Experimental Mortality and Terminal Drop

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The problem of experimental mortality, i.e., subject attrition, is a major issue of concern for behavioral scientists engaged in longitudinal or sequential research. It has been well substantiated in the literature (Baltes and Nesselroade, 1972; Baltes, Schaie, and Nardi, 1971; Riegel and Riegel, 1972; Riegel, Riegel, and Meyer, 1967b; 1968; Schaie, Labouvie, and Barrett, 1973; Schaie and Parham, 1974; Streib, 1966) that dropouts in longitudinal studies are a population with specific negative attributes insofar as intellectual, social-psychological, and personality attributes are concerned. Unless this effect is controlled for, studies employing retests will not accurately describe "true" developmental trends. Individuals who remain in a study employing a retest design represent a population which becomes more positively biased with each retest, and if true population trends are to be charted, the characteristics of dropouts in a given population should be determined and used as bases for extrapolation of results to the sample of interest.

One aspect of the subject attrition problem which might serve to confound the description of dropout subject characteristics is that of the attributes of subjects who have died between testings. Various researchers (see Siegler, 1975, for a review) have been concerned with this issue and the related one of a sudden decrement in psychological functioning known as terminal drop. Although the present study does not deal directly with the concept of terminal drop, it does attempt to chart simultaneously performance on intellectual measures for retested individuals, dropouts, and decreased subjects in a series of sequential analyses.

Method

Subjects. Data for a total of 1,260 subjects from the 1963 and 1970 independently tested samples described in Schaie and Labouvie-Vief (1974) were analyzed in this study. Subjects were selected on the basis of participation--participants were cooperative retestees at the first contact subsequent to testing, dropouts refused retest or were unable to be contacted, and deceased subjects were those who were known to have died between contacts. Within this scheme, subjects were further categorized into three 14-year birth cohorts, ranging from 1886 to 1927. Data were organized into age groupings with three 14 year age intervals, from 36 to 77 years.

Measures. The measures used were subtest scores from the Primary Mental Abilities (PMA) (Thurstone and Thurstone, 1949) test, two composite measures of IQ and educational ability, derived from the PMA, and three factor scores from the Test of Behavioral Rigidity (TBR) (Schaie and Parham, 1975). A complete listing and description of variables is seen in Table 1.

Measures were transformed into T-scores (M=50, SD=10) and analyzed first in a cross-sequential ANOVA in a 3 (participation group) x 3 (cohort) x 2 (time of testing) x 2 (sex) design. Data were then reorganized by age and a time-sequential ANOVA in a similar design was applied.

Results

Only effects relevant to the question of the role of dropouts and deceased individuals in a retest situation will be discussed. For an explication of results attributable to Cohort, time of test, and sex, see Schaie and Labouvie-Vief, 1974.

Cross-sequential results. A significant main effect for participation at p .001 was obtained on all variables (see Table 2). It was found that retested subjects scored highest and deceased subjects lowest on all measures (see Table 3).

A participation x time interaction (p .001) (see Table 2) was found for verbal and educational ability. Examination of means for both of these variables showed that in 1963, retestees and deceased subjects scored higher than they did in 1970, while the converse was true for dropouts (see Figure 1).

An interaction of participation by cohort (p .01) (see Table 2) was found for word fluency and IQ. Inspection of means in Fig. 2 indicated that in the youngest cohort, there was virtually no difference in score on both variables between all three participation groups, but in the two older cohorts, there was differentiation between the participation and the attrited subjects.

No other interactions involving participation were significant beyond the .01 level of confidence.

Time-sequential results. The time-sequential analysis was used as a supplement to the cross-sequential analysis in order to clarify the source of variance attributable to either age or cohort. In the time-sequential analysis, the generational confound, if present, is located in the main effect for age (since in this analysis a 42-year age span is covered) rather than in time of measurement (which covers only a 7-year span). Significant time-of-measurement effects occurring in both time-sequential and cross-sequential analyses are indeed attributable to socio-cultural change. But those which do not occur in the time-sequential analysis must be attributed to maturational effects. F ratios for age effects equivalent to or lower than comparable F's for cohort in the cross-sequential analysis can be interpreted most parsimoniously as indications of cohort effects. Conversely, when corresponding F's for age are greater than those for cohort, and a time-of-measurement effect now occurs, even though none appeared in the cross-sequential analysis, the observed effects can then be attributed to age.

