating
_____ e. distracting
_____ f. other comments!

II. When the sound cues were reduced, which of the following occurred?

_____ a. increased reliance on vision
_____ b. increased awareness of the "feel" of the racket
_____ c. increased strain to hear the sounds
_____ d. other comments!

III. When the sound cues were reduced, in what way was the application of force altered?

_____ a. tendency to hit harder
_____ b. no change in force application
_____ c. tendency to hit softer, more cautious
_____ d. other comments!

IV. When the sound cues were reduced, what effect did this have on your ability to judge the speed of the moving ball?

_____ a. increase in ability to judge the speed of the ball
_____ b. ability to judge the speed of the ball was not affected
_____ c. decrease in ability to judge the speed of the ball
_____ d. other comments!
V. During the reduction of sound cues, which of the following best characterizes the speed of your reaction to the oncoming ball?

_____ a. reaction time was slower
_____ b. no change in reaction time
_____ c. reaction time was faster
_____ d. other comments:

VI. What effect did the reduction of sound cues have on your ability to concentrate?

_____ a. increase in ability to concentrate
_____ b. no change in ability to concentrate
_____ c. definite decrease in ability to concentrate
_____ d. other comments:
SUBJECT RESPONSE QUESTIONNAIRE

Masking Sound Condition

Name_________________________

Date_________________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include additional responses.

I. When the white noise was initially heard, which of the following words best expresses your initial reaction?

_____  a. pleasing
_____  b. stimulating
_____  c. indifferent
_____  d. annoying
_____  e. frustrating
_____  f. distracting
_____  g. other comments

II. After completion of your performance under the condition of white noise masking the sounds accompanying this performance, which of the following words best express your feelings regarding the experience?

_____  a. pleasing
_____  b. stimulating
_____  c. indifferent
_____  d. annoying
_____  e. frustrating
_____  f. distracting
_____  g. other comments

III. During the absence of sound cues, which of the following occurred?

_____  a. increased reliance on vision
_____  b. increased awareness of the "feel" of the racket and ball contact
_____  c. increased strain in an attempt to hear the sound cues
_____  d. other comments
IV. When the sound cues were no longer heard, in what way was the application of force altered?

_______  a, tendency to hit harder
_______  b, no change in force application
_______  c, tendency to hit softer, more cautious
_______  d, other comments

V. When you no longer were able to hear the sound cues, what effect did this have on your ability to judge the speed of the moving ball?

_______  a, increase in ability to judge the speed of the ball
_______  b, ability to judge the speed of the ball not affected
_______  c, decrease in ability to judge the speed of the ball
_______  d, other comments

VI. During the absence of sound cues, which of the following statements best characterizes the speed of your reaction to the oncoming ball?

_______  a, reaction time seemed slower
_______  b, no noticeable change
_______  c, reaction time seemed faster
_______  d, other comments

VII. What effect did the absence of sound cues have on your ability to concentrate?

_______  a, increase in ability to concentrate
_______  b, no change in ability to concentrate
_______  c, definite decrease in ability to concentrate
_______  d, other comments
APPENDIX E

SUBJECT RESPONSE QUESTIONNAIRES - GAME-LIKE TASK

Control Sound Session
Reducing Sound Session
Masking Sound Session
SUBJECT RESPONSE QUESTIONNAIRE

Control Sound Condition
Game-like Situation

Name__________________________

Date__________________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include any additional responses.

I. When you heard the sounds of the ball hitting the face of your racket, hitting the face of your opponent's racket, and rebounding from the court surface, which of the following words best expresses your general feeling about these sounds?

   ______ a. pleasing
   ______ b. exciting
   ______ c. indifferent
   ______ d. frustrating
   ______ e. distracting
   ______ f. other comments!

II. When the various sounds of the ball were heard during the performance of the game-like task, which of the following words best depicts their general influence on your performance?

   ______ a. provide reinforcement
   ______ b. increase attention
   ______ c. facilitate concentration
   ______ d. no general influence
   ______ e. other comments!

III. When you heard the sound of the ball hitting the face of your racket, what information did the sound provide you about your stroke?

