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The Effect of Tonal Proximity upon the Memory of a Set of Tones

William M. Walters Jr.
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To the Graduate Council:

I am submitting herewith a thesis written by William M. Walters Jr. entitled "The Effect of Tonal Proximity upon the Memory of a Set of Tones." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

William H. Calhoun, Major Professor

We have read this thesis and recommend its acceptance:

Robert G. Wahler, H. M. B. Hurwitz

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

September 10, 1968

To the Graduate Council:

I am submitting herewith a thesis written by William M. Walters, Jr., entitled "The Effect of Tonal Proximity upon the Memory of a Set of Tones." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

William H. Calhoun
Major Professor

We have read this thesis and recommend its acceptance:

Robert D. Wahler

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Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

THE EFFECT OF TONAL PROXIMITY UPON THE MEMORY OF A SET OF TONES

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

William M. Walters, Jr.

December 1968

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ABSTRACT

The purpose of the present study was to investigate the characteristics of music to which people respond. Ortmann's finding that the songs of Schubert, Schumann, Brahms, and R. Strauss are characterized by more frequent use of smaller intervals implies that small intervals are more typical in western music.

In Experiment I random sets of notes were played by the experimenter on a toy xylophone, and the subject was asked to reproduce the set on an identical instrument. The results were that subjects were generally capable of finding the correct notes, but this ability declined as the size of the set increased.

Experiment II was completed in order to discern the effect of interval size upon the memory of a set of notes. Four sets of numbers were constructed, with each number referring to a key on the experimenter's xylophone. The intervals within the four sets were 0-1, 1-2, 2-3, and 3-4.

The data were not completely consistent; however, the results tended to support the contention that as interval size increases, the level of performance declines. Subjects also tended to restrict the range of their responses. The conclusion was that the subjects tend to prefer smaller intervals because they are more characteristic of the music to which they are accustomed.

Attempts were made to explain the inconsistences of the data and to relate the results to Bartlett's theory of mind.

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I. INTRODUCTION

Robert Lundin pointed out in a recent book (1967) that most contributions to the field of the psychology of music have been of a subjective sort. The major authorities in this area have approached music from a mentalistic point of view and have generally shunned an objective, behavioristic approach. Lundin further states that musicians themselves seem to be the main perpetrators of this view, seeing their art as spiritual and unmeasurable. They argue that since music is a product of the very "soul of man," it does not lend itself to scientific investigation. Lundin attempted to show that an objective psychology of music is possible. In his book, he reviewed numerous studies which were presented as examples of this approach. The present study also follows this principle.

The present study will attempt to study some of the characteristics of melodies which influence the perception of them. Since music is made up of temporally arranged stimuli, the perception of a musical phrase presupposes a memory element. That is, the comprehension of a musical phrase involves that one must be able to recall the temporal sequence of the notes. In the present experiment the characteristics of melodies are studied in a memory task.

In a theoretical paper, Hirose (1936) concluded, concerning perception of music, "At first mere movement is heard in a succession of tones, then a form of movement is perceived, and after this stage the perception of the relative position of each tone appears." One could predict from this theory that people would remember the pattern of a series of notes before they would remember the exact position of the specific notes.

In an early study Ortmann (1933) used a piano to play short musical compositions, and students were then asked to draw the shape of the melodies on "printed forms." He does not specify whether these forms were printed with musical staffs. It was found that the students, even though they missed the precise position of the notes, were able to reproduce correctly the general progression of the melodies. As Ortmann states, "ascent remains ascent, descent remains descent."

Burroughs and Morris (1962) attempted to teach a simple melody to their subjects. They played the melody and the subjects were asked to sing it. After eight trials, very few subjects had learned the melody, and there was no regular or continuous improvement. A factor analysis of the data showed that the factor which accounted for most of the variance in the early trials was "memory for melody." This factor was mainly concerned with memory for pitch, but memory and immediate recall for auditory experience also was involved. As this factor dropped out the next factor that was prominent was "recognition for musical shape," and was mainly weighted on the intensity and harmony aspects of the music. This factor increased steadily during the task.

Hirose's contention seems to be supported by the Ortmann finding that students were able to draw the general shape of the melodies, but were unable to reproduce the exact position of each note. This theory is further substantiated by the results of the Burroughs and Morris factor analysis when the major factor after general memory was concerned with recognition for musical shape.

Hirose's theory, therefore, seems to be supported by data. The theory, however, does not account for the fact that some melodies are easier to remember than others. Most of the studies done in this area have utilized the tonal memory test from the <u>Seashore Measures of Musical Talent</u> (Seashore, Lewis, and Saetveit; 1939). In this portion of the Seashore battery, subjects are asked to listen to a series of notes. The series are of varying lengths. Each series is played regularly, and then one of the notes in the series is altered. The subject's task is to indicate which note has been altered. With this method the average person's tonal memory span is about five or six notes.

The span for notes can be increased. O'Brien (1953), using an extended Seashore technique, found that music students could pick the altered note from a series of 10 or 12. It is also interesting to note that the Kwalwasser-Dykema and the Drake music tests of tonal memory also use the Seashore technique, but instead of using a series of random notes, they use small portions of traditional melodies and folksongs. Lundin (1967) reports that a tonal memory span of 10 or 12 notes is typical with these tests.

The question, therefore, arises as to what are the characteristics of melodies that cause them to be more easily remembered than a random series of notes, and why music students are able to remember even a random series easier than others who have not had the benefit of musical training.

Possibly these data show that the crucial aspect of listening to a melody is the pattern which the notes follow. According to Hirose (1936) a major aspect of the perception of a musical phrase is the "form of the movement" or the pattern of the notes.

It would seem that one's experience with occidental musical tradition enables one to discern these patterns easier. In reference to the music students, as one obtains more experience with sundry musical patterns, the easier it will be to remember new phrases, even random series of notes which are not in the traditional western musical culture.