Main effects were found for participation on all variables (p .001) (see Table 4). Comparison of F ratios from the two analyses indicated that age changes have explanatory power only for space, reasoning, and MCR, while effects for all others could be accounted for by generational differences.

Participation by age interactions, (p .05) were found for number, word fluency, and IQ. Means (see Fig. 3) showed that for the youngest sample, participation groups were equivalent on these variables, while in the middle and oldest groups, the retestees and the two attrition groups differed. Here age is the explanatory variable for number since there is no corresponding cohort x time interactions in the cross-sequential analysis, while cohort differs in the major source of variance for word fluency and IQ.

Participation x time interactions were significant (p .001) for verbal and educational ability and (p .005) for reasoning and Personality-perceptual rigidity (see Table 4). Examination of means, (Fig. 4) suggest that deceased and dropout subjects scored higher in 1970 on all four variables than they did in 1963.

Discussion

The results of both cross and time-sequential analyses provide support for the hypothesis that, on measures of intellectual function, retested subjects score highest and deceased subjects lowest. Thus, the effect of participation described by the Riegels (Riegel and Riegel, 1972) is supported by our data.

The meaning of the significant participation by time interactions in the two analyses is somewhat unclear. In the cross-sequential analysis, retested subjects in the 1963 samples scored higher than those in 1970, but in the time-sequential analysis, the significant interaction occurs because deceased subjects scored high in 1970 than did deceased subjects in 1963. However, differences between those subjects who were retested and those who dropped out or died were considerably larger in 1963 than in 1970 (p .001). This finding raises the interesting question of whether attrition effects might be specific to times of measurement. Many of the dropout effects noted in studies conducted in the 50's and 60's might conceivably not be replicable in the future.

The significant participation by cohort interactions significant at the .01 level of confidence, and the participation by age interaction (p .05), support the concept that differences between attrited and retested subjects are greater for older cohort (on word fluency and IQ, and for older Ss number). It might thus be possible to predict future participation status from test scores on number word fluency, and IQ. This finding is in contrast to the Riegels' (Riegel and Riegel, 1972) finding that attrition might be predictable by cohort or age, since we did not replicate their results that either age or cohort level is a predictor of dropout or death (Riegel, Riegel, and Meyer, 1967 a; b; 1968).

Nevertheless, our findings currently lead us to conclude that attrition, through dropout or death of subjects must be treated as an important variable in charting trends of intellectual function across the life span. Attrition, however, may play a greater role in examination of such functioning at older ages, and may otherwise be time-specific. Further study of the age participation phenomenon over time is warranted to determine its stability and to examine more precisely the role of cohort age and time in the study of subject attrition.

TABLE 1

Listing of and brief description of variables

1.	**Primary Mental Abilities subtests (Thurstone and Thurstone, 1949)**	
1.	Verbal Meaning (V)	Recognition Vocabulary (synonyms)
2.	Space (S)	Matching of rotated spatial figures
3.	Reasoning (R)	Determining the "logic" of a letter series
4.	Number (N)	Checking simple addition problems
5.	Word Fluency (W)	Number of words recalled to a given initial letter
2.	**Derived scores (Thurstone, 1958)**	
6.	IQ	V + S + 2N + W
7.	Educational Aptitude (EQ)	2V + R
3.	**Test of Behavioral Rigidity factor scores (Schaie and Parham, 1975)**	
8.	Motor-cognitive rigidity (MCR)	Ability to shift from one activity to another
9.	Personality-perceptual rigidity (PPR)	Ability to perceive and adjust to unfamiliar and new patterns and situations
10.	Psychomotor speed (PPS)	Rate of emission of familiar cognitive responses

TABLE 2

Significant F Ratios, Cross-Sequential ANOVA
(Participation by Cohort by Time by Sex)