   ______ a. indicated a good or poor stroke
   ______ b. indicated where ball hit on racket face
   ______ c. indicated direction ball would take
   ______ d. indicated power of the stroke
   ______ e. indicated application of spin
   ______ f. provided no information
   ______ g. other comments!
IV. When the ball was hit by your opponent's racket, what information did the resulting sound provide?

_____ a. force of hit
_____ b. speed of ball return
_____ c. direction of ball return
_____ d. amount of time available for reaction
_____ e. application of spin and type
_____ f. provided no information
_____ g. other comments*

V. When the ball hit the court surface, what information did the resulting sound provide?

_____ a. speed of ball return
_____ b. direction of ball return
_____ c. amount of time available for reaction
_____ d. application of spin and type
_____ e. provided no information
_____ f. other comments*

VI. Which of the sound cues tends to be most important to your successful receiving and ultimately stroking of the ball?

_____ a. sound of the ball hitting the face of your racket
_____ b. sound of the ball hitting the face of your opponent's racket
_____ c. sound of the ball rebounding off the court surface
_____ d. other comments*

VII. Which of the sound cues tends to rank second in importance to your successful receiving and ultimately stroking of the ball?

_____ a. sound of the ball hitting the face of your racket
_____ b. sound of the ball hitting the face of your opponent's racket
_____ c. sound of the ball rebounding off the court surface
_____ d. other comments*
SUBJECT RESPONSE QUESTIONNAIRE

Reducing Sound Condition
Game-like Situation

Name ______________________________

Date ______________________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include any additional responses.

I. When you heard the reduced sound cues of the ball hitting the face of the racket, hitting the face of your opponent's racket, and rebounding from the court surface, which of the following words best expresses your general feeling about these sounds?

_______ a. pleasing
_______ b. stimulating
_______ c. exciting
_______ d. indifferent
_______ e. frustrating
_______ f. distracting
_______ g. other comments:

II. When the sound cues were reduced, which of the following occurred?

_______ a. increased reliance on vision
_______ b. increased awareness of the "feel" of the racket
_______ c. increased strain to hear the sounds
_______ d. none of the above
_______ e. other comments:

III. When the sound cues were reduced, in what way was your application of force altered?

_______ a. tendency to hit harder
_______ b. no change in force application
_______ c. tendency to hit softer, more cautious
_______ d. other comments:
IV. When the sound cues were reduced, what effect did this have on your ability to judge the speed of the moving ball?

______ a. increase in ability to judge the speed of the ball
______ b. ability to judge the speed of the ball was not affected
______ c. decrease in ability to judge the speed of the ball
______ d. other comments:

V. During the reduction of sound cues, which of the following best characterizes the speed of your reaction to the oncoming ball?

______ a. reaction time was slower
______ b. no change in reaction time
______ c. reaction time was faster
______ d. other comments:

VI. When the sound of your opponent’s racket hitting the ball was reduced, which of the following seemed to occur?

______ a. difficulty in assessing the force of the hit
______ b. difficulty in assessing the application of spin
______ c. difficulty in assessing the direction of ball return
______ d. did not encounter any difficulty
______ e. other comments:

VII. What effect did the reduction of sound cues have on your ability to concentrate?

______ a. increase in ability to concentrate
______ b. no change in ability to concentrate
______ c. definite decrease in ability to concentrate
______ d. other comments:

VIII. Was it more difficult to perform under the reduced condition in the game-like situation as compared to the rally task? In what way(s)?
SUBJECT RESPONSE QUESTIONNAIRE

Masking Sound Condition
Game-like Situation

Name____________________

Date____________________

Directions: Please offer your honest response to the questions posed below by indicating with a check mark (✓) the item or items which best depict your opinion. Please use the space provided for other comments to include any additional responses.

I. When the white noise was initially heard, which of the following words best expresses your initial reaction?

______ a. pleasing
______ b. stimulating
______ c. exciting
______ d. indifferent
______ e. annoying
______ f. frustrating
______ g. distracting
______ h. other comments!

II. After completion of your performance in the game-like situation under the condition of white noise masking the sounds accompanying this performance, which of the following words best expresses your feelings regarding the experience?

______ a. pleasing
______ b. stimulating
______ c. exciting
______ d. indifferent
______ e. annoying
______ f. frustrating
______ g. distracting
______ h. other comments!