These data could be explained other ways. One could argue that the music students merely had extended their memory spans through training and that patterning was not a factor. It could also have been true that the altered notes in a melody might be conspicuous because of the traditional relationships between the notes in a melody. An experiment was done recently that may help to clarify this point. Pinkerton (1956) studied a book of nursery rhymes and found the probability of each note following another. Based on these probabilities, he was able to construct melodies that sounded very much like traditional western music. Therefore, to the extent that these nursery songs are exemplary of our musical tradition, one may be able to perceive the altered note in a melody because the probability of one note following another is not random in our music.

The present study is an effort to discover what it is that subjects remember. If it is true that the patterns one is familiar with influence one's ability to remember melodies, then we must first attempt to find the characteristics of the patterns most prominent in Western music.

Chandler (1934) argues that propinquity is the first characteristic of occidental music. He proposed that a progression of tones proceeding from one note to another by small intervals is more coherent and unified than a series with larger skips. Ortmann (1926) studied 160 songs by Schubert, Schumann, Brahms, and Richard Strauss. He found that the most common intervals in over 95 per cent of the songs were unisons and seconds. In general, he found that the order of intervals closely resembled the order of frequency. In 60 per cent of the songs the most frequent intervals were unisons and seconds, intervals of thirds next more frequent, and intervals of fourths next most frequent.

It would seem, therefore, that for people with a western musical background, an otherwise random series of notes would be easier to remember if they consisted of small intervals than if they were separated by larger intervals. Van Nuys and Weaver (1943) tested part of this conjecture by presenting music students with melodies of varying complexity through a tachistoscope. The subject was allowed to look at the melody for 2.8 seconds, and then was asked to play it. They found that as the melodies became more complex and as the intervals between the notes increased, they were more difficult to remember. These results may not be very generalizable, however, because of the extremely select nature of the subjects and the mode of stimulus presentation. They may not even relate to the present question because of the difference between visual and auditory memory.

The Seashore technique was not used because of experimental findings which cast doubt upon its validity. Guilford and Hilton (1933), using psychophysical methods and concentrating on one note at a time, found that altering one note in the Seashore test influences the perception of the other notes in the series. A recent finding (Mikkonen, 1965) has shown further that interpolated pitches affect the perception of memorized tones. A new method was therefore proposed. It was reasoned that the poor performance of the subjects in the Burroughs and Morris (1962) study was primarily due to the fact that they not only had to remember the shape of the melodies, but also had to have perfect pitch.

In the present experiment an attempt was made to limit the almost infinite gradation in pitch of which the human voice is capable by using toy xylophones for presenting the stimuli as well as for the subject's responses. Because of the novelty of the experimental apparatus a preliminary study was done to test the subjects' ability to deal with the xylophones. Another purpose of the preliminary study was to develop methods of summarizing the data.

A final purpose was to seek evidence that would support the hypothesis that people tend to utilize patterns when attempting to remember a series of notes. This study is labeled Experiment I.

II. EXPERIMENT I

Method

Subjects. Ten University of Tennessee undergraduates (4 males and 6 females) were used in the study. The subjects participated to fulfill part of a requirement of an introductory psychology course in which they were enrolled.

Materials. Two identical toy xylophones of 10 keys each were used in the study. One of the xylophones was used by the experimenter and the other by the subject. The instruments consisted of the C-major scale plus a repetition of the first three notes. The keys on the experimenter's instrument were numbered from one to 10. Twenty sets of random numbers were generated for each subject. The sets ranged in length from one to 10 units with two sets at each length. Each random number referred to one of the numbered keys on the experimenter's xylophone.

Procedure. The subject was first presented with the toy xylophone and asked to familiarize himself with the sounds of the various keys. The experimenter then played a series of the random notes twice and asked the subject to repeat those notes. The stimuli were timed by a metronome so that the notes were presented at a constant rate of 40 per minute. The metronome was stopped while the subject attempted his response. The subject was cautioned not to look when the experimenter produced the stimuli and sat facing away from the experimenter's xylophone.

Results

The crucial result of the first study was that the subjects could generally find the notes that were played by the experimenter. When only one note was presented, the subjects were able to find that note correctly 70 per cent of the time. Eight out of 10 subjects were correct the first time they were presented with one note and six out of 10 the second time. An inquiry performed after the experimental task revealed that the subjects came from wide ranging musical backgrounds and that musical training is not required for this task. The results also seem to imply that perfect pitch is not necessary.

In Figure 1 the number of notes that all subjects reproduced correctly over both sets at each length are shown. This curve is compared to the chance expectation of 10 per cent being correct if each note is assumed to be equally probable. One can see that as the number of notes the subject is asked to remember increases, their production approaches chance levels.

There also seemed to be a tendency on the part of many subjects to respond systematically and to attenuate the range of the stimuli. Figure 2 presents examples of this tendency. In this figure selected subjects' responses are compared to the stimuli presented by the experimenter.

The first example is from the record of Subject 3. In this case, the subject reproduced the general pattern of the stimuli, but there was a tendency to restrict the range. The range of the stimuli is from key 10 to key two, whereas the subject's responses