VARIABLE	PARTICIPATION (P) df=2/1190	TIME (T) df=1/1190	PxT df=1/1190	PxCOHORT df=4/1190
Verbal Meaning	69.999***		7.599***	
Space	37.172***	7.592***		
Reasoning	61.415***		4.263*	
Number	22.221***			
Word Fluency	21.110***			4.246**
IQ	66.155***			3.687**
Ed. Aptitude	78.418***		7.763***	
MCR	35.047***	11.845***		
PPR	29.087***		4.063*	
PPS	55.457***	12.797***		

* Significant at or beyond the 5% level of confidence
** Significant at or beyond the 1% level of confidence
*** Significant at or beyond the .1% level of confidence

TABLE 3

MEANS FOR ALL VARIABLES, PARTICIPATION MAIN EFFECT
(Cross-Sequential ANOVA)

VARIABLE	PARTICIPANTS (N=528)	DROPOUTS (N=563)	DECEASED (N=135)
Verbal Meaning	51.229	47.089	42.563
Space	49.728	47.170	43.763
Reasoning	49.547	46.028	42.170
Number	51.199	48.699	45.467
Word	49.621	47.267	44.667
IQ	59.480	46.670	42.156
Ed. Aptitude	50.902	46.665	42.015
MCR	50.181	47.318	43.919
PPR	50.711	47.856	44.459
PPS	49.719	46.962	41.733

TABLE 4

Significant F Ratios, Time-Sequential ANOVA
(Participation by Age by Time by Sex)

VARIABLE	PARTICIPATION (P) df=2/1224	TIME (T) df=1/1224	PxT df=2/1224	PxAGE df=4/1224
Verbal Meaning	71.879***		7.463***	
Space	37.043***			
Reasoning	66.867***	17.532***	3.604*	
Number	22.236***	7.420**		3.136*
Word Fluency	24.075***			2.726*
IQ	70.194***	13.141***		3.057*
Ed. Aptitude	82.192***	19.318***	7.399***	
MCR	37.071***			
PPR	29.962***	12.796***	4.315*	
PPS	57.848***	63.022***		

* Significant at or beyond the 5% level of confidence
** Significant at or beyond the 1% level of confidence
*** Significant at or beyond the .1% level of confidence