III. During the absence of sound cues, which of the following occurred?

______ a. increased reliance on vision
______ b. increased awareness of the "feel" of the racket and ball contact
______ c. increased strain in an attempt to hear the sound cues
______ d. none of the above
______ e. other comments!
IV. When the sound cues were no longer heard, in what way was your application of force altered?

________ a. tendency to hit harder
________ b. no change in force application
________ c. tendency to hit softer, more cautious
________ d. other comments:

V. When you no longer were able to hear the sound cues, what effect did this have on your ability to judge the speed of the moving ball?

________ a. increase in ability to judge the speed of the ball
________ b. ability to judge the speed of the ball not affected
________ c. decrease in ability to judge the speed of the ball
________ d. other comments:

VI. During the absence of sound cues, which of the following statements best characterizes the speed of your reaction to the oncoming ball?

________ a. reaction time seemed slower
________ b. no noticeable change
________ c. reaction time seemed faster
________ d. other comments:

VII. When the sound of your opponent's racket hitting the ball was no longer heard, which of the following seemed to occur?

________ a. difficulty in assessing the force of his hit
________ b. difficulty in assessing opponent's application of spin
________ c. difficulty in assessing the direction of ball return
________ d. did not encounter any difficulty
________ e. other comments:

VIII. What effect did the absence of sound cues have on your ability to concentrate?

________ a. increase in ability to concentrate
________ b. no change in ability to concentrate
________ c. definite decrease in ability to concentrate
________ d. other comments:

IX. Was it more difficult to perform under the white noise condition in the game-like situation as compared to the rally task? In what way(s)?
APPENDIX F

QUALITATIVE RESPONSES TO SUBJECT RESPONSE QUESTIONNAIRE

Preliminary Normal Sound Session

149
QUALITATIVE RESPONSES TO SUBJECT RESPONSE QUESTIONNAIRE

Preliminary Normal Sound Session

Name________________________

Date_________ Time__________

Directions: During the next three upcoming sessions, the wall rally task will be performed under three experimental conditions. At this time, I would like to pursue your feelings in anticipation of those sessions. Please offer your honest response to the questions posed below.

1. During the wall rally performance the sounds of the ball hitting the racket, hitting the target wall, and rebounding from the court surface will be received in a normal manner except that a modified earmuff, which will not block incoming sounds, will be worn as a control variable. Do you feel the hearing of these normal sound cues will be a factor in your performing the rally task as well as you can?_______ Why do you feel this way?

[The subject responses are reproduced exactly as they appeared in response to the questions posed.]

Subject Responses:

A. Yes. I feel the sound of the ball hitting the wall, floor and racquet tend to help you time your stroke and therefore you do not have to rely as much on sight.

B. Yes. The skill of hitting with accuracy and speed depends on coordination and timing. Sight, hearing, feel all are conglomerated into this skill. By removing or clouding one the skill is not the same.

C. Yes. If I'm hitting well, I establish a rhythm, based more on sound than sight. Interference with the sound "pattern" would be detrimental, I think.

D. Yes. I can only assume that hearing is a very vital part of everything, especially athletics. I have always been told it is a vital part of reactions as well as coordination of the body, therefore feel it will affect my hitting.

E. Yes. I think it depends, I am not exactly sure how much I actually concentrate on the sounds as opposed to sight.

F. Yes. Because you rely on the sound if you don't concentrate on watching the ball.
G. Yes; You will not know exactly when you meet the ball when hitting.

H. No. Without knowing the answer to this question my first impression would be that it would make no difference if one could hear or not. I would think I watch the ball closely enough so that I could judge the ball without hearing it’s rebounds.

I. No. I have been hitting against walls for a long time and I think that I should be used to the sounds of the ball hitting the racket and the wall.

J. Yes. I feel this way because to sound of the ball enables me to have good timing and also judge the distance and depth of the ball.

K. Yes. Because when you hear the ball hit the racket or wall you can tell how square you hit it.

L. Yes. Because I have learned to gauge how well I hit the ball by how solid the ball sounds hitting my racket. I think I would be disoriented if I didn’t have my clue.

