PRIOR LEVELS OF PERFORMANCE AS FACTORS PREDICTING SUBJECT ATTRITION IN THE SEATTLE LONGITUDINAL STUDY

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Introduction

Longitudinal research has produced a fair amount of evidence illustrating the considerably higher levels of functioning that exist in individuals who continue to participate in longitudinal studies compared to those who drop out (Baltes, Schaie & Nardi, 1971; Riegel & Riegel, 1972; Riegel, Riegel & Meyer, 1968; Schaie, Labouvie & Barrett, 1973; Siegler & Botwinick, 1979). The methodological importance of examining factors related to subject attrition grows, therefore, as longitudinal studies are extended over time, and the samples become increasingly positively selected.

In major longitudinal studies of adulthood, however, the issue of subject attrition has gathered attention for reasons that go beyond its specific methodological relevance. By examining factors related to subject attrition we can also expand our substantive understanding of processes such as dying - one cause associated with much of the attrition in studies of adulthood and aging. Generally, the research addressing death-related attrition and its correlates employs the concept of terminal decline. Kleemeier (1962) defined terminal decline as that decline in functioning that was not a mere reflection of chronological age, but rather was a reflection of pronounced deterioration prior to death. Berg (1985) recently convincingly argued that, indeed, decline relates more strongly to distance from death than it does to chronological age.

While many studies have compared study survivors with non-survivors who die, few data are available on individuals within attrition groups who drop out for reasons other than death, such as

illness or non-health related reasons. It is not clear, therefore, how these different types of drop-outs differ from study survivors, or how they might differ from one another. An analysis focusing on this issue has relevance for studying terminal decline; the terminal decline hypothesis would suggest that at the testing point prior to attrition, those subjects who eventually die should be functioning less adequately than the subjects who become ill but do not die by the attrition point. And both ill and deceased subjects should be functioning less effectively than non-health related drop-outs and survivors. The same question can be examined with decline levels rather than absolute levels of performance prior to attrition. In that case, we might expect greater decline for the death imminent group than for the group who would become ill but not die by the next testing point. Age within specific attrition groups might also be an important factor in the differences we observe, since the probability of dying will notably increase in a sample of older study participants.

These issues are addressed here with data from the Seattle Longitudinal study, a 28-year study of cognitive functioning in adulthood. We propose to examine the following questions:

1. Are prior levels of performance on measures of cognitive functioning significantly different for individuals who eventually drop out of the SLS due to non-health related reasons, illness, or death?

2. Does the reason for attrition differentiate between the degree of decline observed prior to the attrition point?

3. Are the effects of drop-out status (reason for attrition) on cognitive functioning different, dependent on the age of the subjects?

Methods

Subjects. All of the subjects included in this study were participants of the Seattle Longitudinal Study (SLS). The original SLS sample was drawn from membership records of the Group Health Cooperation of Puget Sound. Demographic characteristics of the sample are favorably biased: most of the employed individuals work in either skilled or semi-professional jobs, obtained education levels are generally in the high school to college range, and SES tends to be somewhat skewed toward the middle to upper income brackets. The participants included in our subsample ranged in age from 43 to 84 in 1970, and thus are part of the oldest six seven-year cohorts of the SLS.

A subset of 520 individuals was chosen for inclusion in this study because they had participated in the two testing occasions (1970 and 1977), immediately preceding the 1984 assessment, which we identified as our attrition point. Between 1977 and 1984, 141 of these participants dropped out of the SLS, leaving 379 individuals who we refer to hereafter as the Survivors. Reasons for the non-participation of the 141 drop-outs are of central importance to this paper. Information was therefore obtained on the reasons why individuals did not continue to participate in the study, either from the response cards they returned during the 1984 recruitment period or from their physicians' records. These data indicated that 39

individuals voluntarily eliminated themselves from the SLS for non-health related reasons, such as traveling, time constraints, etc. We will refer to these non-survivors as the Voluntary Drop-outs. Thirty-five individuals, who we will refer to as the Disabled, dropped out of the study because they were reportedly too ill to continue participating. The remaining 67 individuals died between the years of 1977 and 1984, and thus make up the Deceased portion of our non-survivor group.

