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A developmental study of temporal judgment

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CHAPTER I

INTRODUCTION

> The American people are growing up, in the most literal sense. The average age level is rising steadily and the proportion of older people is increasing with equal constancy. Since 1900, the population of the United States has doubled, the number of persons aged 45 to 64 has tripled, and the number 65 years and older has quadrupled (Tompkins, 1955, p. 1).

Today there are an estimated 13.3 million persons over age 65 living in America (U.S. Bureau of the Census, 1954). It is predicted that by 1975 over 11 per cent of America's adult population will belong to the over 65 age group (U.S. Bureau of the Census, 1947, p. 49).

Due to better nutrition, advances in medical care, and improved conditions of living and working, average life expectancy has increased by 75 per cent over the past century (Tibbetts & Donahue, 1960). "But while medical science has been increasing the relative number of old people, society has been progressively reducing the social and economic functions of the aged" (Tompkins, 1955, p. 1).

The elderly have always been with us, but it is only within the past twenty years that they have come to be regarded as "problems." The increase in the number of persons over age 65 in the population is not solely responsible for the change in attitude toward the generation at the upper

end of the continuum in our three-generational society. Blame for the fact that the elderly have come to be regarded as problems is generally laid on the doorstep of the nation's shift from a predominantly rural society to an urban society, with its concommitant restrictive housing arrangements. The average two or three bedroom suburban house cannot easily absorb an aging parent or other relative, without resulting friction between the generations, as did the large rambling farmhouses of a predominantly rural America of a generation ago. Changing economic conditions share the responsibility. An average retirement income planned for fifty, or even twenty, years ago is not adequate to meet the high costs of living and of medical care today. These problems are intensified when an unexpected bonus of five or more additional years is added to the lifespan.

The "problem of the senile aged is actually a small part of the larger problem of the aged today" (Tompkins, 1957, p. 1), but the following statistics show that it ranks as "Serious" on the scale of problems of the elderly.

The 1935-36 National Health Survey estimated that 68 persons out of every 100,000 were disabled by senility (National Conference on Care of the Long-Term Patient, 1954a). The senile mentally ill constituted about 17 per cent of the population in California state hospitals in

1950 (National Conference on Care of the Long-Term Patient, 1954b); and over a third of all patients cared for in California county hospitals that year were senile (California Governor's Conference on the Care and Treatment of Senile Patients, 1950).

"Today one third of all persons entering state mental hospitals for the first time are sixty years of age and over. Even more striking, the median age of all psychotic first admissions is about sixty-one years" (Barron, 1961, p. 50). "Thirty per cent of all patients in American mental hospitals are more than sixty-five years of age" (Barron, 1961, p. 90).

The assumption that the mental disorders of old age are the results of the inevitable breakdown of the human organism is being replaced by the belief on the part of sociologists and psychologists that the social experiences of the aged, such as loss of status and isolation, are chief contributors to the development of the disorders. It is also becoming increasingly clear that many aged persons who are not mentally ill are being placed in mental institutions by their own families, who cannot or will not care for them, and by county or state agencies who have no alternative facilities for their care. In institutional terminology aged persons in this category have come to be classified as "Harmless Seniles."

The senile are aged persons who manifest one or more of such symptoms as childishness, irritability, and forgetfulness. They are often mildly depressed, careless about toilet habits and personal cleanliness, restless at night, and temporally disorganized. Since the amount of disturbance is a matter of degree and may involve one or all of the foregoing symptoms, no specific definition of senility is commonly accepted. That senility is a mental rather than a physical state is agreed upon, even though it is often accompanied by and related to physical ailments, such as arteriovascular disease (Tompkins, 1955).

The arteriosclerotic and the senile are the two groups of psychoses most clearly associated with old age. There are, in addition, the involutional psychoses, often called "change-of-life psychoses" and thought to be a product of the physical changes, stresses, and anxieties that occur during the fifth and sixth decades of life (Kaplan, 1945). The psychotic aged often display the same symptoms associated with the "harmless seniles," but in addition, they are the victims of severe personality disorganization while the simple seniles are not.

I. THE PURPOSE OF THE STUDY

Temporal disorganization is a symptom of disorder manifested by both the aged psychotic and the harmless

senile. The purpose of this study is to investigate the relationship of temporal judgment, specifically the adult human's ability to judge the passage of time accurately, to chronological age. The study was suggested by a prominent geriatrician who conjectured as to whether the disability to estimate and to order time effectively was a dysfunction peculiar to senility and its related psychoses, or if, during the lifespan, there is a gradual deterioration even in normal human beings in the ability to judge time accurately.

A study conducted by Rouart (1962) in which the genesis of the earliest manifestations of time integration in infancy were traced, indicated that time disturbances point to severe psychotic illness, particularly the obsessional neuroses. In discussing the sense of time and its relation to psychiatric illness, DuBois (1954, p. 49) states that " . . . time agnosia may be an outstanding symptom in the psychoses and to a lesser degree in the neuroses where it may operate as one of the manifestations of personality disorder." He lists the organic reactions to head injury, electroshock, alcohol, drugs, fever, cerebral arteriosclerosis, and senile dementia, as physiological processes which may markedly disturb the time sense. They are capable of destroying it partially or totally. DuBois feels that time distortions are most clearly evidenced in

their relation to memory.

"Van der Horst stressed that many of the errors of memory are due not so much to loss of retention of recent events as to their temporal reference" (Birren, 1959, p. 627). The relationship between temporal disorganization and memory loss became evident to him as it manifested itself in the amnesic syndrome.

Gillespie, also investigating the amnesic syndrome, feels that the time ordering of experience may be a primary mental function (Birren, 1959). Spira (1959), working in France on time estimation, found a close relationship between time and memory, with memory, representing one of the most sublimated forms of time anxiety, being one of the ego's multiple functions.

Time, therefore, is probably not an intellectual creation; it may be, rather, an idea based on affective elements experienced since birth. Gesell and Ilg (1943) agree that awareness of time is not inherent in humans at birth--for the newborn child has no sense of duration--but is acquired by learning, ultimately becoming an integral part of the personality. The development of a subjective appreciation of time closely parallels norms of human development, with the abstract concept of time of adulthood appearing at about age 14 in the normal youngster. Lewin (1935) writes of the undifferentiated time sense of the

infant, the adolescent years when time is not well defined and seems unlimited, and the realistic awareness that comes at about age thirty that time is finite.

In a comparative study of the growth of the concept of time in normal and retarded children, Lovell and Slater (1960), using a Piaget type experiment on judgment of synchronous intervals, order of events, age, and interior time, found that with both groups there was a similar sequence in growth of the understanding of time but that the development occurs several years later, if at all, in children of below average intelligence.

Many time limits are imposed upon the human organism. Some of them are biological, such as the age of childbearing; many of them are cultural, such as the age of forced retirement. Thus, the time variable becomes more significant and more threatening at some ages than others. It also seems logical to assume that perception of time is influenced by whether the majority of one's lifetime lies ahead or in the past.

Kuhlen (Pressey & Kuhlen, 1957) believes that sensitivity to the time variable may be one of the most distinctive features in the psychology of the adult years, with changing time perspective representing one of the major variables in developmental psychology. He feels that it may be one of the most important factors distinguishing the

"psychology" of old age from that of the middle years, from that of early adulthood, and from adolescence.

The purpose of the present study is to investigate the relationship of chronological age, with the related assumptions of changing time perspectives with increasing age, to the ability to accurately estimate time. While the investigator is primarily interested in the increasing ability or disability to judge time in the over 65 age group, the entire age span of maturity must necessarily be studied to determine the presence or absence of a relationship between chronological age and temporal judgment.

II. THE PROBLEM

Statement of the problem. Using a time estimation test requiring judgment of various intervals of filled and unfilled past-time, a representative sample of normal persons, age 15 to 95 years, who are in good health and living actively in a rural community as determined by a questionnaire, were tested to determine the relationship of chronological age to the ability to judge time accurately.

The hypothesis. The ability to estimate the passage of time accurately will show an inverse relationship to increasing chronological age from about age thirty onward, the decline in ability being a very gradual one until about age eighty, when the decline in ability will decrease markedly.

III. DEFINITION OF TERMS USED

The majority of the terms requiring definition are discussed in CHAPTER III which describes the instruments used in the testing and analyzes each item included in them individually. Thus, only four terms, which do not appear in that chapter, require definition here.

Underestimation. Underestimation of a time interval is said to have occurred when a subject estimated the stimulus interval as having been shorter in duration than it actually was in standard stopwatch units.

Overestimation. Overestimation of a time interval is said to have occurred when a subject estimated the stimulus interval as having been longer in duration than it actually was in standard stopwatch units.

Empty interval. An empty interval is an interval during which neither the examiner nor the subject is engaged in a physical activity.

Filled interval. A filled interval is a stimulus interval during which either the examiner or the subject is engaged in a physical activity.