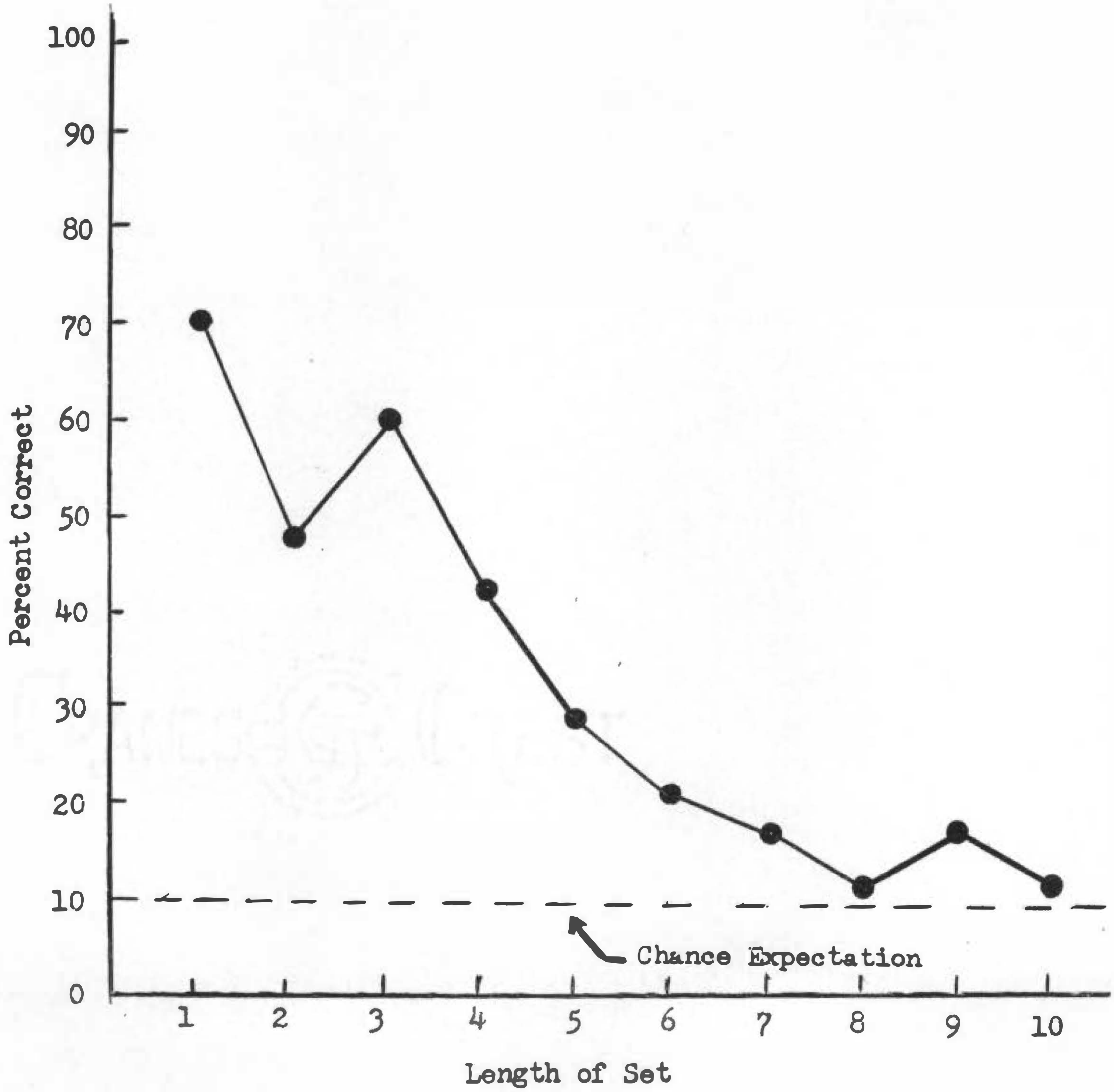

Figure 1. Graph showing percent of notes correct in Experiment I compared to chance expectation.

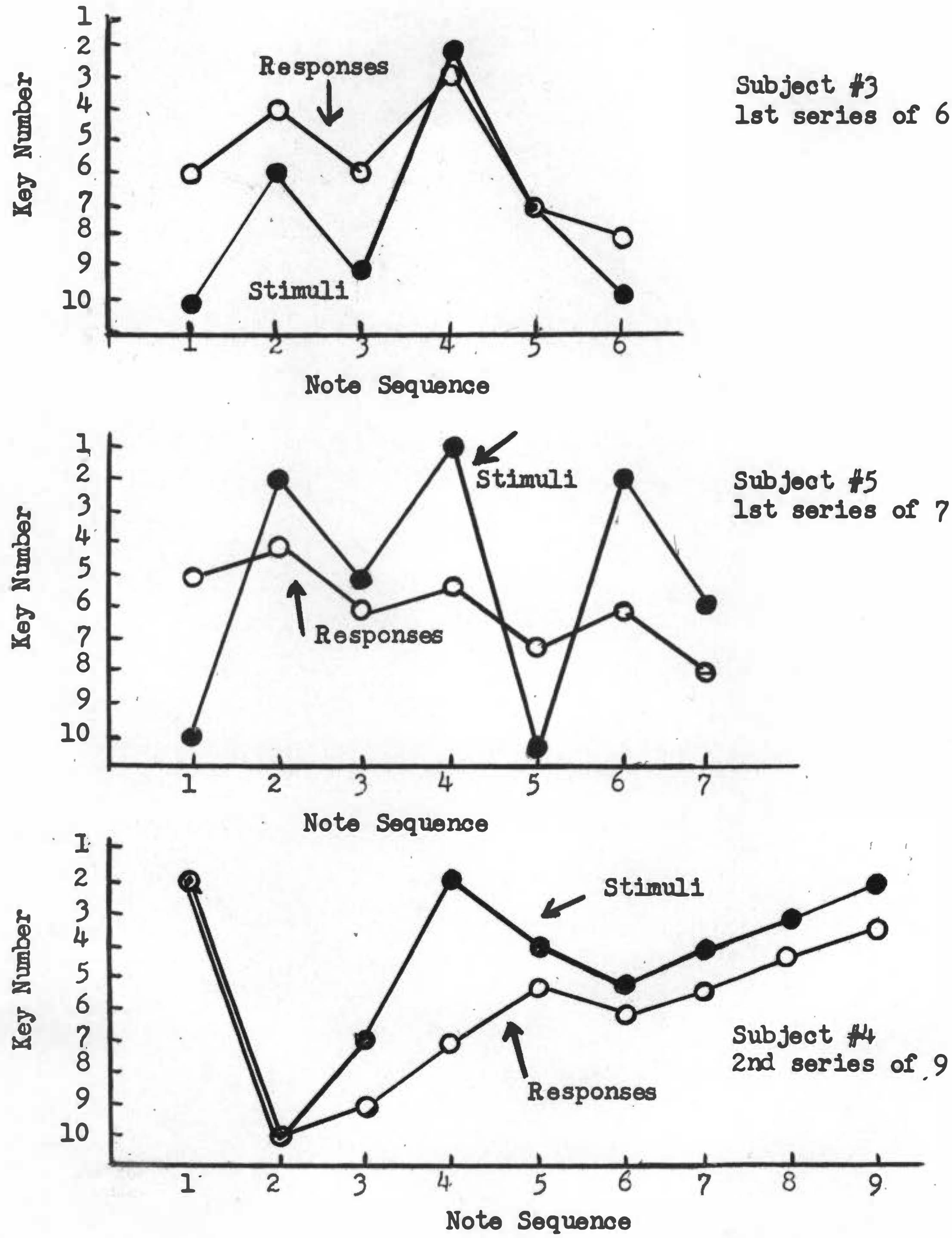

Figure 2. Graphs showing tendency for individual subjects to systemize and restrict range of stimuli.

