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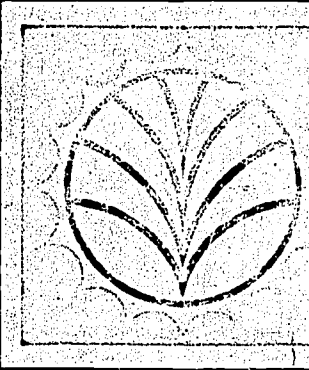
ABSTRACT

This paper explores the relationship between age and individual differences. Two hypotheses were tested through the use of repeated measures of functioning in terms of social, psychological, and physiological parameters: (1) individual differences do not decrease with age, and (2) individuals tend to maintain the same rank in relation to age peers throughout the later years of life. Data is taken from an ongoing eighteen-year longitudinal investigation of human functioning. The sample is composed of 106 survivors of an original panel of 271 persons initially 60 years or older. Conclusions are as follows: (1) when the mortality and dropout of a sample are controlled, the variances of a number of social, psychological, and physiological factors tend to remain constant through time; and (3) the range of observed individual differences is maintained, and within that range individual's rank ordering is relatively constant. (Author/LKP)



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# AGING AND VARIABILITY OF INDIVIDUAL DIFFERENCES: A LONGITUDINAL ANALYSIS OF SOCIAL, PSYCHOLOGICAL, AND PHYSIOLOGICAL INDICATORS

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The Problem

This paper explores the relationship between age and individual differences. The issues discussed are substantively important to understanding the later years of life and to the development of research methodology appropriate to the study of the human life cycle.

Does differentiation increase with age? Literature on human development repeatedly concludes that this is the case. (Sarbin, 1954, p. 239) But what about the later years--the middle and late years of life? Here scholarly literature does not reflect consensus but controversy. One important reason for this is that the literature on variability of individual differences in social and psychological functioning in late life has tended to be speculative in the absence of reliable data to support hypotheses.

One confronts, on the one hand, the claim--derived from life cycle theory--that individual differences persist in late life. Heterogeneity in late life reflects, it is argued, persistence of demonstrable differences in social life style and intellectual functioning in the middle adult years of life (cf. Bromley, 1966; Havinghurst, 1957; Neugarten, 1964; Riegal, 1971; Riegal, et. al., 1967). The literature on physiological functioning in late life suggests, moreover, that individual differences actually increase in late life (cf. Botwinick and Thompson, 1968; Comfort, 1968; Obrist, 1953). Dispersion of scores on a variety of physiological measures, it is hypothesized, increases through the aging process because some persons have maintained their earlier performance level while others have declined because of decremental aging effects.

But on the other hand, one also encounters arguments for de-differentiation in the later years. Proponents of such a view in the literature on

social, psychological, and physiological functioning typically argue that mean performance on a variety of parameters decreases in the later years (cf. Kelly, 1955; Malmo and Shagass, 1949; Riegal, et. al., 1967). With death being the end point of life, it is implied, individuals become increasingly alike as they approach this common denominator. Mean performance decreases, and there is an apparent regression toward the mean. Such dedifferentiation would presumably result from both selective mortality, which removes individuals who function least well, and increased morbidity, which limits the physiological functioning of survivors. Increased morbidity, in turn, constrains social and psychological functioning. In fact, then, there is not a regression toward the mean, in the traditional meaning of that term, but rather a narrowing of the range, with the less able persons dying from the population.

The available literature thus offers contradictory conclusions, and assessment of the comparative strengths of the competing arguments has been difficult because adequate explicit data often have not been available. Whether heterogeneity in populations remains stable, or increases, or instead decreases in the later years of life, and whether the hypothesized differentiation applies equally to social, psychological and physiological phenomena, remain unresolved issues in the absence of reliable data. The purpose of the present paper is to take a step towards resolving these issues through an analysis of data derived from a current longitudinal investigation of the aging process.