M. Yes. Hearing the ball is just another form of sensory input which helps to locate the ball and to determine it’s speed; e.g., the louder the sound the ball makes on impact the faster it’s moving. The sound of the ball hitting the racket tells me how "solid" my shot was.

N. Yes. Basically, because of the fairly short distance between the wall and the player, sound plays a fairly important role in perceiving the speed at which the ball rebounds from the wall.

O. Yes. By hearing the impact of the ball on the racquet and the wall one can determine if the ball was hit well and prepare for the next shot more easily.

P. No. The headset, if not blocking off any noise, should not be any more distracting to me than wearing a hat.

Q. Yes, No. The sound can be a psych factor because inside one can hear the loud crack of the opponents serve, but also he can hear his own sounds also.

R. No. I do not really notice noise.

2. During the wall rally performance the sounds of the ball hitting the racket, hitting the target wall, and rebounding from the court surface will be received via an attenuating earmuff which will
reduce the sound level of these cues. Do you feel the reduced sound cues will cause a decrement in your performance? Why do you feel this way?

Subject Responses:

A. Yes, I feel this way because without the sound cues it will be difficult to time the speed of the ball and it might throw my timing off.

B. Yes, Reasons [as noted in question] number 1.

C. Maybe. Same reason as above, but being able to hear somewhat would help.

D. Yes, Because the reaction and co-ordinating the bounce of the ball to its speed will be impaired.

E. Possibly. Again it depends on how much I pay attention to the sounds.

F. Yes, Because unless the sound is in proportion it will be hard to adjust.

G. Yes. Same as [noted in question] number 1.

H. Yes, Although I said I did not think it would make that much difference I do feel it will make some difference. When a ball bounces slower or faster you tell a difference in the sound to some degree.

I. Slightly. It will probably throw off my timing somewhat.

J. Yes, As in the above question I feel that to perform well you have to have your timing down and also be able to judge the ball. With the sound reduced my performance would decrease.

K. No. Because the sound no matter how loud is after you hit the ball where you have no control.

L. Yes, Tennis is a game of rhythm and if the sounds aren't there to help you will have to set up an artificial rhythm and it will be more difficult.

M. Yes. The reduced sound level will decrease the amount of information received by my ears. This reduction should make judgment of the balls location and velocity more difficult.
N. Yes. For the above mentioned reason -- However the effect of reduced sound will not drastically affect play since the speed at which the ball rebounds from the wall is actually determined by the speed put on the ball by the player.

O. Yes. By not hearing sounds it will be more difficult to determine the speed at which the ball will be returning.

P. Yes. Because I think that sound probably does affect the way you hit the ball. At the time the ball bounces, I feel that my timing will be thrown off as the sound decreases.

Q. Yes. Because it is not what I am accustomed too, however if things like that happen sometimes I make myself concentrate better. It depends on my mood.

R. No. I do not really notice the noise.

3. During the wall rally performance, white noise (static) will be transmitted via headphones masking (concealing) all sounds which would normally accompany the performance. Do you feel the incoming white noise will disturb your performance? Why do you feel this way?

Subject Response.

A. Yes. It will be harder to concentrate with the incoming noise therefore I feel my accuracy will go down as a result.

B. Yes. Same reason as in question number 1.

C. Yes. Same reason [as in question number 1], plus "white" noise would be distracting, impairing concentration.

D. No. Not really because of the concentration involved, I will not consciously hear the static but it should impair me a little.

E. No. Because while playing in many tournaments people and crowds and other goings on have been loud enough as to drown out any ordinary occurring sounds.

F. No. No more than any other distracting noise.

G. Yes. You will not know when you meet the ball. The sound of it hitting the racket will be eliminated causing confusion.
H. Yes. I would think it would because it might hurt one's concentration.

I. Yes. Because the sound of the ball hitting the racket and the wall create a kind of rhythm which keeps one's timing and concentration more acute.

J. Yes. Without being able to hear the sound cues judgement and timing will probably be thrown off.

K. No. Because you are used hearing sounds.

L. Yes. I think at first I will be disoriented because concentration will be scattered but then it will become less.

M. Yes. The interference by white noise will make interpretation of the sound from the ball more difficult.

N. Yes. To a small degree. See [answer under question] number 2. Secondly, with "white noise" (as opposed to the absence of sound) there is a positive distraction which will increase the difficulty of concentration since it is somewhat natural for one to continually try to interpret any incoming sound.