CHAPTER II

REVIEW OF THE LITERATURE

A review of the literature revealed that much attention has been given by investigators to the subject of time estimation. Comparative studies testing the differences in ability of differing age groups, males or females, normal children as opposed to retarded children, have been made. The differences between subjects' objective and subjective estimates of time have been investigated. The effects of various ongoing activities on the subjects' ability to accurately estimate time have been examined; and related were the studies examining the differences in temporal judgment of filled and empty intervals. Estimation of short intervals of fractions of a second, involving the interval of indifference, and long intervals of an hour or more have come under the scrutiny of investigators. Accuracy of estimation of past-time as opposed to present-projected time has been compared. Many studies have been done on the young child's ability to judge time under various conditions; and many investigations concerning the relationship of psychopathology to time perception have been conducted in mental institutions.

In view of the mass of data which has been gathered on time estimation, only those studies directly pertinent

to the present investigation will be reviewed.

I. TIME ESTIMATION LITERATURE

In a study made by Loehlin (1959) to determine what different kinds of influence the contents of time intervals have on the apparent duration of the intervals, it was found through factor analysis of time estimates made under a variety of conditions that the main variables contributing to the apparent length of the time intervals appeared to be: (a) interest vs. boredom, (b) filled vs. empty intervals, (c) repetition of an activity, (d) activity vs. passivity.

Axel (1924) felt that both boredom and the attention-to-time dimension were responsible for overestimation of activities of a repetitious sort (tapping and writing i's).

In reviewing the literature it was difficult to draw a distinction between those studies which were investigating filled vs. empty intervals, per se, and those concerned with activity vs. passivity. As pointed out by Clausen (1950) an interval considered empty by an investigator may be filled with fantasies or memories of a subject which are far more interesting to him than any task designed to fill an interval could be. There was much overlap in material. Swift and McGeoch (1925), in a study to determine the general, individual, and sex differences in the estimation of

filled and unfilled intervals, ranging in time from thirty seconds to ten minutes, found that short intervals (thirty seconds to five minutes) both filled and unfilled are overestimated by men and women irrespective of age. They also found no consistent difference between estimates of empty time and the same interval filled with copying uninteresting material. As the interest content of the filled intervals increased, however, estimations of time decreased; and it was concluded that intervals filled with a physical activity, even an uninteresting one, seem shorter than empty intervals (with one exception, which will be discussed later). Gullicksen (1927) corroborates their findings using intervals ranging from complete rest (empty) to the working of difficult division problems. He also found evidence that the difficulty of the task involved affects the estimation of time, intervals occupied at solving the more difficult tasks tending to be underestimated. The findings of Harton's study (1938) requiring easy and difficult weight discriminations concur. Reutt (1959), using children 11 to 15 years of age as subjects, found concurring evidence that physical activity produces low time estimates; but her evidence does not support level of interest as a main variable affecting time estimation, as the time intervals during which the children were being read an interesting story were overestimated.

It seems necessary to digress momentarily to discuss a finding referred to earlier and which again appeared in the Reutt study. Listening to a story being read is considered a filled interval, but it is not an interval involving physical activity (it is passive); yet Swift and McGeoch (1925) found such intervals to be consistently overestimated as did Reutt. Two other studies (Sturt, 1923; Spencer, 1921) in which subjects were required to estimate time spent reading aloud give supportive evidence to the finding that reading, either silently or aloud, produces overestimates. It was expected by investigators that reading aloud, which requires motor participation, would produce underestimates. In discussing this phenomenon, Loehlin (1959) offers two hypotheses: (1) that reading does involve a passive element in that the author has already decided what action will take place, and, (2) the time scale is generally condensed in a literary narrative.

To return to discussion of Loehlin's main variables, pertinent to the variables of activity vs. passivity is a study by Goldstone, Boardman, and Lhamon (1958) in which it was demonstrated that the length of the subjective second was directly proportional to the amount of motor participation involved. Estimates made while counting seconds aloud, with their accompanying kinesthetic cues, as compared to counting seconds silently were much more accurate. However,

counting aloud, which certainly involved more muscle activity than the subvocalization of silent counting, resulted in significantly longer estimates of a second, which is contradictory to findings of several previously discussed studies.

Loehlin also mentioned that time may seem long if a person is passive and related passivity to life activity. A study by Wallach and Green (1961) investigated the cultural adage "time seems to go faster if we are busy; slower if we are idle," by testing younger and older adults on the Knapp time metaphor test on the subjective speed of time. It was found that though the older adults' level of activity had decreased, their value of time had increased, the older persons considering swift metaphors more appropriate for describing time than static ones. Kluckhohn (1954) feels that in some cases activity and the value of time are closely related and contrasts the hasty conception of time of urban middle-class American adults with the slow conception of time of the Spanish-Americans of the Southwest. She observed that time seems to become more precious and pass more quickly when it is filled with the frantic activity common to middle-class urban Americans. Hall (1959) made a similar observation.

In another experiment (Knapp & Garbutt, 1958) using the Knapp time metaphor test, the hypothesis that high and

low need for achievement influences a person's value of time, was supported. It was found that persons high in need achievement used swift metaphors to describe the passage of time as opposed to slow metaphors used by low need achievers. The investigators pointed out that it is the high need achiever's aim to fill time with as many personal accomplishments as possible and that, therefore, time has a high value for him.

Loehlin (1959) in his study asked his subjects to make two time estimates: (a) how long the time seemed to the subject, or subjective judgment, and (b) how long the subject thought the time actually was, or objective judgment. The subjects were not required to make a distinction between the two judgments as the instructions permitted both estimates to be the same. For a few subjects the distinction was a meaningless one.

Hoagland (1943) supports the swift passage of subjective time for the elderly with his findings that metabolic activity decreases with increasing age, and with a slower metabolic rate less subjective time will pass per unit of clock time, thus making clock time appear "to fly."

Concerning the estimation of objective time, on the other hand, Feifel (1957) was attracted by the hypothesis that older persons would underestimate objective time. Two groups whose mean ages were 67.0 years and 24.0 were asked

to delimit, or produce intervals of thirty, sixty, one hundred eighty, and three hundred seconds. Both groups underestimated all intervals; however, the degree of underestimation in the older group was significantly higher.

Consistent with Feifel's findings, a study (Gilliland & Humphreys, 1943) using intervals of nine to one hundred eighty seconds found that very short intervals tended to be overestimated while longer intervals were underestimated, by both children and young adults. A study mentioned earlier (Swift & McGeoch, 1925) of filled and unfilled short intervals corroborates their overestimation. Loehlin (1959) points out, however, that the subjective scale of time is apparently not a highly integrated dimension for most persons; for people who overestimate seconds do not necessarily overestimate minutes.

Though intervals of less than a second were not considered in the present investigation, some mention of research in that area should be included in a survey of time estimation literature. Much research in time estimation is being done in Europe, notably France and Sweden. Since the journals containing reports of that research were generally unavailable, the abstracts of the studies appearing in Psychological Abstracts had to suffice. Fraisse's studies (1958) of the reproduction of short durations have resulted in some agreement as to the location of an

indifferent interval at about 0.60 seconds. This is approximately the duration of a psychological refractory period, and evidence supports the hypothesis that this particular interval is related to the duration of certain basic neural processes. According to Treisman (1963, p. 1), "The constant errors of estimates of temporal durations are usually positive for short intervals and negative for long ones, with a transition point, the indifference interval, at which the constant error is zero." In his discussion of the under-overestimation phenomenon, which includes mention of the Fraisse (1958), Gilliland and Humphreys (1943), and Swift and McGeoch (1925) studies mentioned previously, as well as one by Clausen (1950), he points out that each of these investigators, each using a different range of short intervals varying from .78 to 1.39 seconds and from 30 seconds to 10 minutes, found an indifference interval to exist but did not agree as to its location. Woodrow (1934), using a different group of subjects for each range obtained the classical pattern of over-underestimation with an indifference interval at .60 second. Treisman cites Hollingworth's defense of Woodrow's findings; that only intervals between .40 and 2 seconds are "perceived."

Experimental procedure in time estimation studies falls into several general categories. As outlined by Clausen (1950) they are the method of reproduction, the

method of estimation, the method of production, and comparison. The comparison of intervals has fallen into disuse in recent time estimation studies as the influence of the order of presentation of intervals to be compared cannot be ascertained. Of the three remaining methods, Clausen feels that the method of reproductions, in which the subject is asked to reproduce an interval presented by the examiner, is the least satisfactory in that the reproduction task is independent of any relation of personal time to objective time. The methods of estimation and production, on the other hand, deal with relations of personal time to clock time. In verbal estimation, the subject estimates an interval demonstrated by the examiner. In production, the subject produces an interval stated by the examiner by some operative procedure, such as depressing a telegrapher's key for an interval of time. If a subject's personal time moves rapidly he would by verbal estimation name a demonstrated interval to be longer than its clock value, but by operative estimation keep the key down for a shorter interval than was required.

Comparison of past- and present-time estimations were made by Frankenhaeuser (1959). Subjects were required to name randomized digits at an estimated rate of one per second (present-time estimate) for a given period of time, and to estimate in retrospect the length of the time period

(past-time estimate). The estimates of past-time were consistently smaller than the estimates of present-time.