Hypotheses

We propose two hypotheses related to the question of aging and the maintenance of variability of individual differences in late life:

(1) Individual differences do not decrease with age. Variability within a variety of indicators is at least maintained, if not increased.

In most cases the decreases in individual differences which some studies have reported, we propose, are artifactual rather than substantive; they are due to selective survival and/or sampling variability rather than to decreases in the heterogeneity of the persons themselves who survive to old age.

(2) Individuals tend to maintain the same rank in relation to age peers throughout the later years of life. Maintenance of group variability is not due basically to "dynamic equilibrium" within a specific population, whereby there is random individual crossover and movement throughout the range of relevant scores. Again we argue that maintenance of differentiation is not artifactual but substantive. Even if social activities, for example, are curtailed in the aged group, those who earlier in life were the most active of their cohort remain, relatively speaking, the most active; less socially active middle aged persons become the less socially active elderly persons. This hypothesis is based on the claim for a persistence of life style throughout the adult years.

A major implication which these hypotheses have is that any generalization about "the aged" which assumes or implies increasing homogeneity should be viewed with the same skepticism as generalizations made about other highly diverse groups: for example, adolescents, adults, females, Blacks, Americans. Selective mortality does create a social, psychological, physiological elite among the older cohorts, and less diversity among the aged than among younger age groups is possible, though not demonstrated. What we seek to demonstrate in this paper is a different point: In an identified cohort, the range of individual differences among survivors is maintained. These persons continue to grow, develop, change--in short, to maintain their diversity in the face of the decrements of aging. As medical advances make possible more people living a normal life span, we would suggest, this diversity among the aged in the future will not be different from that observed in younger age groups.

Research Design

We have employed data from an on-going eighteen year longitudinal investigation of human functioning at the Duke University Center for the Study of Aging and Human Development. From a broader study we have concentrated on variability in individual differences over time. Our sample is composed of 106 current survivors of an original panel of 271 persons initially 60 years of age and older. Repeated measures of functioning in terms of a wide range of social, psychological and physiological parameters have enabled us to test the two hypotheses in a defined population.

Six rounds of observation are available, spanning an average of 13 years from time 1 to time 6. At each observation we have been able to measure and compare the variability observed among non-survivors as well as survivors in the original panel of 271.

We tested our first hypotheses through the use of Pitman's (1939) test for correlated variances, and we tested the second hypothesis by the Spearman rank order correlation.

For convenience in presenting data we have concentrated primarily on comparisons of surviving panelists at the first and sixth observations, though some information is presented here on observations at time two through time five.

From a battery of hundreds of measures covering a wide range of interdisciplinary variables, we identified 19 measures, which are listed on each of the tables in the handout, as illustrative for our purposes. Not all 19 variables were measured in all six observations, so at any particular observation there may be less than 19 variables for comparison. Only at time 6 are all 19 variables available. There are 15 variables with observations both at times 1 and 6. When times 3 and 6 are compared, on the other hand, there are 18 variables available.

We were also able to test variability of intra-individual differences with respect to one variable--visual reaction time. This is important to our argument because it enabled us to assess the extent to which observed variability in the aged is due to group differences or to changes in stability of responses with age, and the resulting effect of personal instability on group differentiation. Individual reaction time variability scores were subjected to the Pitman's test of correlated variances to see whether the dispersion of the variability scores changed significantly over time. A paired t test was made to see whether mean individual variability changed from time 1 to time 6.

Findings

Table 1 in the handout reports changes in variability of individual differences for the series of social, psychological, and physiological measures dealt with in this study. We will concentrate on comparing observations 1 and 6 in this summary of findings. Fifteen variables are available for comparison in testing the first hypothesis.

(1) For 8 out of the 15 variables there was no significant change in variance between times 1 and 6. Existing differentiation was maintained.

(2) For 5 out of 15 variables there was a statistically significant increase in variance from the first to the last observation. Differentiation in these cases increased.