Measurement Variables. The present study employed data from 8 measures that were part of the larger test battery of the S.L.S. Five of these measures are subtests of the Primary Mental Abilities Test (PMA) (Thurstone & Thurstone, 1948) that assesses the basic intellectual abilities of Verbal Meaning, Space, Reasoning, Number and Word Fluency. In addition, the Test of Behavioral Rigidity (TBR) (Schaie & Parham, 1975) sampled 3 aspects of cognitive response style, including Motor cognitive rigidity (MCR), Personality-Perceptual Speed (PPR) and Psychomotor Speed (PPS). Details of these 8 variables and their assessment measures may be found in Schaie (1983).

Design & Analyses. In order to address the questions raised above, a 4 X 2 X 2 (Drop Status X Cohort X Occasion) ANOVA design was examined. All 520 subjects were assigned a Drop Status (Voluntary Drop-out, Disabled, Deceased or Survivor) based on information discussed above. The two Cohort groups were formed by combining cohorts 1, 2 and 3 (ages 64-84 in 1970) for the Old-old group and cohorts 4, 5 and 6 (ages 43-63 in 1970) for the Young-old group. The within group factor, Occasion, refers to the two times of testing,

1970 and 1977, prior the the 1984 attrition point.

The analyses to be presented consist of two parts: (1) comparison of prior performance levels based on Drop Status and Cohort using mean group scores in the AOV procedure, and (2) examination of change scores to assess the mean level of change between test periods for individuals in each Drop Status group.

Results

Levels of Performance. The results from the 8 ANOVA's are presented in Table 1. For ease of presentation only effects relevant to the questions asked by us are shown here: the main effect of Drop group, the interaction of Drop group and Cohort group, the interaction of Drop group and Occasion and the interaction of Drop group, Cohort group and Occasion.

Significant main effects ($p < .01$) for the Drop group factor were found on 3 of the 8 abilities: Verbal Meaning, Reasoning, and Psychomotor Speed (PPS). On all three tests, performance across the 4 drop groups revealed similar patterns; the Disabled group was consistently functioning at the lowest levels and the Survivor group was performing at the highest levels of all four groups. In addition to significant differences between the Disabled group and the Survivors, the Voluntary Drop-outs scored significantly lower ($p < .04$) than the Survivors on the PPS and Reasoning measures. Although, on some measures, non-survivors were functioning at lower levels than Survivors prior to the 1984 attrition point, the significance of these differences varied across groups that dropped out of the study for different reasons. In general, those who left the study because of

health disabilities had performance levels farthest below those of the study Survivors.

The observed Drop group effects could be due to age differences, however, since the Disabled group is also older, on the average, than the Survivor group ($\bar{M}$ = 2.8 Disabled, $\bar{M}$ = 4.6 Survivors). It is important, therefore, to examine the Drop group X Cohort group interactions, where the effects of Drop group are considered while controlling for age. The Drop group X Cohort group interactions in row 2 of Table 1 show that on four measures, the Verbal Meaning, Word Fluency, PPS and PPR tests, effects of Drop varied by Cohort. The interaction patterns are similar four all four variables: examining the right set of bars in Figures 1 through 4, representing the Young-olds, it may be seen that the Disabled group functions at much lower levels than the other three groups, including the Deceased group. However, inspection of the bars on the left, depicting the Old-olds, shows that the Deceased group is performing at the lowest levels. The Disabled X Deceased comparisons are significantly different ($p < .02$) across the two Cohort groups. The difference between the Survivor and Deceased groups is also significant, as the two groups differ more in the Old-old than Young-old cohorts ($p < .02$). In summary, it appears that in the Young-olds, low levels of performance are more highly related to illness and disability, while in Old-olds deficits in functioning are more closely related to impending death.

The Drop group X Occasion interactions are shown in row 3 of Table 1. Significant interactions were found on four abilities:

Verbal Meaning, Word Fluency, Number and Space, which are illustrated in Figures 5 through 8. On the Word Fluency and Space tests all four groups experienced declines over the 7 year period. Yet, the extent of decline in functioning was significantly greater ($p < .01$) for the Disabled group than the Survivors on these measures. These two groups differed significantly on the Number and Verbal tests as well. On the Verbal Meaning test, the group means for the Voluntary Drop-outs and the Deceased group also declined significantly more ($p < .01$) than the means for the Survivors. The extent of decline on the Number test was also significantly greater for the Deceased group than the Survivors ($p < .02$) and for the Disabled group compared to the Voluntary Drop-outs ($p < .03$).