O. Yes. I think there will be a marginal difference in my performance because of the white noise. It will not allow me to estimate the speed of the returning ball.

P. Yes. For the exact reason as above. I definitely think the decrease in sound will hamper my timing.

Q. Probably but the answer above plays this question also.

R. Yes. If being used for the first time will upset concentration.

4. Do you feel the absence of sound cues will cause a decrement in your performance? Why do you feel this way?

A. Yes. I feel the absence of sound cues will reduce my performance for it will be harder to time my strokes and also concentration will be affected in that it will be harder to concentrate under these conditions.

B. Yes. Same reasons as presented in question number 1.

C. Yes. Same reason [as presented in question number] 3.
D. Yes. Just summing up what I've said, the reaction will be slower as will the co-ordination between mind and body will be reduced.

E. No. It might just help my concentration!

F. No. More ability to concentrate.

G. Yes. Only in the way you hit the ball. Same as number 1 and 2.

H. Yes. Some but not very much.

I. Yes. Same as above.

J. Yes. Same as above.

K. Maybe because you might not get as good a start.

L. [Subject did not answer question.]

M. Yes. For the same reasons as above.

N. Yes. Again to a small degree—and I believe less than the "white noise." (See number 3)

O. Yes. I feel sound is important in preparing to hit a shot.

P. Yes. For the same reasons as stated above.

Q. Yes. Absence of sound will hurt and help. Hurt--because it No. is not what I am used too. Help--because I will be able to think better.

R. No. Does not effect concentration.
APPENDIX G

SKILL RATING FORM—SUBJECTIVE EVALUATION
SKILL RATING FORM - SUBJECTIVE EVALUATION

Skill Rank

Name ___________________________ Date __________ Evaluator _______________________

Directions: As you view this subject, indicate by a check mark (√) the description that best characterizes his performance in the categories posed below. Please keep in mind that the descriptions are characterizing general situations which would enable the development of a rank order list composed of all subjects; there may be variations from these descriptions. Consistency and control in performance are implied in the rank order.

I. Serve

1. Balance of speed and spin with controlled placement and variation
2. Slight loss of balance between speed and spin, maintains reasonable placement and variation
3. Emphasis on speed, spin inconsistent and irregular placement
4. Moderate speed with lack of spin and irregular placement
5. Lacks speed and placement

II. Forehand Drive

1. Low, but slightly lifted, deep with control and pace
2. Medium lift, deep with reasonable control and some loss of pace
3. Medium to high, deep with fair control and lack of pace
4. Low to high and lands in mid-court with minimal control
5. Low to high and lacks speed and control

III. Backhand Drive

1. Low, but slightly lifted, deep with control and pace
2. Medium lift, deep with reasonable control and some loss of pace
3. Medium to high, deep with fair control and lack of pace
4. Low to high and lands in mid-court with minimal control
5. Low to high and lacks speed and control
IV. Volley

1. Reasonably close to net, meets ball in front of body with a block or punch forcing it well angled, with good control to the baseline

2. Fairly close to net, meets ball in front of body with a crisp stroke forcing it well angled with control, but somewhat short of baseline

3. Medium distance from net, increased backswing and decrease in angle of return, somewhat short of baseline

4. Medium distance from net, increased backswing, poor angle of return, lack of depth and control

5. Great distance from net, full backswing, poor angle of return, lack of depth and control

V. Smash

1. Gets into proper position quickly, waits for the right moment and plays shot with decisiveness and control

2. Gets into position quickly, but tends to rush swing resulting in occasional net balls, shot is generally decisive and has reasonable control

3. Hesitates before moving into position, swing is rushed and balls are often netted, plays shot with uncertainty and fair control

4. Slow to move into position, has difficulty in judging proper moment for ball contact and holds back resulting in a soft hit and lack of control