(3) For 2 out of 15 variables there was a significant decrease in variance

(4) Table 2 presents the group variances for all the measures for all observations. For 6 out of 15 variables, the time 1 variance was the smallest of the six variances. For 6 out of the 19 measures available at the last observation, the time 6 variance was the largest of the six. However, there was no linear, monotonic increase in variance (except for the 3 measures of weight) from times 1 through 6.

(5) This lack of a linear, monotonic increase in variance through all six observations led us to test the difference in variance between times 3 and 6 to insure that our earlier findings were not an artifact of the particular observations selected. When times 3 and 6 were compared, there were 18 variables available. Sixteen of the 18 showed a maintenance of variability. Two variables showed a significant increase in variance; there were no significant decreases in variance. This leads us to conclude that maintenance of variability is an hypothesis consistent with these data.

(6) Table 3 presents average variances over three adjacent time periods. These averages were computed in an effort to make generalizations about the pattern of variance between times 1 and 6. In sum, for 15 out of 19 measures the average of times 1, 2, 3 variance was smaller than the average of times 4, 5, 6 variance, indicating a general, though not necessarily significant, trend toward increase in variance through time.

(7) In a separate analysis of these longitudinal data we did not control for mortality and, thus, were essentially observing two different groups at times 1 and 6 in much the same way as those doing a cross-sectional analysis. Comparing the two sections of Table 3, one observes that when mortality is not controlled, variance for most measures does appear to decrease with time. From this we infer that reported decrease in variance is in most cases a spurious finding, frequently an artifact of sampling.

(8) There was no clear evidence of change in variability of intra-individual differences of reaction time (RT) through the five available observations. Figure 1 presents the RT means, standard deviations, RT variability, and mean RT variability. Both the Pitman's test of correlated variances and the paired t test showed no evidence of an increase in personal "instability of RT measures with aging.

(9) Finally, Table 4 presents the rank order correlations for the 15

variables at times 1 and 6 and the 18 variables at times 3 and 6. Rank order is clearly maintained in most measures of functioning.

Conclusions

Our conclusions are straightforward. When the mortality and dropout of a sample are controlled, the variances of a number of social, psychological, and physiological variables tend to remain constant through time. In some instances there is a significant increase in group heterogeneity. Increased variability of individual differences, moreover, is not due simply to increased personal variability or instability. On the contrary, there is stability through time in individual variability in at least the case of visual reaction time. Rarely is there a decrease in group differentiation through time. Our first hypothesis is confirmed.

The range of observed individual differences is maintained, and within that range individual's rank ordering is relatively constant. The second hypothesis is confirmed.

This study thus refutes the generalization that, while children and adolescents become more differentiated through their development, adults become less differentiated with increasing age. The data presented here give further evidence that development, change, growth, continue through the latter years of the life cycle in spite of the decrement of social, psychological, and physiological functioning which often accompanies the aging process. This development is reflected basically in a relative maintenance or persistence of life style and functioning which continues from the middle-adult years.

TABLE 1

CHANGES IN VARIABILITY: OBSERVATIONS 1 AND 6, 3 AND 6, FOR SELECTED PARAMETERS OF FUNCTIONING

| Parameter | N# | Test for correlated Variances + 1 and 6 | Test for correlated Variances + 3 and 6 |
|---|---|---|---|
| **Social/Social Psychological** | | | |
| Life Satisfaction | 69 | -.26* | -.20 |
| Level of Social Activity | 71 | -.07 | .05 |
| Self Health Assessment | 72 | .23* | -.03 |
| Concern about Health | 64 | -.37** | .04 |
| Depression | 60 | ++ | .02 |
| **Psychological** | | | |
| WAIS, full scale | 59 | -.10 | -.15 |
| WAIS, verbal weighted | 63 | -.09 | -.12 |
| WAIS, performance weighted | 59 | -.02 | -.12 |
| Reaction time | 56 | ++ | -.15 |
| **Physiological** | | | |
| Physician's Functional Rating | 55 | .12 | .07 |
| Performance Status | 80 | ++ | -.38** |
| Weight | 63 | -.07 | ++ |
| Cardio-vascular State | 51 | -.31* | .01 |
| Visual Acuity, right | 55 | -.46** | -.03 |
| Visual Acuity, left | 53 | -.45** | .06 |
| Hearing Loss, binaural | 59 | -.14 | -.30* |
| Diastolic Blood Pressure | 62 | .30* | .22 |
| Systolic Blood Pressure | 62 | -.04 | .04 |
| Blood Cholesterol | 33 | ++ | -.18 |