Row 4 of Table 1 shows the 3-way interactions of Drop group X Cohort group X Occasion. Only two measures, Personality-Perceptual Rigidity (PPR) and Motor-Cognitive Rigidity (MCR) had significant three-way interactions. (See Figures 9 and 10.) First, the Old-olds on Occasion 1, on both PPR and MCR, show similar performance levels across drop groups, with the exception of the Deceased group which was functioning at markedly lower levels (more rigid) than the other groups. By 1977, however, the Voluntary Drop-outs had dropped to much greater levels of rigidity (lower scores) than the Deceased, Disabled and Survivor groups on the MCR measure. On the PPR measure, the Voluntary drop-outs and Survivors became significantly more rigid than the Deceased group by 1977. The Young-olds show very different patterns between Drop groups across time. At occasion 1 the Disabled group was more rigid than the other groups on the PPR test; on the

MCR measure the Voluntary Drop-outs were most rigid. By 1977, however, the Disabled and Survivor groups had remained fairly stable on the PPR, while the Voluntary Drop-outs had become more flexible (higher scores) and the Deceased group had become markedly more rigid (lower scores). On MCR, the Voluntary drop-out group also increased in flexibility by 1977, while the Deceased and Survivors remained stable and the Disabled had become more rigid.

Levels of Change in Functioning. In addition to the Analysis of Variance which focused on prior performance levels and their relationship to eventual attrition status, change scores from 1970 to 1977 were examined. The analysis of change scores provides insight into whether the extent of decline during the testing interval immediately preceding the attrition point was related to the cause of subjects dropping out or remaining in the study. Change score analysis was performed on the Old-old and Young-old groups separately in order to control for age-related changes.

For the Old-old age groups, change scores generally reflected the tendency for the Survivors to decline less over the period from 1970 to 1977 than the non-survivors. However, the extent of these change score differences depended on the reason for dropping out and the ability being considered. The only significant differences ($p < .05$) in change scores for the Old-old groups occurred on the Number test, as illustrated in Figure 11, where the Disabled and Deceased groups showed markedly greater declines in functioning than the Survivors over that seven year period.

In the Young-old age groups, the effects of Drop group on decline

over the seven year period preceding attrition were more widespread and marked. On 4 of the 8 measures (Verbal Meaning, Space, Reason, and MCR), presented in Figures 11-12, the Disabled group experienced far greater ($p < .01$) declines in functioning than did the Survivors. On the Reasoning measure the Deceased group also declined more ($p < .04$) than the Survivors, and on Verbal Meaning all 3 drop-out groups showed significantly greater ($p < .02$) decrements across the 1970-1977 period than the Survivors.

Discussion and Conclusions

These findings provide support for previous conclusions that differences exist between survivors and non-survivors in longitudinal studies; non-survivors were functioning less adequately than survivors on several dimensions prior to attrition. In addition, however, the present findings indicate that it is not enough to merely compare survivors with non-survivors, since the latter differ markedly in their prior functioning, depending on the reason for their attrition. Voluntary drop-outs, for example, resemble survivors on many dimensions, and this fact suggests that individuals who drop out for reasons such as travel or other time commitments, may actually be highly involved in intellectual pursuits and social activities, both of which are known to be associated with the maintenance of intellectual functioning in later adulthood (Cribbin, Schaie & Parham, 1980). Therefore, when studies lose participants primarily for reasons of subject inconvenience or non-cooperation, the remaining sample may not be as favorably selected as if many subjects had been lost due to illness or death.