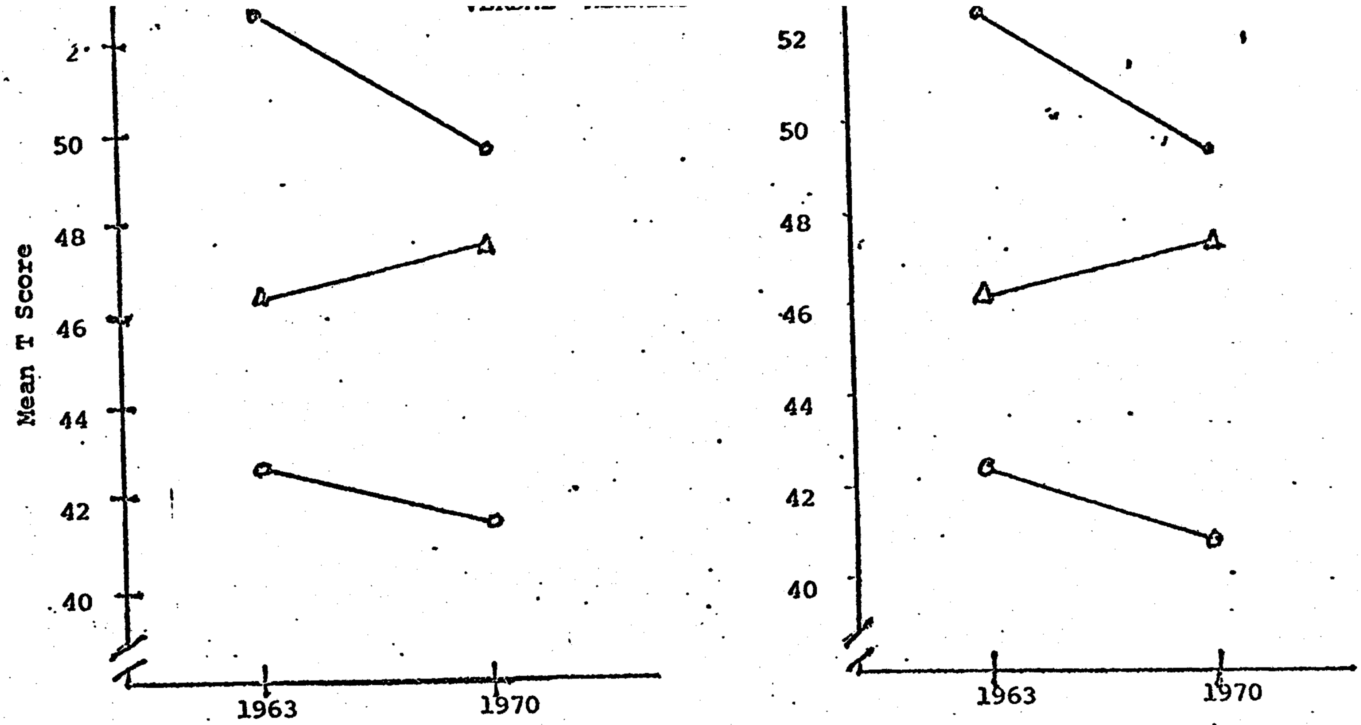


Figure 1
Significant Participation x Time Interactions,
Cross-Sequential Analysis