Two studies (Axel, 1924; Gullicksen, 1927) previously mentioned found that women more frequently overestimate time than do men. Harton (1938) found just the opposite to be true--that men not only gave more overestimates but on the average gave 48 per cent greater overestimates. Later studies by Gilliland and Humphreys (1943), and Swift and McGeoch (1925), also previously mentioned, have not found sex differences in the ability to estimate time. Loehlin's findings, with the exception of performance scores, agree with the later studies which failed to find sex differences in time estimation. The present investigation will not compare sex differences in the ability to estimate time but will proceed on Loehlin's premise that there are no differences.

Relating to the foregoing paragraph and to the statistical procedures of the present investigation, which include group means and percentages, is an observation made by Harton (1939) that an average of the estimates of a group more closely approaches the actual duration of the interval than do the estimates of individuals taken from the group at random.

II. SUMMARY

A survey of the literature revealed data related to innumerable aspects of time estimation. Many studies were found which related chronological age to the ability to estimate time, but the groups used were limited. Studies using children as subjects are numerous, as are those comparing young adults to old adults such as Wallach & Green (1961) did comparing young adults of 18 to 20 years to old adults whose median age was 71. Feifel (1957), too, used groups of only older and younger adults and not the full continuum of chronological age. Acting upon the advice of a colleague who suggested that large variations in age might affect time estimation, Loehlin eliminated subjects falling outside the age range of 17 to 22 years. With an age range approximately the same as that used by Loehlin, Swift and McGeoch (1925) found no relationship of age to time estimation. In view of the limited age ranges used by those investigators, it occurred to the present investigator that present knowledge of time estimation might bear the influence of predominantly "college sophomore" subjects, common to many psychological testing results. Since no study was found which studied the ability to estimate time in relation to the entire continuum of adult chronological age, from very early maturity to late maturity, the present investigation was undertaken.

CHAPTER III

INSTRUMENTS, SUBJECTS, AND PROCEDURES

This chapter deals with the methods and procedures utilized in the study undertaken.

An item analysis for each of the instruments used in the investigation is presented. The total number of subjects participating in the study is described, and the criteria a subject was required to meet in order to have his Time Estimation exercise qualify for inclusion in the statistical analyses of the investigation are explained. The actual testing procedure is also discussed briefly.

I. INSTRUMENTS USED

Two instruments were used to investigate the relationship of chronological age to temporal judgment. Each was presented to the subjects in mimeographed form, one following the other, during the testing session, and the subjects were requested to fill them out as directed.

Time Estimation. The instrument first presented to the subjects was entitled, simply, "Time Estimation" (see Appendix, p. 71), the word "test" being deliberately avoided in all investigator-subject reference to the exercise. Consisting of two mimeographed pages, the Time

Estimation exercise was an adaptation of Loehlin's (1959) time estimation test which was designed to test the apparent length of intervals in relation to the activities which were ongoing during them. While the estimation of time intervals, per se, regardless of the activities filling them was not Loehlin's purpose, he did indicate that his test would be suitable for simple measurement of subjects' ability to judge time intervals. Anticipating an extremely unsophisticated testing group, a group undoubtedly at the opposite end of the continuum from the usual college sophomore, psychology major test subject, Loehlin's test was shortened from 16 two-minute intervals to 8 two-minute intervals, with the more difficult items, such as the Gottshaldt figures, being omitted entirely. Two items consisting of 8 short intervals of a few seconds apiece were included within the body of the exercise, as they were in Loehlin's test, though the intervals differed; and one long interval to be estimated was included. In Loehlin's test the long interval was twenty minutes in length and fell near the middle of the testing session. In the present exercise, subjects were asked to estimate the total length of the time estimation exercise as their answer to the last item in the exercise, Item 11.

The Time Estimation exercise was deliberately mimeographed on two pages stapled together. The rationale for

this will be clear as a breakdown of the items is presented. When the exercises were passed out, subjects were requested to look only at the first page and not to turn to the second page until directed to do so.

Five items appeared on the first page of the exercise. Each item consisted of a task and a box to the far right of the item numeral, entitled "Estimate of Time Interval," in which the subject, after completing each task, was directed to write his estimate, in minutes and seconds, of the time spent at the task. Each interval began when the examiner said "Start" and ended when he said "Stop." A stop watch calibrated to tenths of seconds was used to time the intervals. (See Appendix, p. 66, for verbatim instructions given in administering the Time Estimation exercise.)

Item 1. The task in Item 1 was to write 1's repeatedly. This is considered a boring, repetitious task. However, it is the first item in the exercise, which is probably a novel experience to the majority of the subjects. Item 1 was the first of the two-minute intervals presented. Speaking in terms of stimulus and response, the two-minute interval spent working at the task is considered the stimulus interval while the estimate of the time spent working at the task is considered the response.

Item 2. The task in Item 2 was an easy anagram.

Presented with the word "TRANSPORTATION," subjects were directed to make as many words as possible using the letters in the word, during the interval allotted. Many words can easily be made from the word "TRANSPORTATION;" thus this interval is one in which subjects experience a feeling of success.

Item 3. The procedure for Item 3 differed from that of the two previous items in that eight empty intervals of only a few seconds apiece were presented to the subjects. Each interval began when the examiner said "Start" and ended when he said "Stop." A stop watch calibrated to tenths of seconds was used to time the intervals. Subjects were asked to judge the duration of each interval and to write their estimates after the proper letter, (a) through (h), under Item 3. The intervals consisted of 4, 7, 2, 4, 4, 1, 8, and 4 seconds in that order.

Item 4. During the two-minute interval of Item 4, the examiner read an interesting section of "Huckleberry Finn" to the subjects. When the examiner finished reading, subjects were asked to judge how long he had read. This is considered a filled interval.

Item 5. Item 5 is considered an unfilled interval during which subjects were directed to think pleasant thoughts. There is some doubt as to whether this is truly an unfilled interval as a person's pleasant thoughts may be

far more interesting to him than the previous item's, presumably, interesting reading.

Item 6. The task in Item 6 at the top of the second page was a repetition of Item 1, writing 1's, a boring, repetitious task. The present investigator felt its placement at the top of a second entire page to be completed by subjects, would increase its boring affect on time estimation.

Item 7. Item 7 was a repetition of Item 3 on the first page of the exercise. The short intervals of only a few seconds apiece were the same and appeared in the same order. It was expected that familiarity with procedure and practice would affect the accuracy of judgment of time of the intervals presented in Item 7 for the second time.

Item 8. The task in Item 8 was a difficult anagram. Using the letters in the word "MISSISSIPPI," subjects were directed to make as many words as possible. Not many words using those letters are known to the average subject, and frustration becomes a factor affecting temporal judgment.

Item 9. During the interval of Item 9 another passage from "Huckleberry Finn" was read by the examiner. During this reading, the subjects were directed to count the number of times the word "the" appeared in the test. Thus, the interval was filled with activity on the part of examiner, reading, and on the part of the subjects,

counting "the."

Item 10. Item 10 was an empty interval during which the subjects were directed to concentrate on the passage of time. They were told that during that interval they might even count seconds to themselves if they felt it would help them to estimate time more accurately.

Item 11. The examiner did not say "Start" at the beginning of Item 11, only "Stop." At the word "Stop," subjects were directed to write their estimate of the amount of time they had spent working at the entire exercise.

Questionnaire. A third mimeographed paper entitled "Questionnaire" (see Appendix, p. 73) was presented to the subjects at the close of the Time Estimation exercise. Ten questions regarding the subject's health, activities, age, living arrangements, etc., were included. Though only seven of the questions were pertinent to the present investigation, in view of the surge of interest in gerontology three additional questions were included in the Questionnaire as it was thought that they might be of value to future research.

In order that subjects' Time Estimation exercises qualify for inclusion in the primary statistical analyses of the investigation, subjects individually had to meet the criteria of "being in fairly good health" and "living

actively in the community." (After some deliberation it was decided that the listing of "Housewife" as an occupation met criterion; as it was felt that a woman who considered being a housewife an occupation would be working actively at it.) If, however, the blank following Question 3 was left unfilled, or a subject's occupation was listed as "Retired," one positive answer to Questions 4, 5, or 6 was required. In order to meet criterion, membership in one club or organization in Question 4, or one special interest or hobby in Question 5, or at least moderate activity in church affairs in Question 6, had to be indicated.

Failure to meet either criterion of "being in fairly good health" or "living actively in the community" disqualified a subject's Time Estimation exercise from inclusion in the primary statistical analyses of the experiment.

Question 8 of the Questionnaire asked the subject to indicate with a check in the appropriate box, the age group into which his present age fell. The age groups were set up in 5 year increments (i.e., 15--19; 20--24).

At the close of the Time Estimation exercise, the Questionnaire was presented to the subjects and stapled to the back of each subject's Time Estimation exercise, making up the third page of the exercise. It was stapled to the back of the first two pages for purposes of privacy and

anonymity. Subjects were requested not to put their names on any of the pages. The Questionnaire was purposely not attached to the Time Estimation exercise until the exercise was completed, as it was felt that the presentation of three mimeographed pages to be filled out would be threatening, particularly to an unsophisticated testing group, some of whom would be of low educational level, and that it would therefore influence subjects' perception of time.