The most salient differences between participants and non-participants were reflected in the Disabled and Deceased groups, yet the relative levels of performance for these two groups varied by cohort. The finding that in Young-old age the Disabled group was functioning least adequately and in Old-old age the Deceased group looked most intellectually disadvantaged suggests that death and illness might have very different characteristics at these two age ranges. We can only speculate on what these differences might be since we do not always know the cause of death or the type of illness individuals in these two age groups experienced. However, it is likely that those who died in Young-old age experienced acute illness that led to a sudden death and those who died in Old-old age suffered from chronic illness leading to death over the course of many years. Therefore, the intellectual functioning of Young-olds would have had less time to decline prior to death because of their acute condition, while the long-term condition of the Old-olds allowed for marked deterioration in functioning over time. Similarly, the low levels of functioning for the Disabled group in Young-old age may suggest that chronic conditions, like heart disease and hypertension existed and were already impairing functioning. Several reports have emerged from the Duke Study suggesting strong negative effects of chronic illness on cognitive performance (Wang & Busse, 1974; Wilkie & Eisdorfer, 1972; 1974). Therefore, the negligible difference that exists between the Young-old and Old-old Disabled groups might suggest that the Old-olds' deterioration may have been extended over many years and may even have peaked early on in their illness.

Consideration should also be given to the specific abilities where differences between drop out groups and the survivors were most evident. Repeatedly, the Verbal Meaning, Word Fluency, Number and Psychomotor Speed measures revealed marked differences between non-survivors and survivors. One commonality of these measures is their relationship to speed; the Verbal Meaning and Number measures employed in the SLS have been found to be highly speed-related (Schaie, Willis, Hertzog & Schulenberg, 1985), and of course Psychomotor Speed is a measure of perceptual speed. Therefore, health conditions and impending death do appear to impair speeded performance. In general, the salient measures in these analyses also represent the crystalized aspects of intellectual functioning. In addition, it appears that increases in rigid attitudes are predictors of death, while increase in motor-cognitive rigidity predicts voluntary drop-out.

In conclusion, performance levels and levels of observed decrement prior to attrition did vary across groups who dropped out of the SLS for different reasons. However, unlike the terminal decline hypothesis, the Deceased group did not display the lowest levels of functioning or even the greatest decline prior to attrition. Although age influenced the magnitude of effects, it was the Disabled group that appeared to experience more extreme decrements and lower levels of functioning than the other groups. If the observed drop X age effects are attributable to the types of illness experienced at different ages, it appears that the terminal decline hypothesis might be more valid when applied to death caused by chronic illness in later

life, rather than to death following short-term acute conditions.

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Figure 1.

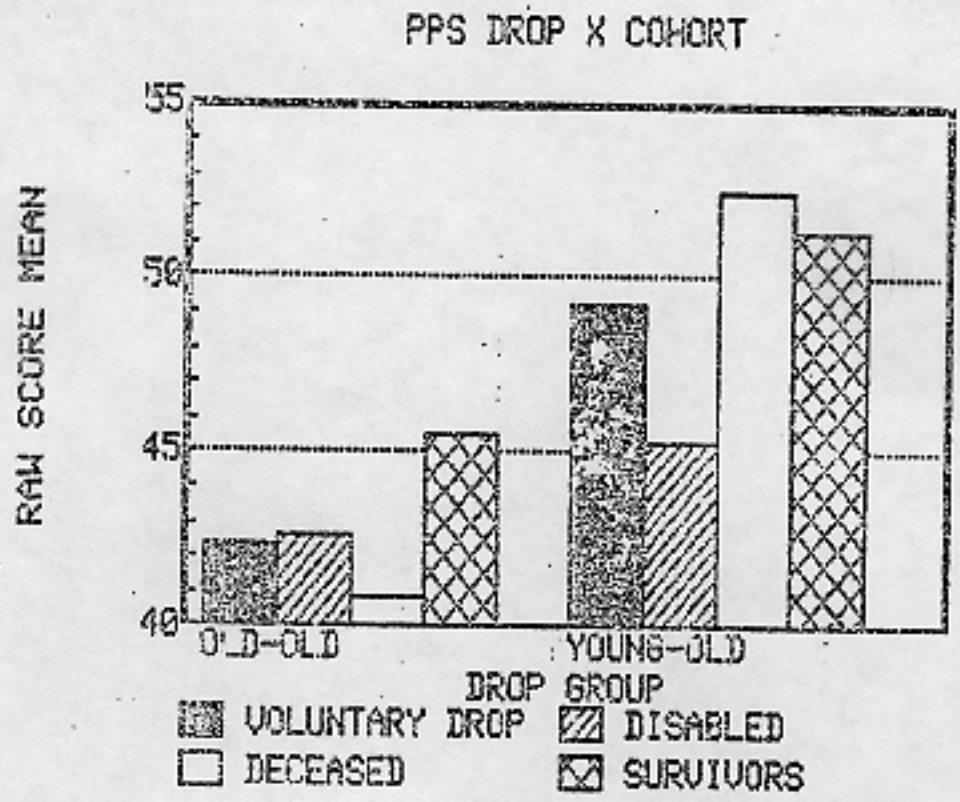


Figure 3.