# The basic sample size for this study was 106. For specific analyses the number of subjects varies because there were missing data at various points of measurement for almost all subjects. For each measure of functioning only persons who had all completed data for that one measure were included.

+ A negative correlation indicates an increase in variance through time. A positive correlation means a decrease.

++ No data was collected for this variable at the times indicated.

* $p < .05$

** $p < .01$

TABLE 2

GROUP VARIANCES: OBSERVATIONS 1 THROUGH 6 FOR SELECTED PARAMETERS OF FUNCTIONING

| Parameter | N# | Time 1 + | Time 2 | Time 3 | Time 4 | Time 5 | Time 6 |
|---|---|---|---|---|---|---|---|
| **Social/Social Psychological** | | | | | | | |
| Life Satisfaction | 69 | 20.5* | 23.9 | 22.5 | 23.5 | 26.2 | 31.1** |
| Level of Social Activity | 71 | 37.3 | 38.5 | 44.8** | 31.2* | 32.3 | 41.7 |
| Self Health Assessment | 72 | 3.2** | 2.3 | 1.9 | 1.6* | 2.2 | 2.0 |
| Concern about Health | 64 | .3* | .6 | .7** | .6 | .6 | .6 |
| Depression | 60 | ++ | 1.1** | 1.0 | .6* | .9 | .9 |
| **Psychological** | | | | | | | |
| WAIS, full scale | 59 | 869.4 | 813.4* | 844.4 | 876.8 | 967.8** | 942.0 |
| WAIS, verbal weighted | 63 | 378.7 | 369.4* | 369.9 | 393.5 | 426.7** | 403.9 |
| WAIS, performance weighted | 59 | 138.1 | 123.9* | 128.5 | 130.7 | 141.8** | 141.3 |
| Reaction time | 56 | ++ | 109.3* | 247.1 | 131.7 | 160.2 | 305.2** |
| **Physiological** | | | | | | | |
| Physician's Functional Rating | 55 | 1.0** | .8 | .9 | .5* | .8 | .8 |
| Performance Status | 80 | ++ | ++ | 118.8 | 95.4* | 175.7 | 239.1** |
| Weight | 63 | 8.6* | 8.9 | ++ | ++ | ++ | 9.1** |
| Cardio-vascular State | 51 | 1.3* | 1.6 | 2.4 | 2.5** | 1.6 | 2.4 |
| Visual Acuity, right | 55 | 1.5* | 3.4 | 3.6 | 2.9 | 2.2 | 3.8** |
| Visual Acuity, left | 53 | 1.2* | 1.5 | 3.1** | 2.9 | 2.1 | 2.8 |
| Hearing Loss, binaural | 59 | 139.3 | 128.1* | 129.4 | 150.5 | 162.3 | 167.6** |
| Diastolic Blood Pressure | 62 | 1.7 | 1.0* | 1.5 | 1.5 | 2.3** | 1.0 |
| Systolic Blood Pressure | 62 | 5.3 | 4.4* | 6.1 | 5.7 | 6.8** | 5.6 |
| Blood Cholesterol | 33 | ++ | ++ | 16.2 | 16.1* | 16.5 | 21.8** |

# See Table 1 for explanation of sample size.
++ No data was collected for this variable at times indicated.
* Smallest variance in the six observations.
** Largest variance in the six observations.
+ Years between times of observation vary. In the early years of the study subjects were interviewed every 4-5 years. Later observations have been made at 2-3 year intervals as the sample has decreased in size and subjects have become very old.