ranged from 8 to three. The second example is from Subject 5, and the main point concerning the responses here is their regularity, unlike the irregular stimulus pattern. The third example is the second set of 9 notes from Subject 4. In this record the subject seems to attenuate the peaks of the pattern of the stimuli. There is also, in this example, a tendency for the pattern of the responses to match, in a general way, the pattern of the stimuli.

A measure of the accuracy of the subject's pattern was obtained by taking the mean of the differences between each stimulus note and the corresponding response for a given set. This mean was then subtracted from each difference, thereby obtaining an estimate of consistency. The average of these deviations from the mean difference of a set is used in data presentation. This measure is labeled the discrepancy score. Therefore, as this discrepancy score increases, the subject's pattern becomes more dissimilar to the pattern of the stimulus notes. A discrepancy score of zero indicates that the pattern of the subject's responses are perfectly correlated to the pattern of the stimuli, even though he strikes none of the correct stimulus keys.

In Figure 3 these scores have been plotted for the data and compared to the same scores from an artificial experiment in which experimental stimuli were paired with random responses from a random number table. The results indicate that as the number of notes in a stimulus set increases, the pattern reproduction of the subjects becomes more like the random group.

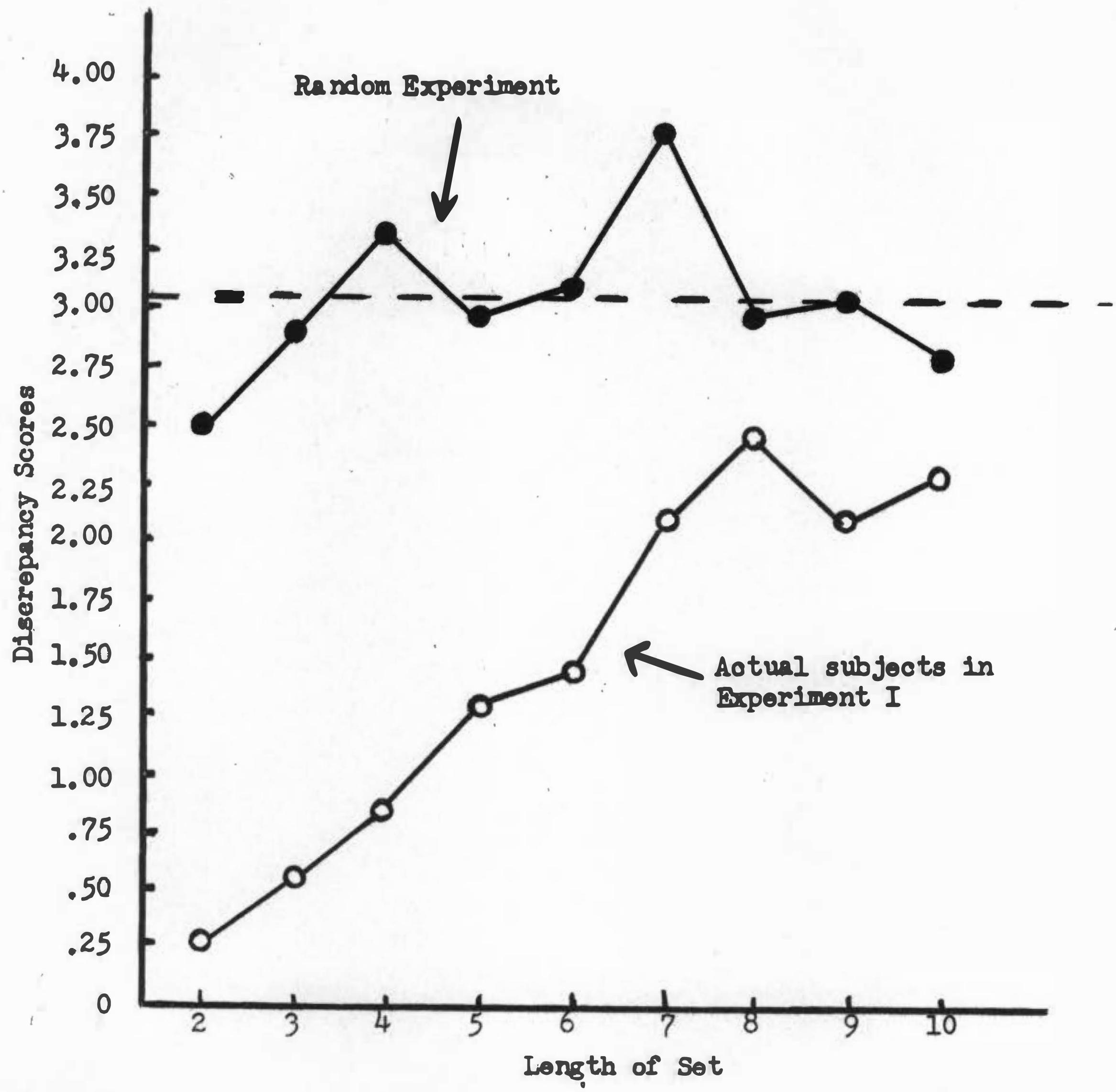

Figure 3. Comparison of discrepancy scores in Experiment II with random group.