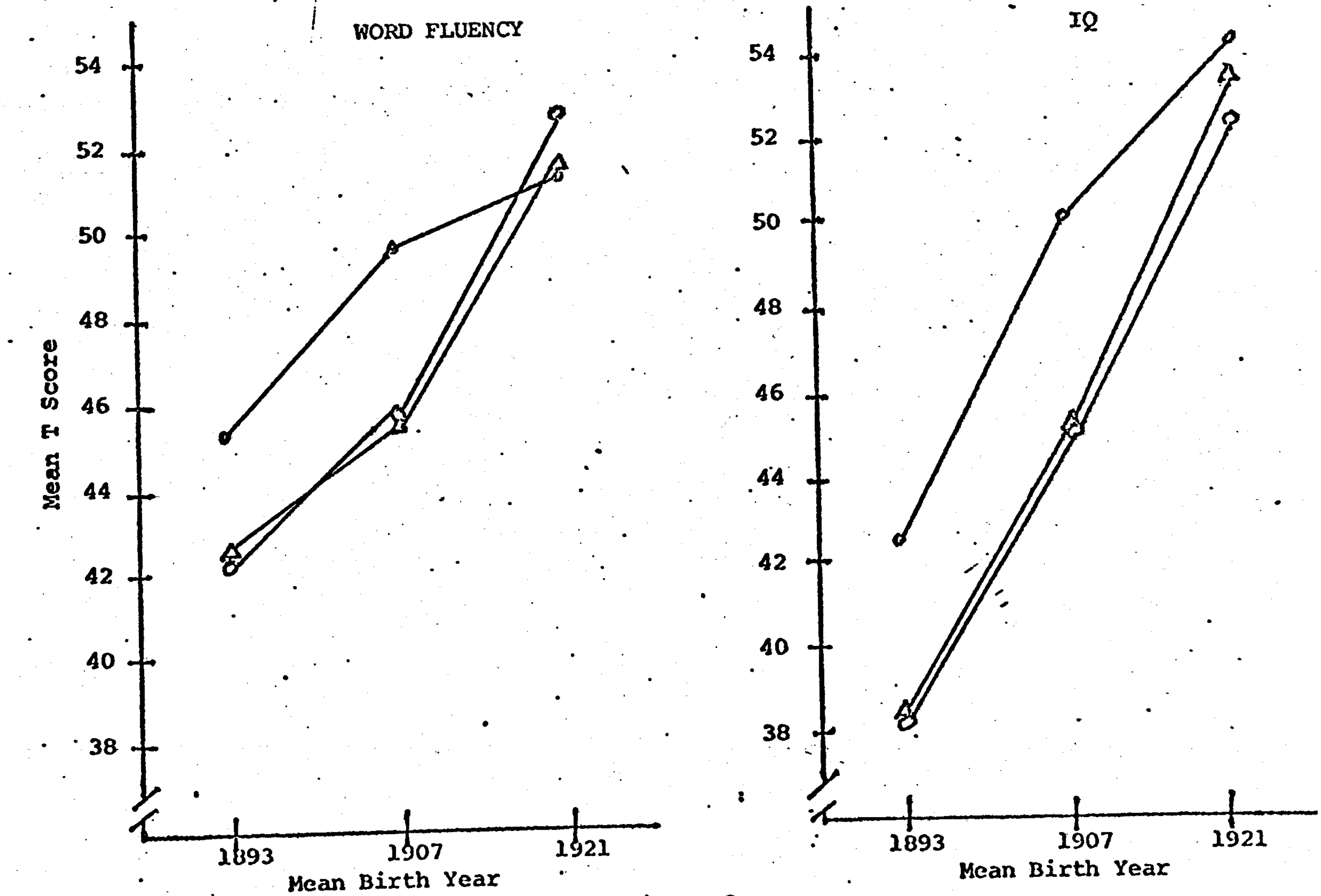


Figure 2
Significant Participation x Cohort Interactions,
Cross-Sequential Analysis