TABLE 3

CHANGES IN VARIABILITY: OBSERVATIONS 1-3 and 4-6 FOR SELECTED PARAMETERS OF FUNCTIONING, MORTALITY CONTROLLED AND NOT CONTROLLED

| Parameter | Mortality Controlled+ Average Variances Times 1-3 | Times 4-6 | Mortality Not Controlled++ Average Variances Times 1-3 | Times 4-6 |
|---|---|---|---|---|
| **Social/Social Psychological** | | | | |
| Life Satisfaction | 22.3 | 26.9* | 31.8* | 31.2 |
| Level of Social Activity | 40.2* | 35.1 | 42.9* | 42.6 |
| Self Health Assessment | 2.5* | 1.9 | 3.0* | 2.4 |
| Concern about Health | .5 | .6* | .7 | .8* |
| Depression | 1.0* | .8 | 1.1* | .8 |
| **Psychological** | | | | |
| WAIS, full scale | 842.4 | 928.9* | 1007.5 | 1054.5* |
| WAIS, verbal weighted | 372.7 | 408.0* | 416.5 | 434.3* |
| WAIS, performance weighted | 130.2 | 137.9* | 159.8 | 165.9* |
| Reaction time | 178.2 | 199.0* | 195.1 | 531.6* |
| **Physiological** | | | | |
| Physician's Functional Rating | .9* | .7 | 1.2* | .8 |
| Performance Status | 118.8 | 170.1* | 194.7 | 203.7* |
| Weight | 8.8 | 9.1* | 9.2* | 8.7 |
| Cardio-vascular State | 1.8 | 2.2* | 2.5* | 2.1 |
| Visual Acuity, right | 2.8 | 3.0* | 3.3 | 3.3 |
| Visual Acuity, left | 1.9 | 2.6* | 3.0 | 3.0 |
| Hearing Loss, binaural | 132.2 | 160.1* | 231.3* | 206.7 |
| Diastolic Blood Pressure | 1.4 | 1.6* | 1.8* | 1.6 |
| Systolic Blood Pressure | 5.2 | 6.0* | 7.6* | 6.0 |
| Blood Cholesterol | 16.2 | 18.1* | 16.4 | 18.0* |