The findings may be summarized as follows: (1) Subjects were capable of reproducing a set of notes on a toy xylophone with reasonable skill. (2) This skill decreased as the number of notes increased. (3) The responses of the subjects tended to be more systematic than the stimuli, and the subjects tended to respond within a more restricted range than was true of the stimuli. (4) When a discrepancy score was used to measure the ability of subjects to reproduce the pattern of the stimuli, it was found that as length of the series increased, the subjects' patterns became more dissimilar to the stimulus patterns.

III. EXPERIMENT II

Method

Subjects. There were 20 subjects in the second experiment (16 females and 4 males). The subjects were University of Tennessee undergraduates who participated voluntarily in order to fulfill a requirement of a course in introductory psychology.

Materials. The xylophones in this experiment consisted of 20 keys and covered the chromatic scale from A below middle C through one octave to the E of the next. Each key was numbered from one to 20 and lists of random numbers were constructed, each number representing a key to be struck by the experimenter. Four sets of numbers were constructed. The first set was random within the restriction that the difference between one number and the following number was either zero or one unit in either direction (the 0-1 group). The second set limited the differences between adjacent numbers to one or two in either direction (the 1-2 group). In the third series the differences were plus or minus two and three (the 2-3 group), and in the fourth, they were plus or minus three or four (the 3-4 group).

There were series of three lengths within each of these restrictions. The sets were of four, 7, and 10 units long. Each subject was presented with all 12 combination of lengths and restrictions (interval pairs). Different random sets were constructed for each subject. The first number in each set was, however, fixed at 10.

Procedure. The procedure in Experiment II was essentially the same as in Experiment I. The subject was first allowed to familiarize himself with the instrument by playing up and down the scale, and then the following instructions were read to all subjects:

> This is an experiment to study how people remember melodies. You will be provided with this toy xylophone. I will play a series of notes on this other xylophone, and when I finish, your task will be to attempt to reproduce the same notes on your xylophone over there. Be sure to tell me when you feel that you have found the correct notes. Since we are only interested in your memory of the sounds of the notes that I play, I must ask that you don't look while I play the notes. As an aid to help you in this task, I can tell you now that all series start on key number 10. The series will be of three lengths, four, seven, and 10 notes long.
>
> Let's try an example.

(The experimenter then played first only one key, then two keys, and then three keys until the subject was able to achieve a moderate amount of skill in picking the correct keys. Two potential subjects were unable to do this, and their data were not used in the analysis.)

> Now let's summarize. I will play some notes on this toy xylophone, and you are to remember the notes that I play and attempt to play them on the xylophone that you have been provided, and no looking. Do you understand?

After the instructions were read, the 12 series were presented to the subject at 40 notes per minute. Each series was played twice, after which the subject was asked to reproduce it as best he could. No time limit was imposed.

Results

First the effect of interval size upon the subjects' performance was determined. The prediction was that as interval size increased, the performance of the subjects would decrease. In Figure 4 the percentage of notes[1] correct are plotted over intervals with series length as a parameter. In this graph one can see that there does not seem to be the general downward trend that was predicted. At length four, there even seems to be a U-curve effect.

By counting the number of correct responses that each subject made, it was possible to test the significance of the observed differences. Parametric statistics were ruled out in this case because the data are extremely skewed, particularly at length four. The Friedman test was employed (Siegel, 1956). Using this test to compare across the four interval sizes, one obtains the following results: at length four, $\chi_r^2 = 11.16$, $p < .02$; at length seven, $\chi_r^2 = 15.405$, $p < .02$; and at length 10, $\chi_r^2 = 20.835$, $p < .001$. It is, therefore, evident that at each set length, the four interval sizes are significantly different. The curves, however, seem to imply that perhaps the main factor attributing to the significant Friedman analysis is the large difference between the intervals of 0-1 and the other three groups of notes.

[1]This measure could be criticized because it confounds subjects. However, when a correlation coefficient was computed between the number of notes correct and the number of subjects at the first presentation for the same data, the Spearman r = .964. This high correlation would imply that either measure would give essentially the same results. The chosen method is utilized because more occasions are involved and the measure is, therefore, more stable.