II. SUBJECTS

A total of 118 subjects, ranging in age between 15 and 95 years, were tested. All subjects were residents of the same rural community in California. The testing was carried on over a period of one week in early spring in 1964. The majority of persons were tested in groups of from 2 to 15 persons, although four individual tests were given in the over ninety age category. The majority of groups tested were neighborhood groups, which would gather at one neighbor's home. Other groups included a senior citizens' club, a teachers' group, residents of a trailer court, and a bridge club.

Of the total number of subjects tested, the Time Estimation exercises of six were disqualified from inclusion in the statistical analyses on the basis of not meeting criteria. All subjects whose tests were disqualified

failed to meet the criterion of "being in fairly good health." No subject's test was disqualified by his failure to meet criterion of "living actively in the community." Disqualified by poor health were three subjects in the 80--84 age category, two in the 75--79 age category, and one subject in the 55--59 age group.

The Time Estimation exercises of two other persons were discarded. The persons are known mental defectives but were members of groups tested and evinced a desire to be included in the activity. Rather than cause them embarrassment by excluding them, they were included in the testing; but their tests were necessarily discarded as one showed no time estimates and the other was illegible.

The tests of two subjects in the 90--94 age group were not included in the statistical analyses as they were not completed. At the examiner's discretion, the Time Estimation exercise was terminated at the end of the first page in both cases, as both subjects seemed overwrought and confused by the testing situation. Table 1 shows by chronological age, in five year increments, the number of subjects whose Time Estimation tests were included in the statistical analyses.

Table 1

Number of Subjects by Chronological Age

Age	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
Number	10	6	6	3	7	7	11	4

Age	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94
Number	10	7	8	11	6	6	4	2

III. PROCEDURE

A guide for procedure was formulated and followed for each testing session (see Appendix, p. 66). A "trial run" of the Time Estimation exercise was conducted, and following it several changes were made in the testing procedure. While Loehlin (1959) allowed only one minute for instruction and explanation between each task and corresponding estimation, the "trial run" indicated that with an unsophisticated testing group, time should be allowed for discussion and questions between tasks, otherwise the estimates of time would be influenced by misunderstanding of tasks and consequent anxiety. However, the time between tasks spent in explanation and discussion was included in the time of the long interval the subject was asked to estimate in Item 11. This was made clear to the subjects when they were directed to estimate the total time spent working on the Time Estimation exercise (see Appendix, p. 71).

It was following the preliminary "trial run" that it was decided that only the two mimeographed sheets of the Time Estimation exercise should be given to the subjects at the beginning of the testing period. The additional third page--the Questionnaire--when presented with the Time Estimation exercise appeared to affect the subjects' judgment of time ("do I have to fill out <u>three</u> pages?"). After

the "trial run," the Questionnaire was presented at completion of the Time Estimation exercise and stapled to the back of the first two pages of the exercise by the examiner, as the examiner discussed the exercise just completed and explained the questions to be answered on the Questionnaire.

It was not possible for all groups to be tested in the same setting or location. However, an attempt was made to conduct the testing sessions in a place which was familiar to the subjects and in which they felt at ease.

CHAPTER IV

INTERPRETATION OF DATA

Four separate statistical procedures were utilized in the interpretation of the data obtained. In each of the four procedures the intervals which were estimated were interpreted according to the three categories of two-minute intervals, short intervals (of a few seconds duration), and a long interval (the total time of the Time Estimation exercise). In the first and fourth statistical analyses, the test results of the entire group of subjects (N=108) were included. In the second and third analyses the two extreme age categories were eliminated (see p. 43) and a truncated group (N=96) was used.

I. MEANS OF AVERAGE ERRORS OF ESTIMATION

Procedure. The first procedure utilized was the computation of the mean average error of estimation by age category. Using the correct estimate of time (i.e., "two minutes" for the two-minute intervals) as the 0 point, amount of error was figured, disregarding sign, for the total number of two-minute intervals for each subject, for the total number of short intervals for each subject, and for each long interval. A subject's total errors of estimation for each type of interval, from the correct time

estimates were designated as his "Scores," or Ys; Y^{I} for the two-minute intervals, Y^{II} for the short intervals, and Y^{III} for the long intervals. Upon obtaining the total amount of error for all individuals in an age category, for each of the three different types of intervals, a mean average error was computed for each five-year age category, for each of the three types of intervals. Since several of the five year categories had a very small number of subjects, means were also computed by decades, with the exception of the 15--19 and 90--94 age groups, to lessen the influence of widely deviant scores of a small group and to smooth the curves. Means were also computed for each age category, both for the five year increment categories and by decades. Chronological age was designated the X score of the present study. Table 2 shows the means of average errors computed by five year increments for the two-minute intervals, the short intervals, and the long interval. Table 3 shows the means of average errors computed in ten year increments for each of the three types of intervals. Figs. I, II, and III are graphic representations of both increment computations for all of the intervals, showing the linear relationships between the age means and the time estimation means of average errors.

Results. Based on the computation of the means of average errors, graphically, the general hypothesis that

Table 2

Means of Average Errors of Estimation

(Computed by 5 year intervals)

Mean Age	17.5	22.5	27.5	32.5	37.5	42.5	47.5	52.5
2-min. Intervals (sec.)	85.4	39.8	42.8	64.0	57.3	70.2	74.3	33.2
Short Intervals (sec.)	1.12	.72	1.30	1.45	1.89	1.31	1.44	2.08
Long Interval (min.)	11.88	7.38	7.79	5.92	9.28	8.26	8.27	17.92

Mean Age	57.5	62.5	67.5	72.5	77.5	82.5	87.5	92.5
2-min. Intervals (sec.)	93.4	67.4	76.6	71.2	71.4	83.1	109.8	164.4
Short Intervals (sec.)	2.87	1.74	2.58	2.10	1.69	3.67	4.04	2.40
Long Interval (min.)	8.63	13.35	11.53	7.93	15.40	8.64	13.02	20.0

Table 3

Means of Average Errors of Estimation

(Computed by 10 year intervals)

Mean Age	25.0	35.0	45.0	55.0	65.0	75.0	85.0
2-min. Intervals (sec.)	41.3	59.4	72.7	76.2	71.3	71.2	93.8
Short Intervals (sec.)	1.01	1.76	1.39	2.64	2.18	1.96	3.82
Long Interval (min.)	7.58	8.28	8.27	11.29	12.38	10.57	10.39