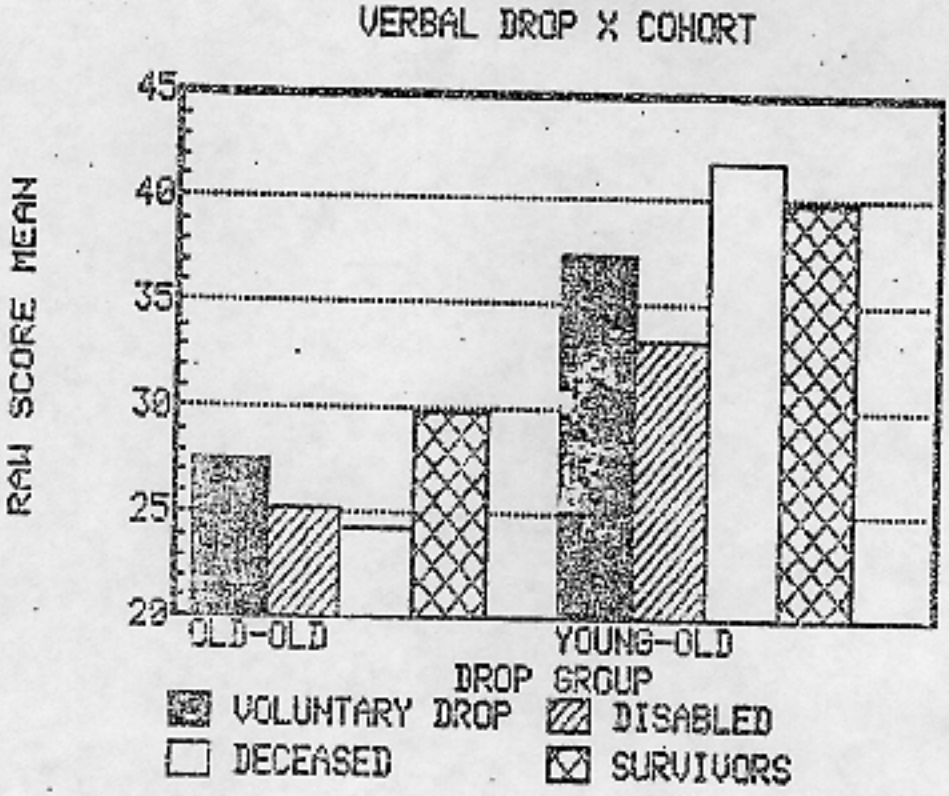


Figure 6.