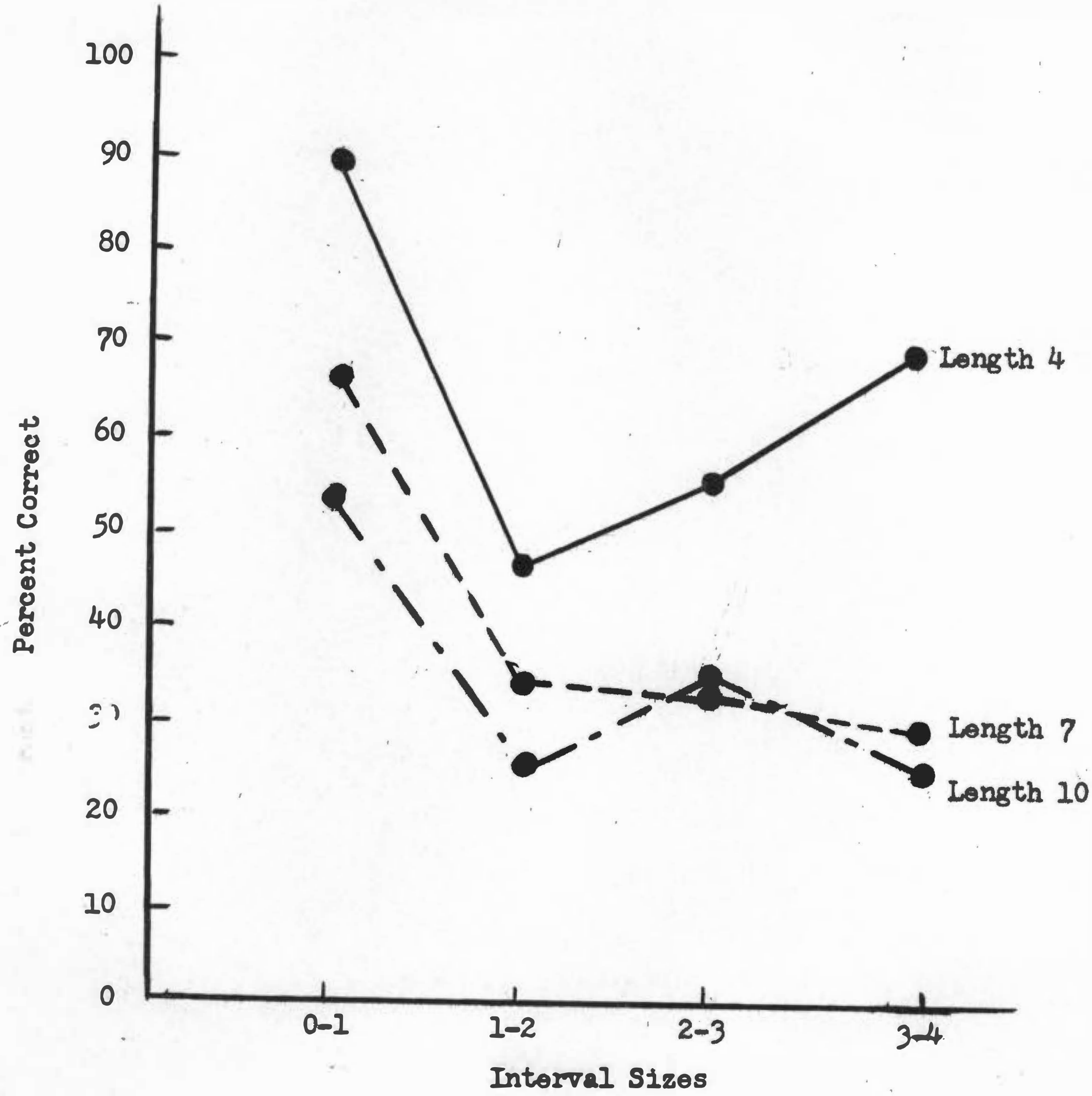

Figure 4. Percent of notes correct across interval sizes (Experiment II).

Another dependent variable relating to the present question of the effects of size of interval on performance is a count of the number of times that the subjects responded correctly to stimulus interval. For example, if the stimulus set proceeded from key 10 to key 12, the subject was given credit for a correct response not only if he struck 10 then 12, but also if he struck 7 then 9, or three then five, or even 18 then 20 because the correct stimulus interval is plus two. In Figure 5 there is plotted the percent of the intervals to which the subjects responded correctly. One can see a general trend for the subjects to become less accurate as the size of the interval increased. There is a reversal of this trend at length four when the intervals are three and four, however. Again it would seem that the main difference is between the 0-1 group and the other three groups of notes.

The distributions were again skewed, so the Friedman was employed to test the differences. Counting the number of correct interval responses for each subject, the results were at length four, $\chi r^2 = 10.905$, $p < .02$; at seven, $\chi r^2 = 28.99$, $p < .001$; and at length 10, $\chi r^2 = 30.165$, $p < .001$. All differences being highly significant, the results indicate that the groups are different within length, the major contribution to the significant χr^2's coming from the large discrepancy between the 0-1 group and the other three groups.