VI. Lob

1. Is low, softly pushed, but clears opponent's highest reach and lands deep in court with good control

2. Is of medium height, softly pushed and lands deep in court

3. Is of medium height, softly hit, lands short of the baseline

4. Is high, hit forcefully and lands deep in court

5. Is high, hit softly and lands in mid-court
VII. Ability to Move

1. Good stroking position, is alert, quick to react, and continually moving
2. Gets into proper position quickly, slight interruptions in moving
3. Average in ability to move
4. Frequently caught flat-footed, slow in moving, which has some affect on stroke production
5. Very slow in moving, greatly affects stroke production

VIII. Concentration

1. Complete focus on game situation, not affected by game pressure, well disciplined
2. Occasionally focus is distracted by adverse situations, reasonably well disciplined
3. Average tendency to let thoughts wander from the court and game situation
4. Frequently distracted and functions ineffectively under game pressure

IX. Motivation

1. Determination to win by giving an all-out-effort
2. Determination to win, but infrequently lacks quality of an all-out-effort
3. Desires to win, but puts forth average effort
4. Would like to win, but frequently lacks effort and drive
5. Would like to win, but lacks effort and drive
APPENDIX H

AUTHORIZATION FOR A MINOR TO SERVE AS A SUBJECT IN RESEARCH

CONSENT TO SERVE AS A SUBJECT IN RESEARCH
I authorize the service of ________________________________
as a subject in the research investigation entitled: The Effects of
Reducing and Masking the Auditory Cues Accompanying Performance of
Select Gross Motor Tasks on the Performance of Those Tasks.

The nature and general purpose of the experimental procedure
and the known risk has been explained to me. I understand that
_____________________________ was given a pre-service explanation
of the research and that he has agreed to serve. Further, I understand
that he may terminate his service in this research at any time he so
desires.

I understand the known risk is: the hearing of white noise
between approximately 84 and 93.5 decibels to mask the sound cues in
the performance of tennis tasks for two sessions: (1) three trials of
three minutes duration each and (2) a fifteen minute trial. The
standardized permissible limits of noise as specified by the Walsh-
Healey Public Contracts Act are accompanied by length of time for which
they may be safely used. Permissible noise exposure for 93.5 decibels
is between four and six hours per day.
I understand also that it is not possible to identify all potential risks in an experimental procedure, and I believe that reasonable safeguards have been taken to minimize both the known and the potential but unknown risks.

Witness ___________________________ Signed _______________________
(Investigator) (Subject)

Signed __________________________
(Parent or Guardian)

Date ____________________________
RESEARCH INVOLVING HUMAN SUBJECTS

CONSENT TO SERVE AS A SUBJECT IN RESEARCH

I consent to serve as a subject in the research investigation entitled: The Effects of Reducing and Masking the Auditory Cues Accompanying Performance of Select Gross Motor Tasks on the Performance of Those Tasks to be performed by or under the supervision of Ethel Docherty.

The nature and general purpose of the experimental procedure and the known risks involved have been explained to me by Ethel Docherty. She is authorized to proceed on the understanding that I may terminate my service as a subject in this research at any time I so desire.

I understand also that it is not possible to identify all potential risks in an experimental procedure, and I believe that reasonable safeguards have been taken to minimize both the known and the potential but unknown risks.

Witness____________________       Signed__________

(Investigator) (Subject)

Date________________________
APPENDIX I

PHOTOGRAPHS OF EXPERIMENTAL APPARATUS
PLATE I

TAPE RECORDER BACK PACK, ATTENUATING HEADSET,
ATTENUATING EAR MUFF, AND MODIFIED EAR MUFF
TAPE RECORDER
BACK PACK

ATTENUATING HEADSET
ATTENUATING EARMUFF
MODIFIED EARMUFF
PLATES II, III, IV, AND V

EXPERIMENTAL APPARATUS AS WORN BY A SUBJECT
PLATES VI AND VII

ATTENUATING HEADSET AS WORN IN A PERFORMANCE
BIBLIOGRAPHY

A. BOOKS


---


B. PERIODICALS


C. UNPUBLISHED MATERIALS


D. PUBLICATIONS OF LEARNED SOCIETIES


E. OTHER SOURCES

Personal interview with Dr. John Hendrix, The Ohio State University, February 15, 1972.


Letter from Chet Murphy, Tennis Coach, University of California, Berkeley, California, May 12, 1972.