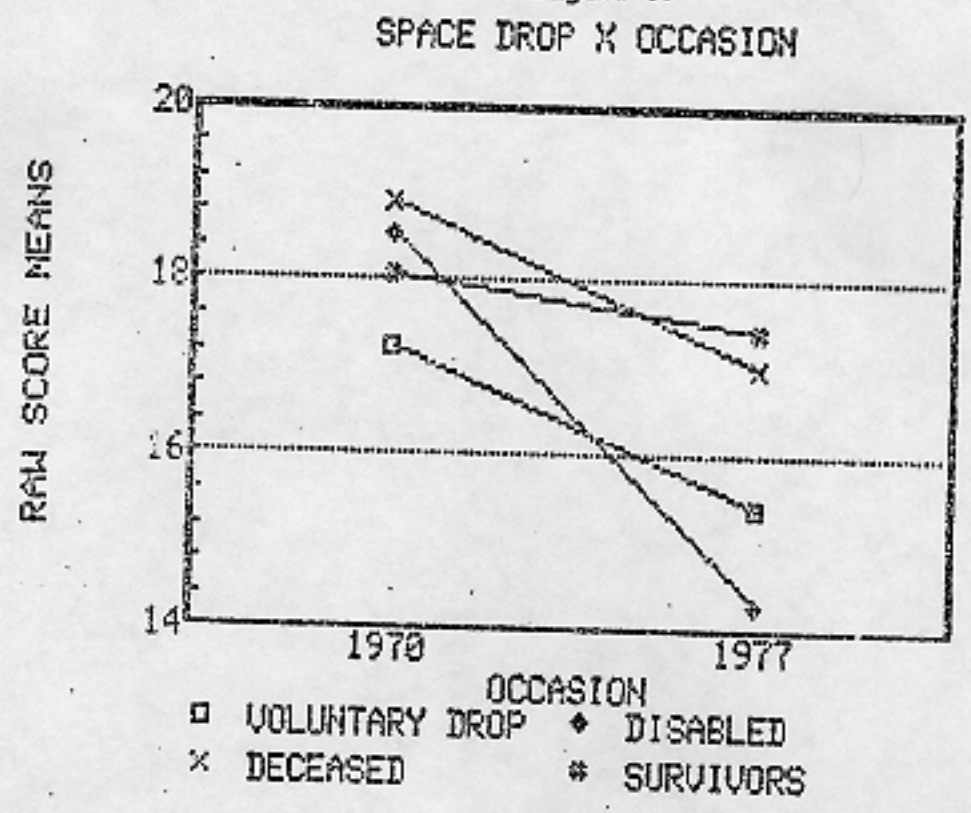


Figure 8.

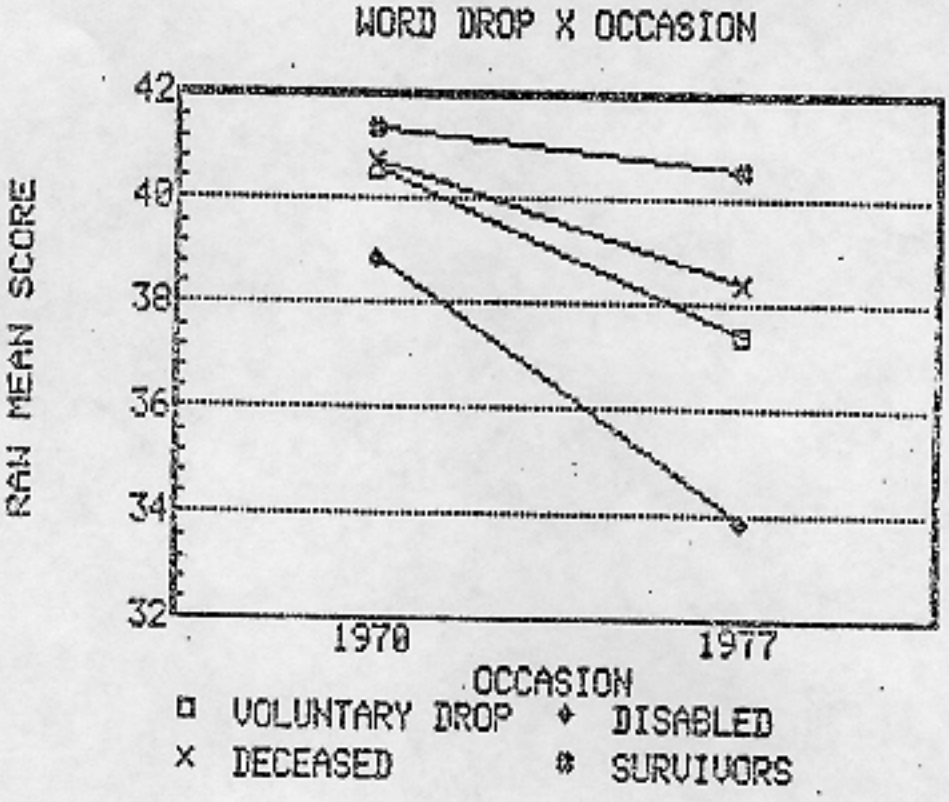
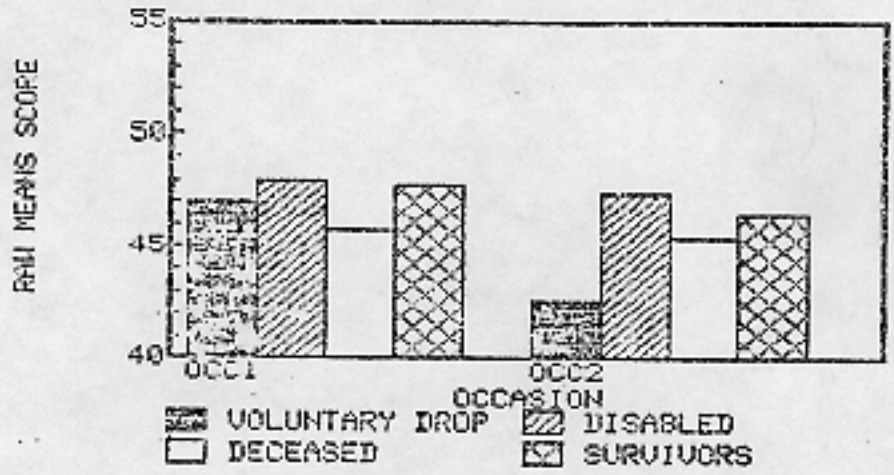