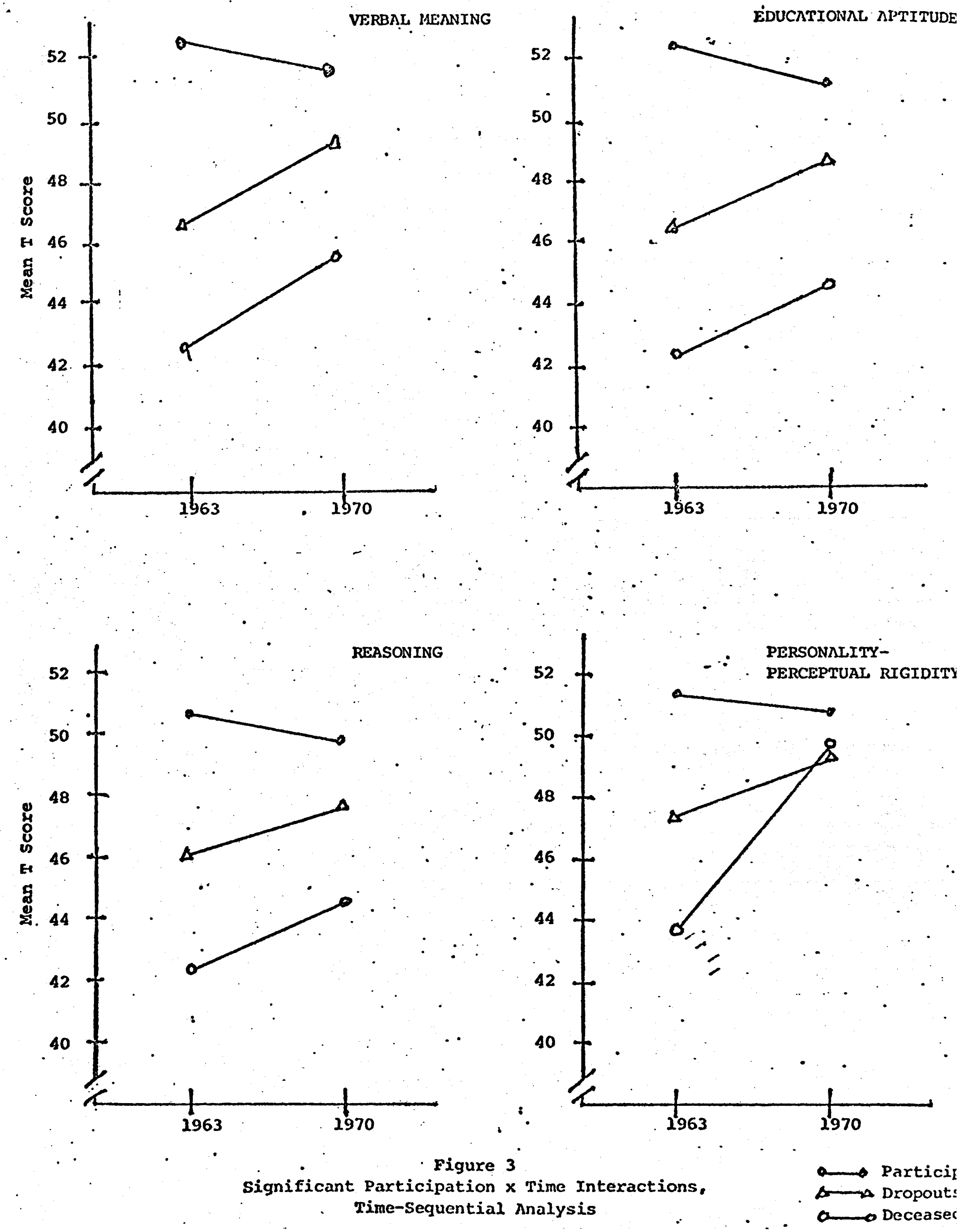
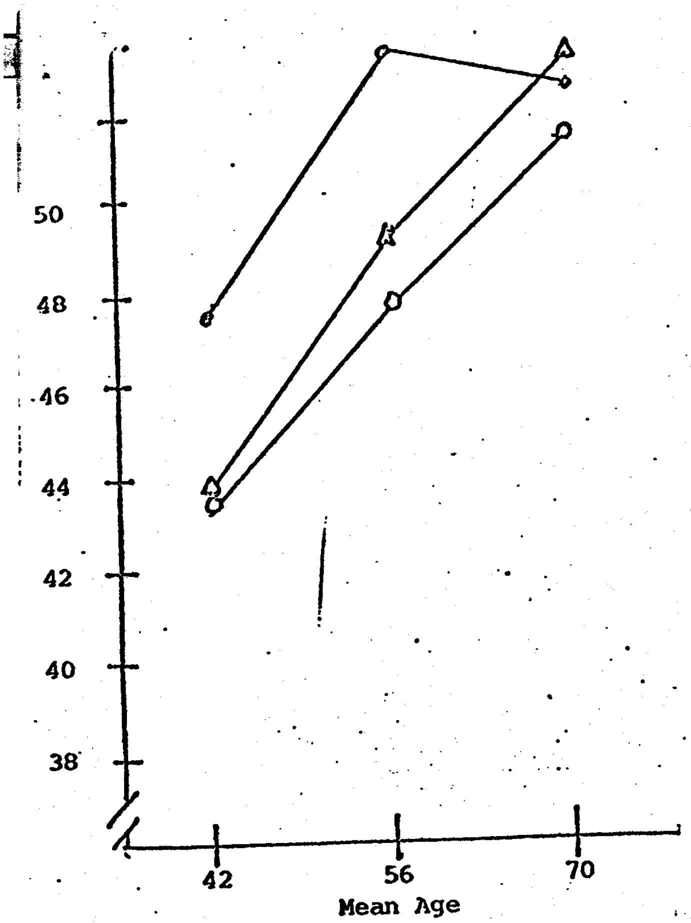
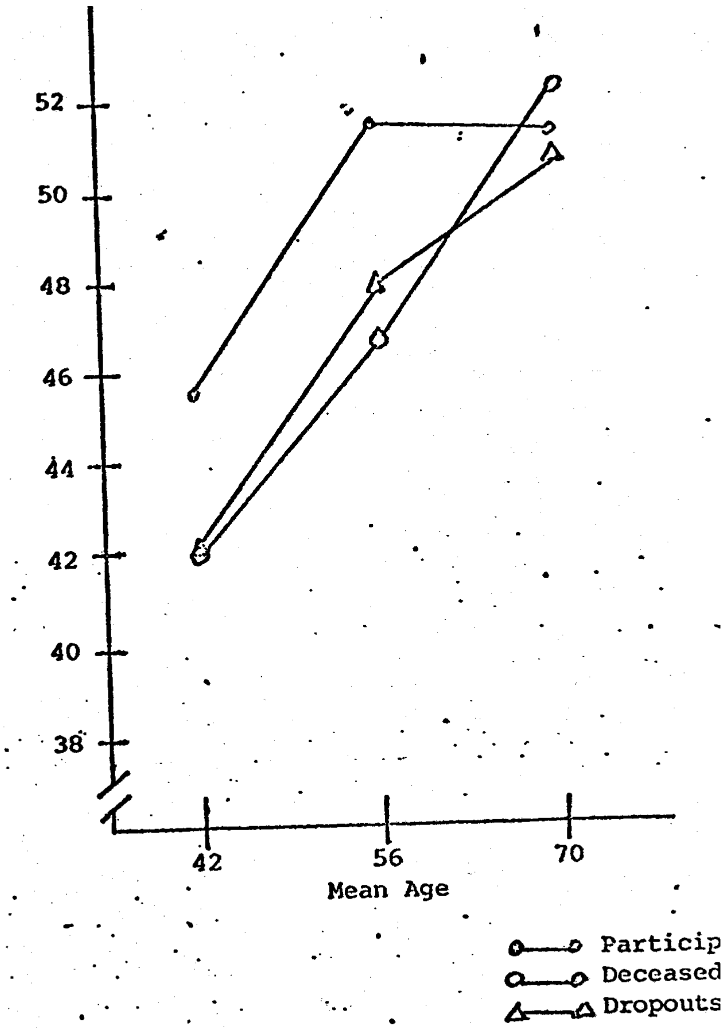