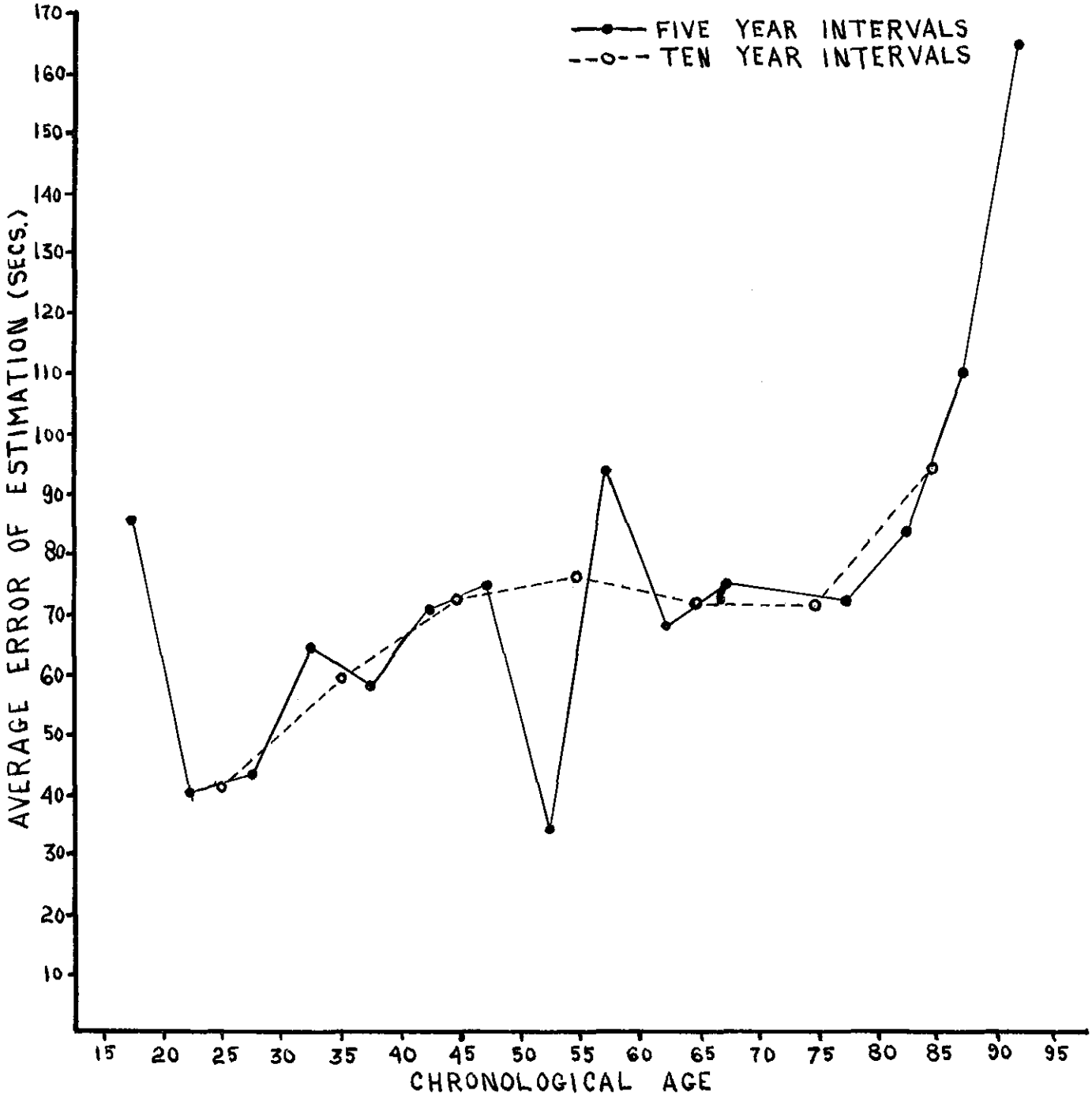

Fig. 1. Means of average errors of estimation of 2-minute intervals.

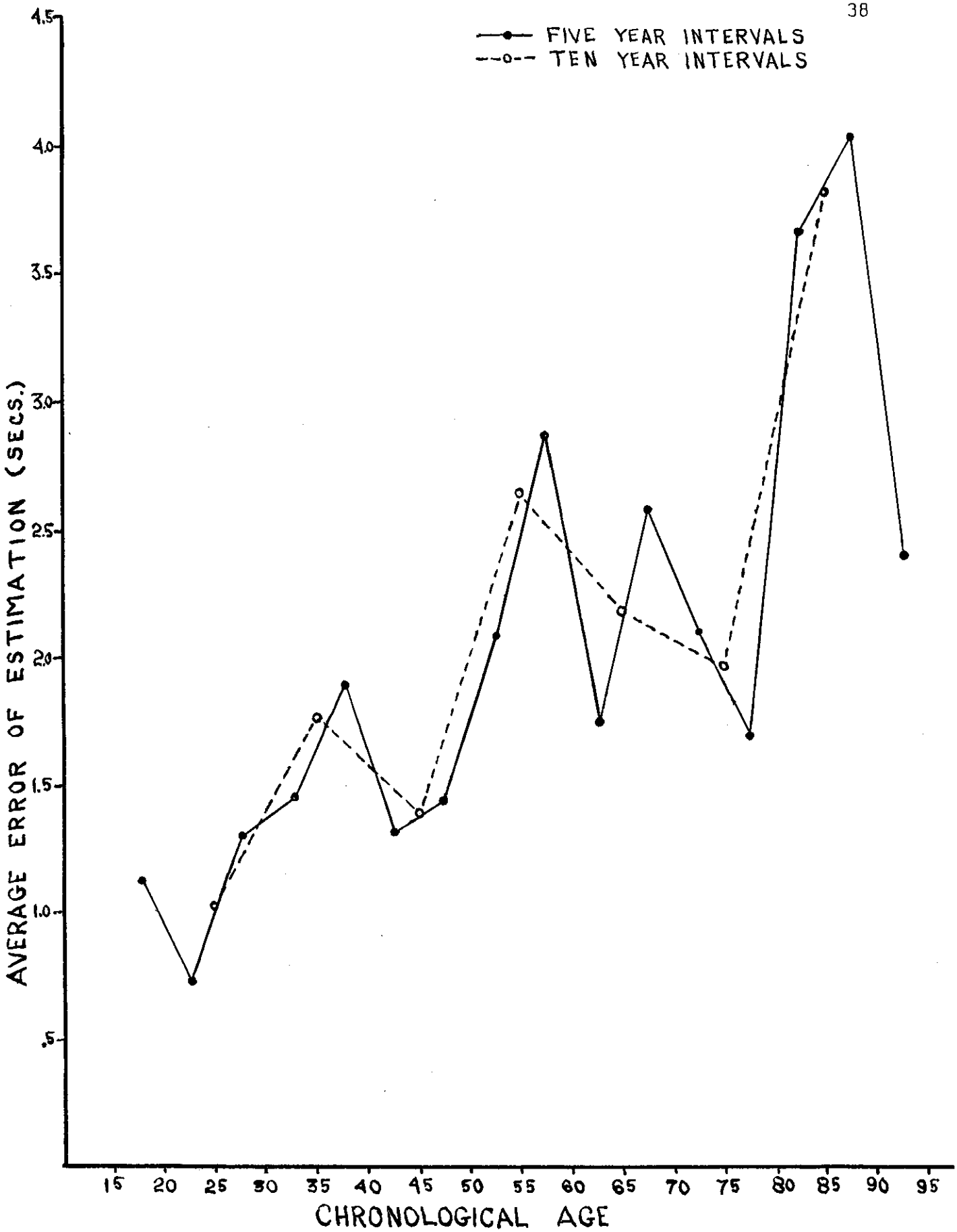

Fig. 2. Means of average errors of estimation of short intervals.

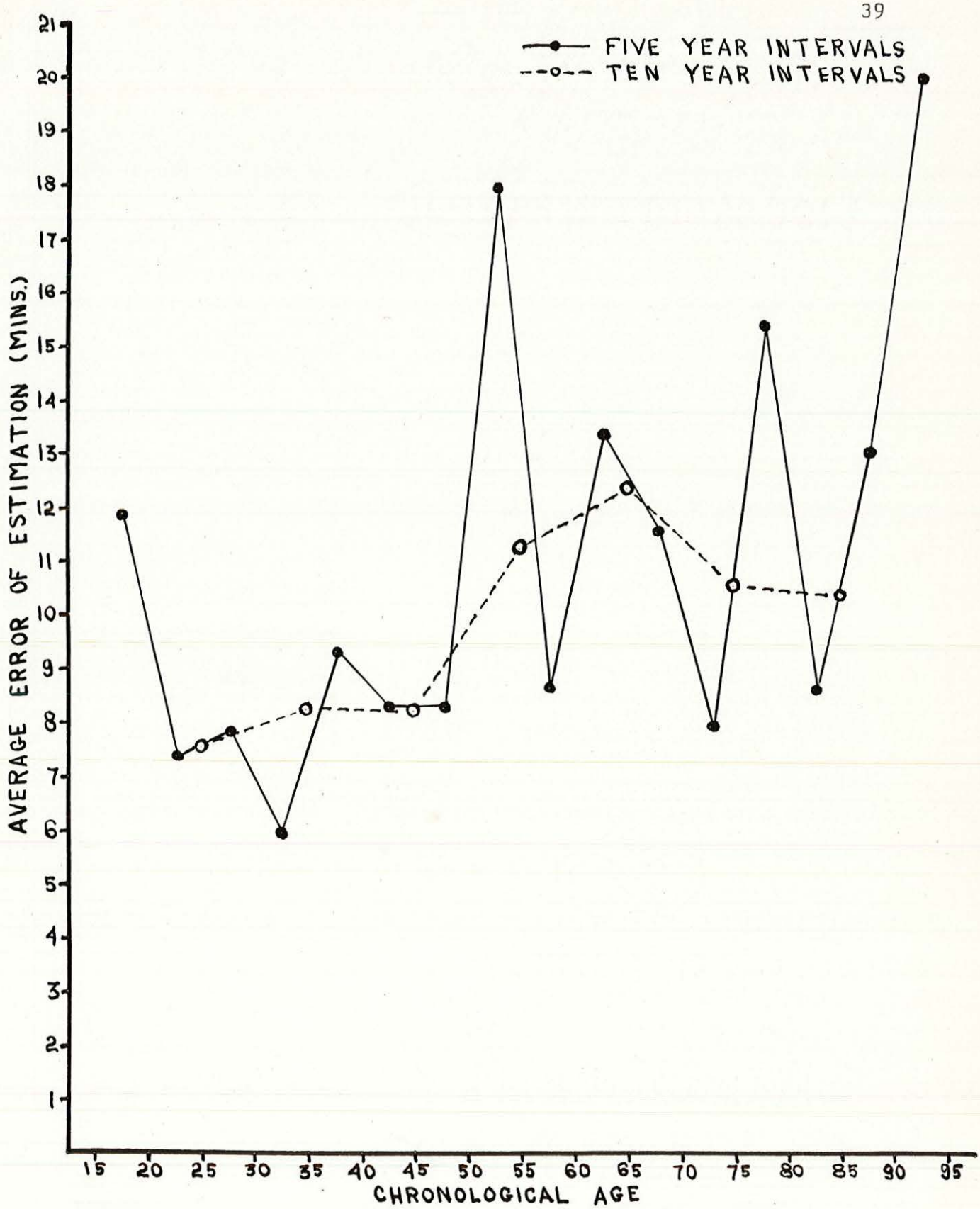

Fig. 3. Means of average errors of estimation of long interval.

the ability to accurately estimate time declines with age, seems to be borne out, particularly in relation to the estimation of the two-minute intervals.