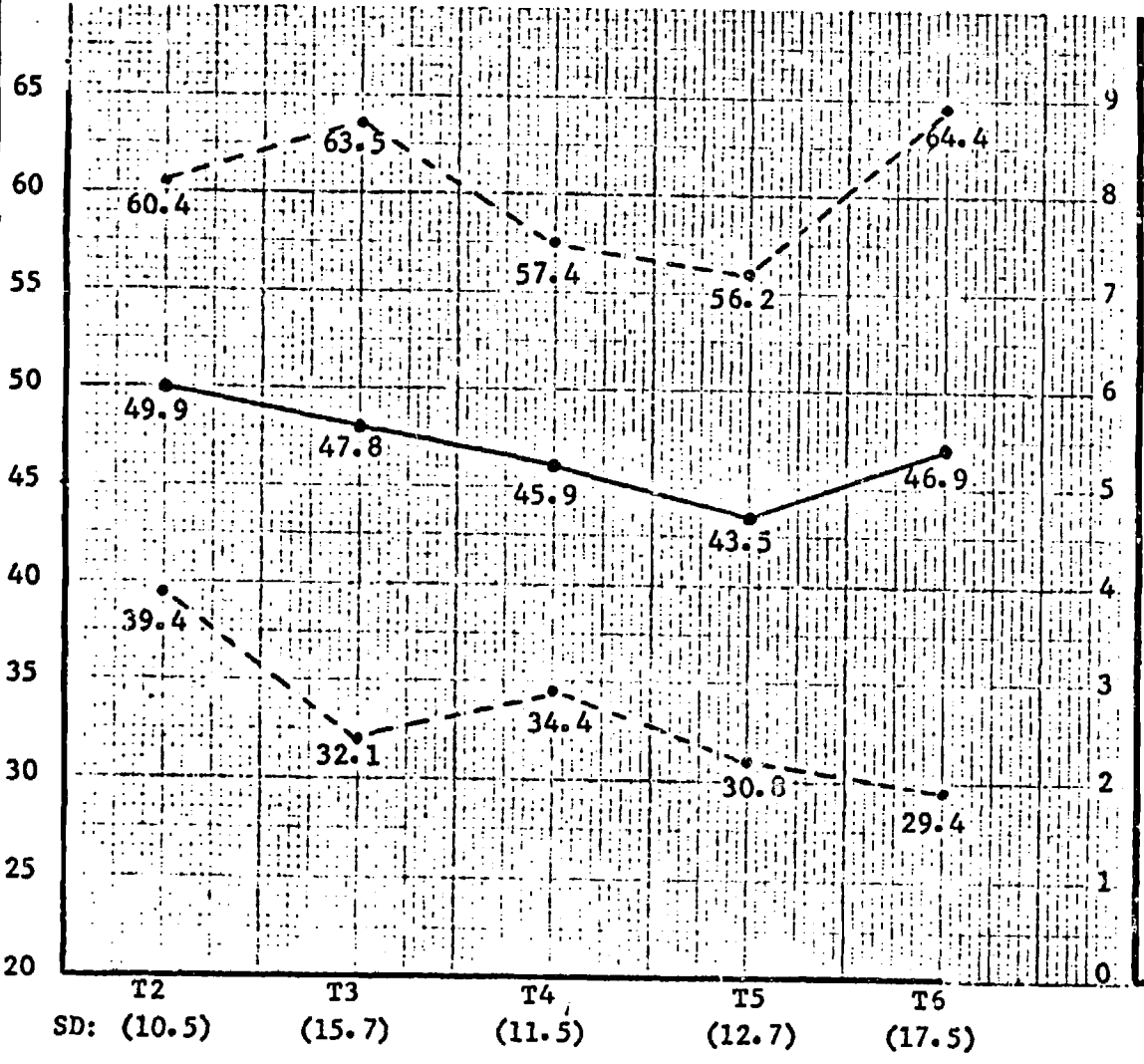
* Larger of the two variance averages

\+ Basic sample N = 106

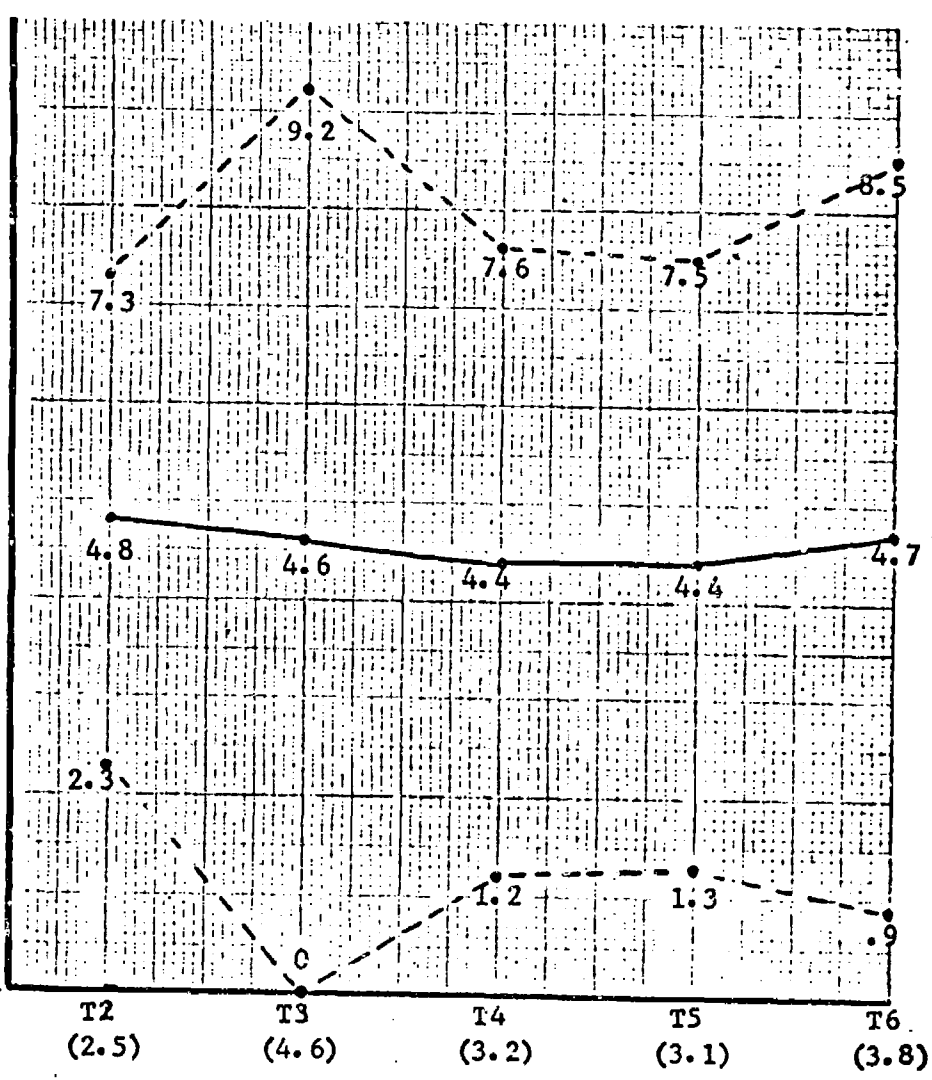
++ Basic sample N = 271

FIGURE 1

Mean Reaction Time Scores (milliseconds) and Standard Deviations by Observation*




Mean Intra-Individual Reaction Time Variability Scores (milliseconds) and Standard Deviations by Observation **




* For each subject a grand mean of his 4 RT mean scores was computed. The above "Mean RT Scores" are the group means of these individual grand RT means.

** The standard deviation of the 4 RT means around the grand mean for each subject became his RT variability score. The above mean RT variability scores are the group means of these individual RT variability scores.

TABLE 4

PERSISTENCE OF RANK ORDER: OBSERVATIONS 1 AND 6, 3 AND 6

FOR SELECTED PARAMETERS OF FUNCTIONING

| Parameter | N# | Spearman Rho, 1 and 6 | Spearman Rho, 3 and 6 |
|---|---|---|---|
| Social/Social Psychological | | | |
| Life Satisfaction | 69 | .65** | .60** |
| Level of Social Activity | 71 | .55** | .67** |
| Self Health Assessment | 72 | -.02 | .17 |
| Concern about Health | 64 | .35** | .29* |
| Depression | 60 | ++ | .02 |
| Psychological | | | |
| WAIS, full scale | 59 | .92** | .94** |
| WAIS, verbal weighted | 63 | .93** | .93** |
| WAIS, performance weighted | 59 | .85** | .91** |
| Reaction time | 60 | ++ | .64** |
| Physiological | | | |
| Physician's Functional Rating | 55 | .12 | .31* |
| Performance Status | 80 | ++ | .48** |
| Weight | 63 | .89** | ++ |
| Cardio-vascular State | 51 | .15 | .44** |
| Visual Acuity, right | 55 | .41** | .43** |
| Visual Acuity, left | 53 | .36** | .53** |
| Hearing Loss, binaural | 59 | .76** | .91** |
| Diastolic Blood Pressure | 62 | .45** | .44** |
| Systolic Blood Pressure | 62 | .51** | .43** |
| Blood Cholesterol | 33 | ++ | .57** |

# See Table 1 for explanation of sample size.
++ No data was collected for this variable at the times indicated.
* $p < .05$
** $p < .01$

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