Figure 3
Significant Participation x Time Interactions,
Time-Sequential Analysis





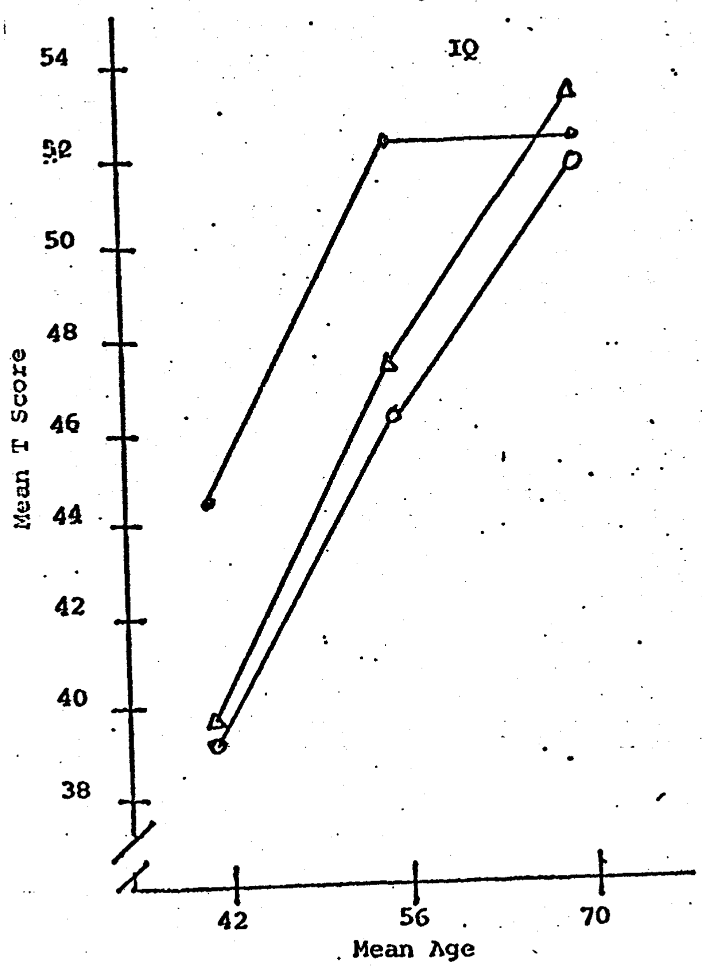


Figure 4
Significant Participation x Age Interactions,
Time-Sequential Analysis