However, regarding the portion of the hypothesis that predicted that the decline in ability would begin at around age thirty, in examining the means of average errors, the decline in estimation ability becomes evident earlier than age thirty. For all three types of intervals the decline is evident between the ages of 22.5 and 27.5 years, going from 39.8 seconds to 42.8 seconds mean average error for the two-minute intervals; from .72 seconds to 1.30 seconds mean average error for the short intervals; and from 7.38 minutes to 7.79 minutes mean average error for the long interval. When the means of average errors were computed by decades, the curve was smoothed and the steady decline in estimation ability became more evident. Between the mean ages of 25.0 and 35.0 the mean average error increased from 41.3 seconds to 59.4 seconds for the two-minute intervals; it rose from 1.01 seconds to 1.76 seconds for the short intervals; and for the long interval it increased from 7.58 minutes to 8.28 minutes.

Regarding the portion of the hypothesis that predicted that the decline in ability would be a gradual one until about age eighty, when it was expected the decline would increase markedly, the mean average error of the estimates of the

two-minute and the short intervals, computed for both five and ten year increments, show a marked decline. For the two-minute intervals, mean average error for mean age 77.5 years was 71.4 seconds, rising to 83.1 seconds for mean age 82.5. In ten year increments, for mean age 75.0 years, the mean average error was 71.2 seconds; at mean age 85.0, it had risen to 93.8 seconds. A difference of 26.2 seconds! For the short intervals, at mean age 77.5 years, the mean average error was 1.69 seconds; at mean age 82.5, it was 3.67 seconds. By decade, from mean age 75.0 to 85.0 years, the mean average error had increased from 1.96 to 3.82 seconds. An increase of 1.86 seconds. An examination of the means of average errors for the long interval shows that just the opposite seems to be true; the ability to estimate long intervals of time seems to increase with chronological age.

The foregoing discussion of the comparison in ability to judge short time intervals as opposed to long intervals seems to corroborate Loehlin's (1959) statement that persons who overestimate seconds do not necessarily overestimate minutes. A glance at Figs. I and III at mean age 52.5 shows the opposite is probably true also, that people who underestimate seconds do not necessarily underestimate minutes. The 52.5 mean age group showed the lowest mean average error of estimation of two-minute intervals, 33.2 seconds, and the

highest mean average error (with the exception of the 92.5 mean age group) for the long intervals, 17.92 minutes.

The mean average error of the teenage group showed interesting relationships to the means of average errors of other age groups in the study. The mean average error for the two-minute intervals for the teenage group was 85.4 seconds, most closely approximating the 83.1 mean average error of the 82.5 mean age group. Their mean average error of 1.12 seconds for the short intervals was the second lowest, most closely approximating that of 1.30 seconds for the 27.5 mean age group. For their long interval estimation, however, their mean average error of 11.88 minutes again approximated that of one of the older age groups, the 67.5 mean age group, whose mean average error was 11.53 minutes.

Some mention should be made of the means of average errors of the 90--94 age group, even though it is felt that a sample of two does not produce a reliable statistic. As was mentioned in CHAPTER III, tests of two other subjects were not included in the statistical analyses as they were not completed. Only the first pages of the Time Estimation exercise had been finished. However, in looking over them, a similarity was noticed between them and the two completed tests of their age group; one subject made fairly accurate estimates of the correct time for both the two-minute intervals and the short intervals, while the other subject's

estimates were completely unrealistic for both types of intervals. No estimate of a long interval was made on the incompleted tests. For the completed tests the mean average error for the two-minute intervals was 164.4 seconds; for the short intervals, 2.40 seconds; and for the long interval, 20.0 minutes. The two-minute and long interval estimations showed a sharp decline in ability to estimate time, but the short interval estimations showed as sharp an increase in ability from the previous 87.5 mean age group whose mean average error was 4.04 seconds.

II. CORRELATION BETWEEN CHRONOLOGICAL AGE AND TEMPORAL JUDGMENT

Procedure. The Pearson product-moment coefficient of correlation formula (Guilford, 1956) was used to determine the degree of relationship between chronological age and the ability to estimate time. It was applied in three separate statistical operations to the estimates of the two-minute intervals, the short intervals and the long interval. The two extreme age groups, from 15--19 and 90--94 years were eliminated from the second statistical procedure and a truncated group of 96 subjects ranging in age from 20 to 89 years of age was used. Rationale for eliminating the two extreme age groups is not as arbitrary as it might seem. Elimination of the very old group was justified by the very

small number of subjects, two, in that age category. In considering elimination of the very young group, Lewin's (1935) "undefined and unlimited time" of adolescence came to mind, and a perusal of the means of average errors of estimation of the 15--19 age group seemed to justify exclusion of the group on the basis of their being "old" adolescents rather than "young" adults. The age range of 20 to 89 seemed a more precise delineation of "young maturity" to "old maturity" without their inclusion.

Thus, the mean of X and the means of average errors of estimation of Y^{I}, Y^{II}, and Y^{III}, of the truncated group were obtained, and from them the standard deviation (σ) of the distributions of the X, Y^{I}, Y^{II}, and Y^{III} were computed in readiness for application of the Pearson product-moment coefficient of correlation.

Results. The coefficients of correlation obtained were +.63 for the two-minute intervals (Y^{I}), +.39 for the short intervals (Y^{II}), and +.2[illegible] for the long interval (Y^{III}). According to Guilford (1956, p. 145), a correlation of .40--.70 shows a moderate correlation and a substantial relationship. A correlation of .20--.40 shows a low correlation and a small but definite relationship. Thus, the hypothesis of a relationship between chronological age and temporal judgment appears to be slightly to moderately supported by the obtained coefficients of correlation.

As a test of reliability, the standard error of each of the coefficients of correlation was computed, as the standard error indicates how much risk is being taken in letting the obtained correlation stand for the parameter correlation. The SE obtained for r^{I} was +.062; for r^{II} the SE was +.087; and for r^{III}, +.098. Interpreted, this means, using r^{I} as an example, that with a SE of +.06 we may expect two-thirds of the sample r's to be within .06 of the parameter $\bar{r}$, or between +.57 and +.69. Interpreting r^{II}, two-thirds of the sample r's will be within .09 of the parameter $\bar{r}$, or between +.30 and +.48. For the long interval, or r^{III}, two-thirds of the sample r's will be within .10 of the parameter $\bar{r}$, or between +.12 and +.32.

The degrees of freedom for the truncated group (df=N-2) are 94. Therefore, a correlation of at least .205 must be obtained at the .05 level and of .267 at the .01 level to be significantly different from zero. Two of the correlation coefficients of the present investigation, those investigating the relationship of chronological age to estimation of two-minute intervals of time, and of chronological age to estimation of short intervals, were significantly different from zero at the .01 level of significance. The relationship of chronological age to estimation of a long interval, with a coefficient correlation of +.22, was significantly different from zero at the .05 level of significance.

III. DUNCAN'S RANGE TEST

Procedure. To test for significant differences among the different age groups who participated in the study, Duncan's Range Test (McGuigan, 1960) as adapted for use with groups of unequal numbers was the third statistical procedure used. Again, only the truncated group of 96 subjects was included in the analysis, the two extreme age groups being eliminated on the basis of the same rationale as outlined in the preceding section. They were also eliminated as it was determined to use decades to delimit the age ranges in order to increase the size of the groups and thereby decrease the error variance of each group, and the two extreme age groups represented incomplete age ranges. Seven groups resulted 20--29, 30--39, etc.) and each group, or more specifically, the mean average error of estimation for each group was tested to see if it differed significantly, at the .05 level, from every other groups' mean average error. The means of average errors of the groups (see Table 3) were tested for all three types of intervals, two-minute, short, and long.

Results. For the two-minute intervals, the means of average errors of all groups failed to be significantly different from each other at the .05 level. However, the difference between the 80--89 and 20--29 age groups lacked being significant by only 1.1 seconds. The Rp value which

the mean difference (52.5) had to exceed in order to be significant was 53.6.

For both the short intervals and the long interval, there were no significant differences, at the .05 level, between any of the groups.

IV. PERCENTAGES OF UNDER-, CORRECT, AND OVERESTIMATES

Procedure. Once again using the entire age span tested (N=108), percentages were computed, using five year age increments, for the number of under-, correct, and overestimates of each of the three types of time intervals. Table 4 gives each of the obtained percentages.