The second question with which this thesis is concerned is

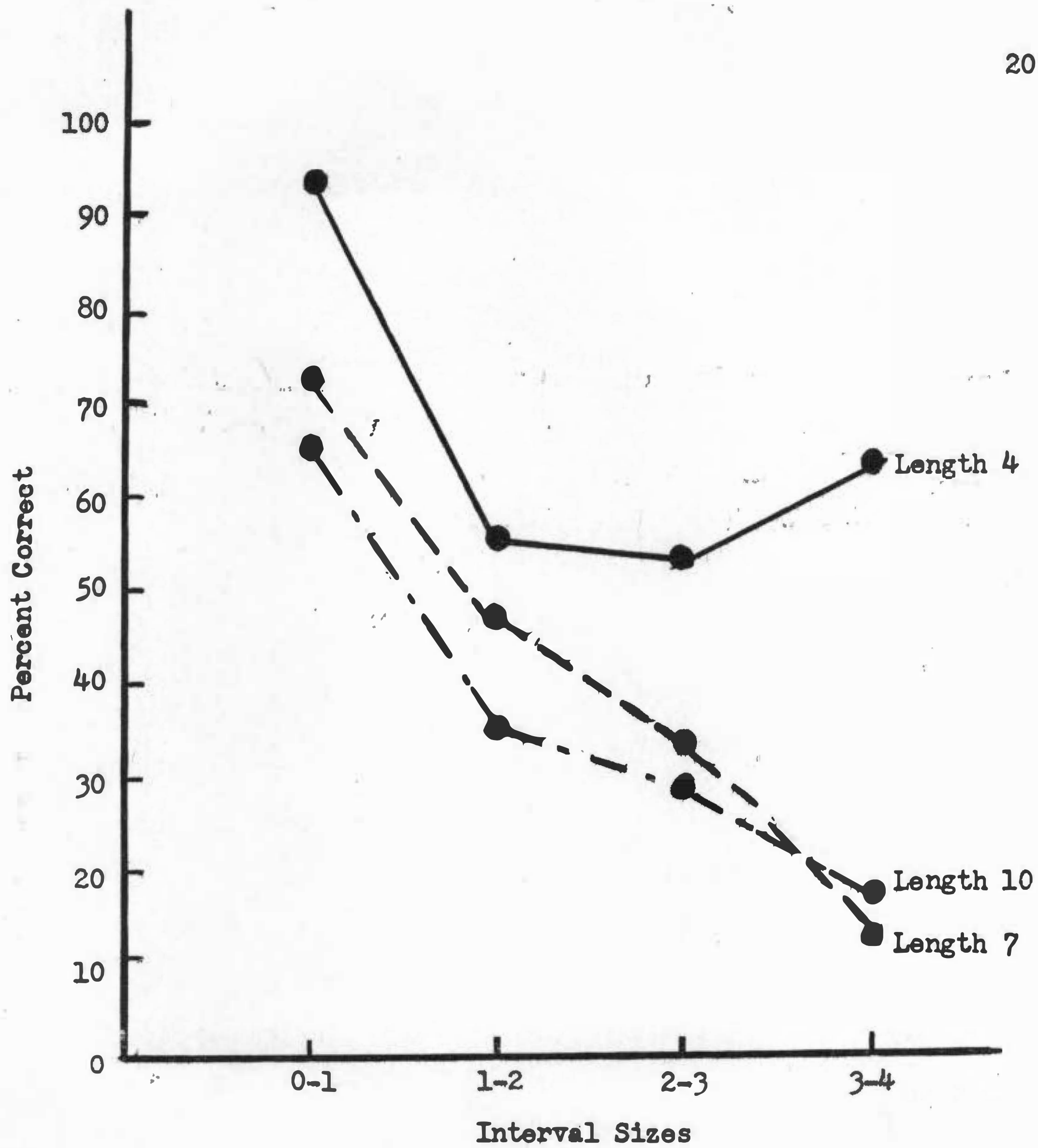

Figure 5. Percent of intervals correct across interval sizes (Experiment II).

whether there is a tendency for subjects to restrict the range of their responses. The prediction was that when the subject made an interval error, his error would tend to be an underestimate more often than an overestimate. That is, he would tend to respond more often with an interval smaller than the stimulus interval than with a larger interval. To test this hypothesis the number of subjects was counted which made more errors which were underestimates, the subjects who made more errors which were overestimates, and the number of subjects who made an equal number. Only the stimulus intervals two, three, and four were used in this analysis; the interval of zero or one was not used because of the restricted lower range. The data are presented in Table I and indicate a consistent tendency for subjects to make more errors which were smaller than the stimulus intervals. A sign test was utilized and showed that the results were significant at all three lengths.

A further hypothesis was that as the number of notes in a stimulus set was increased, the ability of the subjects to reproduce the stimulus patterns correctly would be hampered. For this question the discrepancy measure developed in Experiment I was utilized. In Figure 6 these scores are plotted across all intervals and lengths. The trend seems to be that as the number of notes increases, there is a tendency for the subjects to miss the stimulus pattern. There is the consistent reversal at length four when one reaches the 3-4 intervals.

TABLE I

NUMBER OF SUBJECTS RESPONDING WITH AN INTERVAL LARGER AND SMALLER THAN THE STIMULUS INTERVALS AND THE PROBABILITIES OF THESE PROPORTIONS BEING DUE TO CHANCE. (EXPERIMENT II).

Length	Subjects Making Majority of Errors Smaller Than Stimulus Interval	Subjects Making Majority of Errors Larger Than Stimulus Interval	Subjects Making Equal Number of Errors Large and Small	p of Sign Test
4	11	2	7	.05
7	18	1	1	.01
10	17	3	0	.01

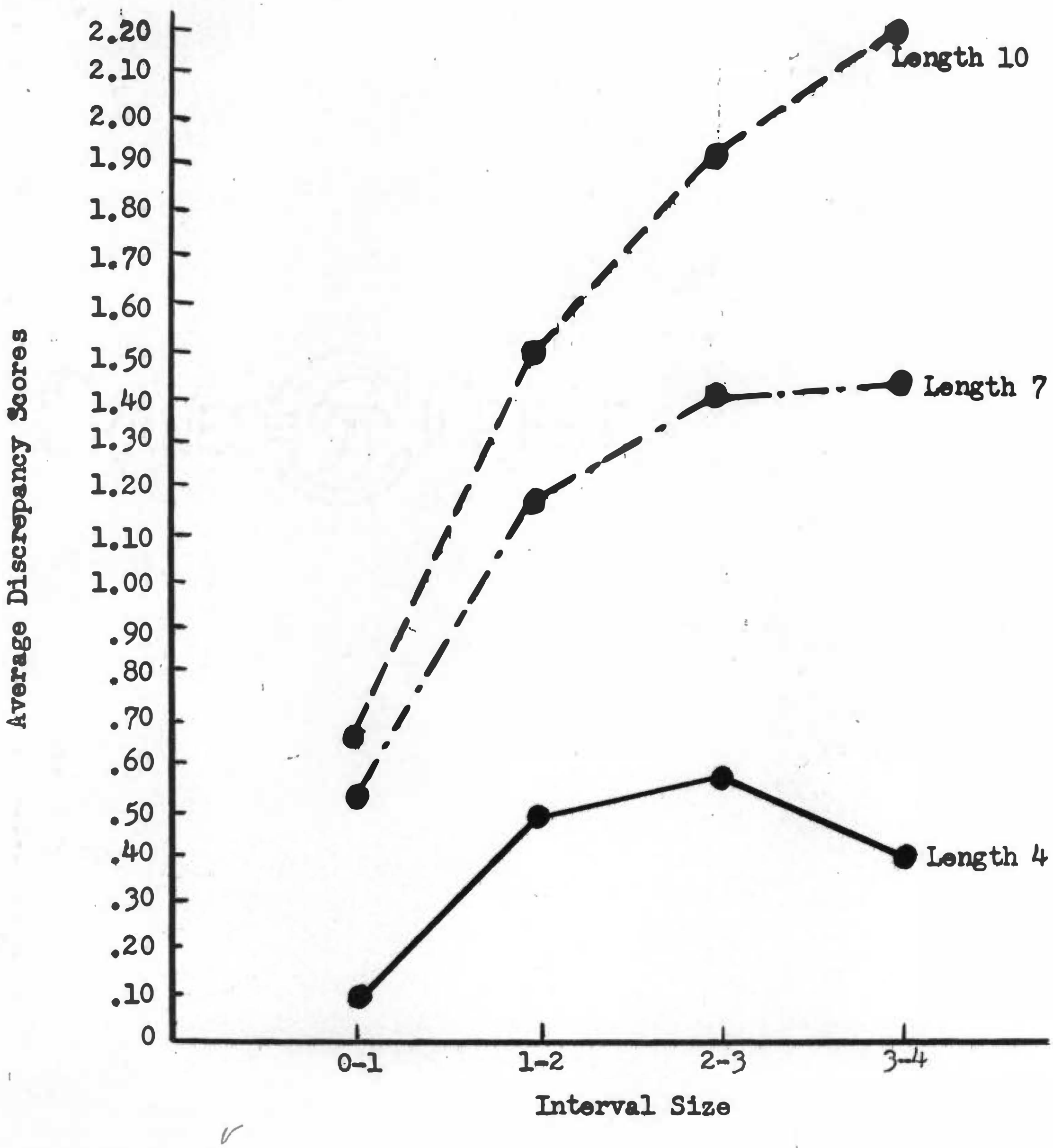

Figure 6. Graph showing discrepancy scores of subjects in Experiment II across lengths and interval sizes.