Results. In the estimation of the two-minute intervals, underestimates of from 12.50 per cent by the 85--89 age group, to 54.17 per cent by the 25--29 age group, were made. The highest percentage of correct estimates, 21.87, was made by the 85--89 age group. The percentages of overestimates of the two-minute intervals ranged from 29.16 per cent for the 25--29 age group to 83.33 per cent for the neighboring age group of 30--34. All but two of the age groups made 52.00 per cent or more overestimates of the two-minute intervals, with a majority of the percentage scores falling above 60.00 per cent, which, if two-minute intervals are considered "short intervals," lends some corroboration to Loehlin's (1959) statement that short intervals tend to be

Table 4

Percentages of Under-, Correct, and Overestimates

	2-Minute Intervals			Short Intervals			Long Interval	
	Under	Correct	Over	Under	Correct	Over	Under	Over
15-19	18.75	2.50	78.75	39.38	28.75	31.87	100	- - -
20-24	49.92	0	52.08	26.04	42.71	31.25	83.33	16.67
25-29	54.17	16.67	29.16	36.46	33.33	30.21	83.33	16.67
30-34	16.67	0	83.33	45.83	20.83	33.33	66.67	33.33
35-39	41.07	5.36	53.57	41.96	24.10	33.93	100	- - -
40-44	19.64	8.93	71.43	31.25	33.93	34.82	85.71	14.29
45-49	15.91	10.23	73.86	45.46	31.25	23.29	100	- - -
50-54	53.13	15.62	31.25	32.81	20.31	46.88	100	- - -
55-59	16.25	12.50	71.25	35.63	20.62	43.75	70.00	30.00
60-64	23.21	14.29	62.50	52.68	17.86	29.46	100	- - -
65-69	25.00	12.50	62.50	28.13	18.75	53.12	100	- - -
70-74	35.23	11.36	53.41	26.70	22.73	50.57	72.73	27.27
75-79	16.67	16.66	16.67	25.00	27.08	47.92	100	- - -
80-84	29.17	4.16	66.67	40.63	19.79	39.58	83.33	16.67
85-89	12.50	21.87	65.63	20.31	18.75	60.94	75.00	25.00
90-94	18.75	6.25	75.00	59.37	9.38	31.25	100	- - -

overestimated.

The largest percentage of correct estimates were made for the short intervals. The age group 20--24 showed the highest percentage, 42.71, of correct estimates for short intervals. The 90--94 age group showed the lowest percentage of correct estimates, 9.38. The next lowest percentage of 17.86 was shown by the 60--64 age group. For short intervals under- and overestimates seem about equal. The total range of percentages of underestimation is from 20.31 to 59.37. The total range of percentages of overestimation is from 23.29 to 60.94. The similarity of the percentages of under- and overestimations does not appear to agree with Loehlin's statement that short intervals tend to be overestimated, and intervals of only a few seconds apiece would certainly be classified as short intervals.

There were no correct estimations of the long interval by any age group. In fact, in eight of the age groups, all subjects underestimated the long interval. The remaining percentages of underestimation ranged from 66.67 to 83.33 per cent. The total range of overestimates was from 14.29 to 33.33 per cent. Loehlin's statement that long intervals tend to be underestimated certainly seems supported by those percentages.

No trend as far as age and under- or overestimation was concerned could be discerned for any of the types of

intervals. Young people seemed to make as many under-estimates or overestimates of all of the intervals as did old people. Table 4 shows the dispersion and lack of trends very plainly.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY

In this concluding chapter, the support or non-support of the hypothesis by the data collected will be examined. The inadequacies and other aspects of the study will be discussed, and recommendations for future research will be made. A summary of the study will close the chapter.

I. CONCLUSIONS

The hypothesis. An inverse linear relationship between increasing chronological age and the ability to estimate time accurately was hypothesized, the decline in ability beginning at about thirty and increasing gradually until about age eighty when the decline becomes marked. The general hypothesis that the ability to estimate time accurately declines with age was supported by two of the statistical procedures used. Means of average errors of estimation derived from estimates made by 108 subjects on a Time Estimation test, computed and graphed by chronological age categories, show the decline in ability, with increasing age, very clearly for all types of time intervals tested. The three coefficients of correlation computed for the three types of intervals also supported the hypothesis

that there is a moderate positive relationship between chronological age and temporal judgment.

One of the sub-hypotheses, however, was not supported by the means of average errors obtained. The decline in ability to estimate time accurately did not appear to begin at about age thirty as was hypothesized, but earlier, at about age twenty-five.

The sub-hypothesis, that the decline in ability to estimate time will decrease markedly at about age eighty, was supported by the means of average errors obtained.

On the other hand, the general hypothesis was not supported when Duncan's Range Test was used to test for significant differences among the means of average errors, of seven age groups, each encompassing a decade. For all three types of intervals, each group failed to be significantly different from every other group at the .05 level of confidence.

No formal hypothesis was made concerning under- and overestimation of intervals as related to age. The computation of percentages of under-, correct, and overestimates by age categories, for each type of interval, was done as a matter of interest to the present investigator, as a duplication of a procedure used by Harton (1939) in his study of time estimation.

The inadequacies of the study. The chief inadequacy of the study it is felt is the number of subjects who participated in it. While an N of 118 might be considered quite large and adequate for other types of studies, for a developmental study it is small and leaves the reliability of the findings open to question. The investigator had great difficulty in securing even 118 subjects. The inherent suspicion of rural residents toward an unfamiliar experience was a nearly insurmountable barrier. Prospective subjects had to be assured repeatedly that the exercise they were being asked to participate in was not a test of intelligence or educational level, and that they would not be required to answer any personal questions.

A second inadequacy of the study was this very factor, that little was known regarding the subjects other than the data gathered by the rather innocuous questions of the Questionnaire. The difficulty encountered in obtaining subjects for a simple, anonymous, time estimation test made it obvious that it would be impossible to persuade rural residents to submit to any type of intelligence test or personality inventory. Socioeconomic status of the subjects constituted another question which necessarily had to be left unasked. However, it was felt that the occupation of the subject as given on the Questionnaire would provide an index to socioeconomic status, except for those subjects

who listed their occupation as "Retired."

The method by which subjects were selected and whether or not it was "random" might be questioned by a critical observer. It was the intent of the investigator to procure a representative sample of persons living in a rural community, as subjects. Necessarily, some of the prospective subjects were known to the investigator, and they, in turn, acted as recruiters for other subjects. However, an attempt was made to contact persons living in various types of neighborhoods; and even the club groups which participated in the study were selected as to their members "representativeness." It is felt that the range of occupations given on the Questionnaires attests to the "representativeness" of the subjects.

There is some question in the investigator's mind as to whether discussion of the fourth statistical procedure should have been included, as percentages are weak statistics, at best; and as under- or overestimation was not a part of the hypothesis, perhaps it should have been excluded from the study. In defense of its inclusion, it seems of value to know whether as persons get older they tend to under- or overestimate time. However, proper inclusion would require that a formal hypothesis be made regarding under- or over-estimation and that a more refined statistical procedure, perhaps the constant error which would indicate direction of

error of estimation, should be utilized. Apart from non-inclusion of under- or overestimation in the hypothesis, the constant error was not explored as there seems a limit to the statistical analyses which should be applied to data which in preliminary analyses seems insufficient as to number, or does not meet significance.

Discussion. Several things which bear mentioning came to the attention of the investigator during the course of the study.

During the testing period itself, with each successive administration of the Time Estimation exercise, the investigator became increasingly impressed with Loehlin's (1959) test, even in shortened form. It is valid in that it seems to measure very effectively what it was designed to measure, the ability to estimate time, particularly effectively the estimation of short and moderate length intervals. In comparing the answers to the items on page one of the exercise to the answers of the related items on page two, a high degree of test reliability seems indicated.

Only the long interval estimates caused the investigator concern. Other investigators had mentioned the tendency for long intervals of time to be underestimated, but the amount of underestimation by subjects in the present study seemed totally unrealistic. The length of the long

interval was often estimated at less than half of its actual duration (i.e., an estimation of 15 minutes was often made for an interval actually of 30 minutes or more duration.) It was first thought that subjects were misunderstanding the directions for estimating the long interval, and special attention was given to making them very clear, during the discussion period between Item 10 and Item 11. When the gross underestimates continued, it was concluded that time estimation was being affected by a strong emotional factor. Being unsophisticated test subjects, most of the subjects had approached the test situation with anxiety and even fear that they would be unable to perform the tasks required, consequently embarrassing themselves. When they discovered how simple the tasks were, and they were successful both at the tasks and, they felt, at estimating time, their tensions dissolved and they relaxed and enjoyed the novel experience. The general feeling of the subjects at the end of each testing session was that they had been a part of something interesting, something they could talk about to their neighbors. Hence the gross underestimates?

It is known that there are certain favored digits which occur repeatedly as answers in tests involving numerals. These digits are 1 and 5. It is also known that there is a tendency for subjects to round numbers to the nearest number divisible by five or ten. Subjects were

requested, in the exercise instructions, to avoid such rounding unless they felt the interval actually was of that duration. In examining the test results, little evidence was found that favored digits had undue influence on the time estimates, and only a few subjects had rounded their time estimation numbers consistently for the two-minute and the short intervals. The long interval estimates were another matter. For all age groups the most common estimates made of the long interval were 15, 20, and 30 minutes, though the long interval's actual duration ranged from 27 to 39.75 minutes.

Most striking of the results obtained and not discussed previously was the apparent internal consistency of a subject's time estimation apparatus (again excluding the long interval.) A subject who underestimated the items on the first page of the exercise, usually underestimated those on the second page also. If he made or approached the correct estimate of the intervals on the first page, he usually did the same on the second page. The same applied to overestimation. It would seem that each individual does have an "internal clock," but whether it is set to standardized units of clock time is another matter.

II. RECOMMENDATIONS

The first and most obvious recommendation for further

research is that the present study be extended to include a larger number of subjects. With a larger N and an equal number of subjects in each age group, more sophisticated statistical procedures could be applied which could establish more reliable relationships between chronological age and temporal judgment than the present study did.

The second recommendation has to do with the content of the two-minute intervals included in the Time Estimation exercise. While the present study was not intended as replication of Loehlin's (1959) study of the influence of different activities on the apparent length of time intervals, the findings of the present study so strongly corroborate Loehlin's findings that not to do an item analysis and correlate the findings of both studies seems a waste of research effort.

The third recommendation perhaps has more interest value than research value. In the test groups were many husband-wife couples. It was suggested that it might be interesting to see if persons who have lived together for several years have similar perceptions of time, that is, are their "internal clocks" synchronized? The discussions of husbands and wives following the testing sessions seemed to indicate that just the reverse is true in most marriages, that one of the marriage partners becomes the "timekeeper" of the marriage while the other partner just drifts along

timewise--having "no sense of time," as described by the other partner. Such an investigation in perception of time might be of value in marriage counseling.

The last recommendation is that investigations be made concerning the relationship of temporal judgment to loss of memory. The possibilities for investigations in this area seem innumerable, a developmental study of memory dysfunction correlated with a developmental study of temporal judgment being only one suggestion.

III. SUMMARY

Using a time estimation test requiring judgment of various intervals of filled and unfilled past-time, a representative sample of 108 normal persons, age 15 to 95 years, who were in good health and living actively in a rural community, as determined by a questionnaire, were tested to determine the relationship of chronological age to the ability to judge time accurately. Subjects were required to judge three types of intervals: two-minute intervals, short intervals of only a few seconds, and a long interval of approximately thirty minutes.

Four statistical procedures were used to analyze the data. Means of average errors computed and graphed by chronological age in five and ten year increments showed a definite decline in ability to estimate time accurately as

age increased, the decline beginning at about age 25 and proceeding gradually until about age eighty when it declined markedly. Using a truncated group of 96 subjects from age twenty to eighty, Pearson product-moment coefficients of correlation were computed for the three types of intervals estimated to determine the degree of relationship between chronological age and temporal judgment. The correlation coefficient for the two-minute intervals was +.63 which indicates a substantial relationship; +.39 for the short intervals and +.22 for the long interval indicate a small but definite relationship. The coefficients of +.63 and +.39 were significant at the .01 level of significance. The coefficient of +.22 was significant at the .05 level of significance. Again using the truncated group of 96 subjects, Duncan's Range Test was used to test for significant differences among the different age groups. For all three types of time estimation intervals, all groups failed to be significantly different from each other at the .05 level, although for the two-minute intervals, the 80--89 and 20--29 age group failed to meet significance by only 1.1 seconds. Percentages of under-, correct, and overestimates made by the total group were computed for each of the three types of intervals. The short intervals showed the greatest percentage of correct answers; the long interval was consistently underestimated by all age groups. No trend could be discerned relating age to under- or overestimates.

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APPENDIX

Time Estimation Exercise Guide

(Pass out exercises)

Please look only at the first page of the papers you have been given. Do not turn to the second page until you are directed to do so.

You are all aware that when you are doing something pleasant, time seems "to fly," but that when you are doing something unpleasant--sitting in the dentist's chair, for example--it appears "to creep." This is an exercise to see how accurately people do judge the amount of time that passes. During the exercise you will be asked to work at a number of different types of tasks. At the end of each task you will be asked to estimate how much time you think you spent working at the task.

The tasks are outlined on the sheets which I have given you. To the right of each task is a box in which you will write down your estimate of the amount of time which you think you spent while you worked on the task. The tasks are numbered. Do not start on a task until you are directed to do so. Then work only on that task; do not move on to the next one until you are told to do so. You must listen to me closely, as each task requires its own individual instructions.

You will begin each task when I say "Start" and end it when I say "Stop." Immediately after I say "Stop," write

how long you think you worked on the task in the appropriate box at the right hand side of the page.

If you have on wristwatches, would you please remove them. Also, please do not use any other method to try to keep track of time, such as counting seconds to yourself, tapping your feet, etc. Just let time "flow by," so to speak.

1. Look at Item 1. The task is to write the arabic numeral 1, over and over, in the space provided. Write at your own normal rate of speed. Begin writing when I say "Start" and stop immediately when I say "Stop" and write in the box to the right of the item how long you think you were occupied at the task of writing 1's. Use minutes and seconds in your estimate.

There will be a rest period between each task, during which I will explain the next task and you may ask questions. Please, however, do not talk while you are working at a task.

Are there any questions?

When I next say "Start" it will signify the beginning of time for Item 1 and for the entire exercise. Ready--

Start--Stop--Write your estimate in minutes and seconds of the time spent writing 1's in the box to the right of Item 1.

2. After the number 2 you see the word "TRANSPORTATION." Your task in Item 2 is to make as many words as possible

using the letters in the word "TRANSPORTATION." Write the words you make in the space provided. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate of the time spent working at that task in the box to the right of Item 2.

3. In Item 3 I am going to give you several short intervals of time which I want you to estimate in seconds. Each interval will begin with the word "Start" and end with the word "Stop." You will have no tasks during these short intervals. Write your estimates immediately after I say "Stop" after the appropriate letter.

4 7 2 4 4 1 8 4

4. In Item 4 your task is to listen to me read. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate of the length of time I read, in minutes and seconds, in the box to the right of Item 4.

5. In Item 5 I want you to relax, close your eyes, and think about something very pleasant to you. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate in minutes and seconds of the time which passed while you were relaxing, in the box to the right of Item 5.

Turn the page.

6. In Item 6 you are again to write the arabic numeral 1 in the space provided, writing at your normal rate of speed. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate in minutes and seconds of the time spent writing 1's.

7. In Item 7 I am again going to give you several short intervals of time which I want you to estimate in seconds. Each interval will begin with the word "Start" and end with the word "Stop." Write your estimates immediately after I say "Stop" after the appropriate letter.

4 7 2 4 4 1 8 4

8. After the number 8 you see the word "MISSISSIPPI." Your task in Item 8 is to make as many words as possible using the letters in the word "MISSISSIPPI." Write the words you make in the space provided. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate of the time spent in the box to the right of Item 8.

9. In Item 9, I am going to read to you again. Your task is to count the number of times the word "the" appears in the passage I read. You may use any means to keep track of the number of times the word appears, either marking your paper or counting to yourself. The interval will begin when

I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate of the length of time I read in minutes and seconds in the box to the right of Item 9.

10. In Item 10 your task is to concentrate on the passage of time. The interval will begin when I say "Start" and end when I say "Stop." Ready--

Start--Stop--Write your estimate in minutes and seconds of the time which passed while you were concentrating on the passage of time in the box to the right of Item 10.

11. Item 11 is the last item. I will not say "Start." I will only say "Stop." When I next say "Stop," I want you to estimate how much time has passed while you have worked on this exercise, from the time when you made your first "1" on page one until I next say "Stop." Your time estimate should include the time spent working at tasks as well as the time we spent talking between the tasks. Ready--

Stop--Write your estimate in minutes and seconds of the total time of the exercise in the box to the right of Item 11.

(Pass out Questionnaire.)

Time Estimation

Use minutes and seconds in estimating time intervals.

For example:

1 min. 37 secs.

Estimate of Time Interval

1. (Write 1's)

2. (TRANSPORTATION)

3. a. e.
   b. f.
   c. g.
   d. h.

4.

5.

Time Estimation (Cont.)

Estimate of Time Interval

6. (Write 1's)

7. a. e.

b. f.

c. g.

d. h.

8. (MISSISSIPPI)

9. (Counting "the")

10.

11.

Questionnaire

1. My health is:

   (check one) ☐ Good ☐ Fair ☐ Poor

2. How often do you go to a doctor?

   (check one) ☐ Once a month or more ☐ Less often than once a month

3. What is your occupation? _____

4. To what clubs and organizations do you belong?

   (list) _____

5. Do you have any special interests or hobbies?

   (list) _____

6. Are you active in church affairs?

   (check one) ☐ Very active ☐ Somewhat active ☐ Not at all active

7. Are you:

   (check one) ☐ Male ☐ Female

8. Put a check in the box above the age range in which your present age falls:

   ☐ 15-19 ☐ 20-24 ☐ 25-29 ☐ 30-34 ☐ 35-39 ☐ 40-44 ☐ 45-49 ☐ 50-54

   ☐ 55-59 ☐ 60-64 ☐ 65-69 ☐ 70-74 ☐ 75-79 ☐ 80-84 ☐ 85-89 ☐ 90-94

9. How long have you lived in Tuolumne County? _____

10. With whom do you live? _____

    (Parents, Spouse, Children, Friend, etc.)