An analysis of variance was utilized to test the significance of these differences. The results of this analysis are presented in Table II. The length is highly significant, showing that accuracy of reproduction is related to length. It is clear from the data in Figures 1, 4, and 5, pages 10, 18, and 20, respectively, that the errors increase directly as a function of length. Also the interval effect is significant indicating that the observed relation in Figures 4 and 5, pages 18 and 20, respectively, is reliable.

In any repeated measures analysis of variance, stringent assumptions are required (Winer, 1962). When the conservative F test of Greenhouse and Geisser (1959), which avoids these assumptions, is applied to the data, the significant interaction reported in Table II no longer holds whereas the treatment effects are still significant. Therefore, the best conclusion which can be drawn in this case would be that there are significant differences between intervals and lengths, but that the interaction effect is probably not significant.

TABLE II

ANALYSIS OF VARIANCE OF MEAN DEVIATIONS ACROSS INTERVALS SIZE AND LENGTHS (EXPERIMENT II)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	205.15	239		
Between S_s	24.03	19	1.26	
Between Cells	89.05	11		
Between Lengths	51.27	2	25.64	58.14
Between Intervals	28.16	3	9.39	21.33
Interaction	9.62	6	1.60	3.63
Error (within)	92.07	209	.441	

All F's significant, $p < .01$.

IV. DISCUSSION

The data seem to generally support the conjecture that patterns with smaller intervals are easier to recall than patterns with larger intervals. The data are not entirely consistent, however. The fact that the differences are significant does not mean that there is a systematic effect of the size of the intervals over the subjects' ability to reproduce the stimulus sets correctly. There is a general trend in that direction, but there are consistent reversals at length four. Perhaps this means that when a set of notes is within the memory span, that notes which are farther apart in pitch are easier to remember because they sound unnatural and are recalled because they are so different from that with which one is familiar.

The data concerning this question could also be criticized by arguing that the 0-1 set of notes is not comparable to the other three because perceiving that a note has changed is a different and probably less difficult task than attempting to discern how much it has changed. This argument could explain why the subjects consistently made less errors in the 0-1 set across all measures, and by a wide margin. The results do seem to indicate, however, that the general trend is in support of the conjecture that smaller intervals are easier to recall.

The first clear-cut result of the study is that subjects generally tend to attenuate the peaks of the stimulus patterns.

There is more than one possible interpretation of this result, the most simple one being that the data is merely an example of regression toward the mean. This possibility is not seen as being adequate to explain the data, however.

A more complex interpretation could be that the subjects' experience with western musical culture established within them a set for the smaller intervals. It almost seems as if the subjects preferred the sets containing small intervals and when the stimulus patterns were large, the subjects perceived them as being smaller. The sets were, therefore, under this interpretation, conceived as being more similar to traditional western music.

The finding that subjects tend to produce patterns that are dissimilar to the stimulus patterns as the number of notes to be remembered increases may be related to the finding of the preliminary study that as the length of the series goes beyond seven or eight notes, the patterns of the subjects approach randomness. This limit of seven or eight notes could be related to George Miller's "magical number seven, plus or minus two" (Miller, 1956) as the human memory span. The mean deviations in Experiment II never, however, reached the level of the data of Experiment I. This could either be due to the limited intervals in Experiment II or to the effect of fixing the first note of each set.

The basic point that all the data seem to point to is the influence of patterns upon our perception of musical type stimuli.

Since Ortmann has shown that our traditional music has a tendency to use smaller intervals, these results seem to indicate that our perception of music is strongly colored by our heritage of western music. This conclusion may seem obvious to the reader, but it is the author's contention that the implications are not so obvious.

To the present author these results imply that the human mind is an active organ. It doesn't passively wait for stimuli and then react to them; it seeks out and actively restructures what it finds. This restructuring is toward a semblance of order. The subjects in the present experiment acted upon the stimuli. One could even say they attempted to make music out of the stimulus sets by trying to make the intervals more like the music with which they are familiar.

This contention is similar to the conclusions reached by Sir Fredrick Bartlett during the earlier part of this century (Bartlett, 1932). Bartlett's work on memory lead him to the following conclusion:

> Remembering is not the re-excitation of innumerable fixed, lifeless and fragmentary traces. It is an imaginative reconstruction, or construction, built out of the relation of our attitude towards a whole active mass of organized past reactions or experience, and to a little outstanding detail which commonly appears in image or in language form.

It is interesting to note Bartlett's finding that when British university students were asked to recall stories, their recollections were transformed to make them more coherent and more in keeping with

English speech patterns, customs, and values. This result is comparable to the tendency of the subjects in the present study to attempt to make the stimulus sets more similar to the music to which they are accustomed.

The results of this study do not imply in any way that tonal proximity is the essence of great music. The conclusions of this study are simply that subjects tend to prefer smaller intervals because this is apparently what they are familiar with, and therefore find easier to remember. It should be noted, however, that memory for melody is a necessary, but not sufficient condition for the appreciation of melody.

The conclusions of this study are, of course, tentative. Before these results lead to the conclusions, it must be shown that music which is outside the tradition of occidental musical culture is not characterized by small intervals as Ortmann (1926) found was true of western music. That is, until it is shown that small intervals are specific to western music, the conclusions of this thesis are merely suggestive.

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