Figure 10.

OLD-OLD MCR



YOUNG-OLD MCR

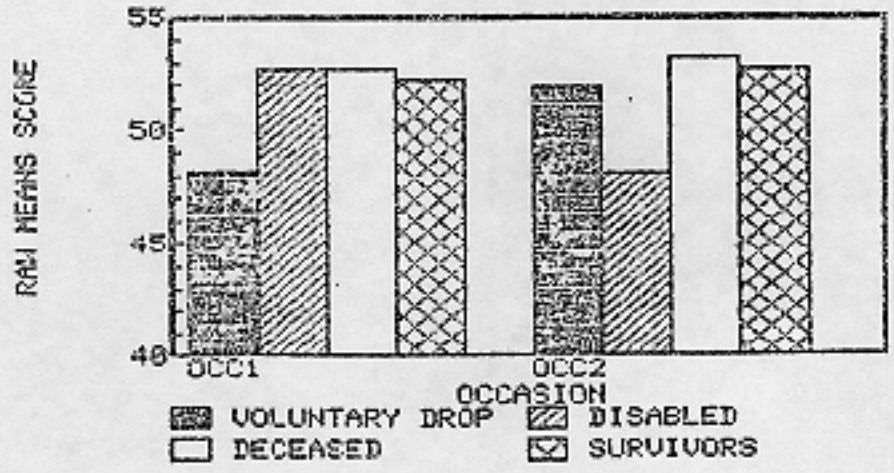


Figure 11.

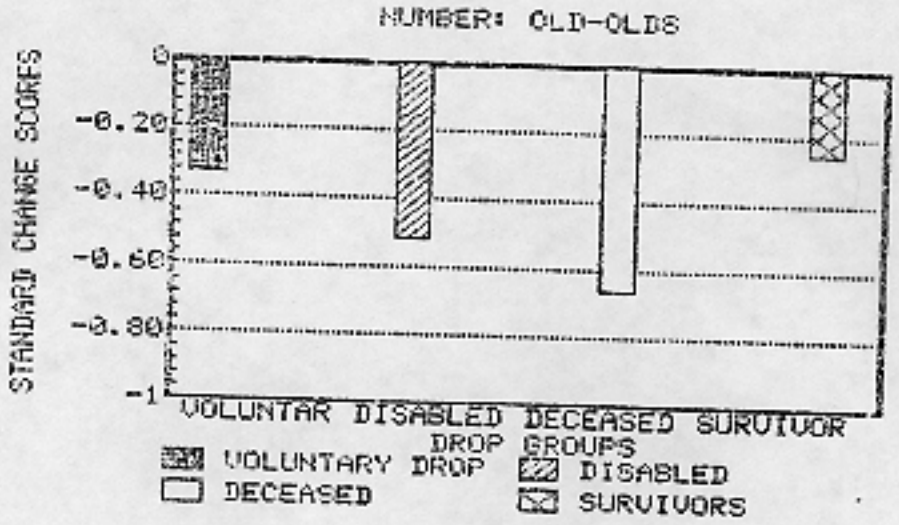


Figure 12.

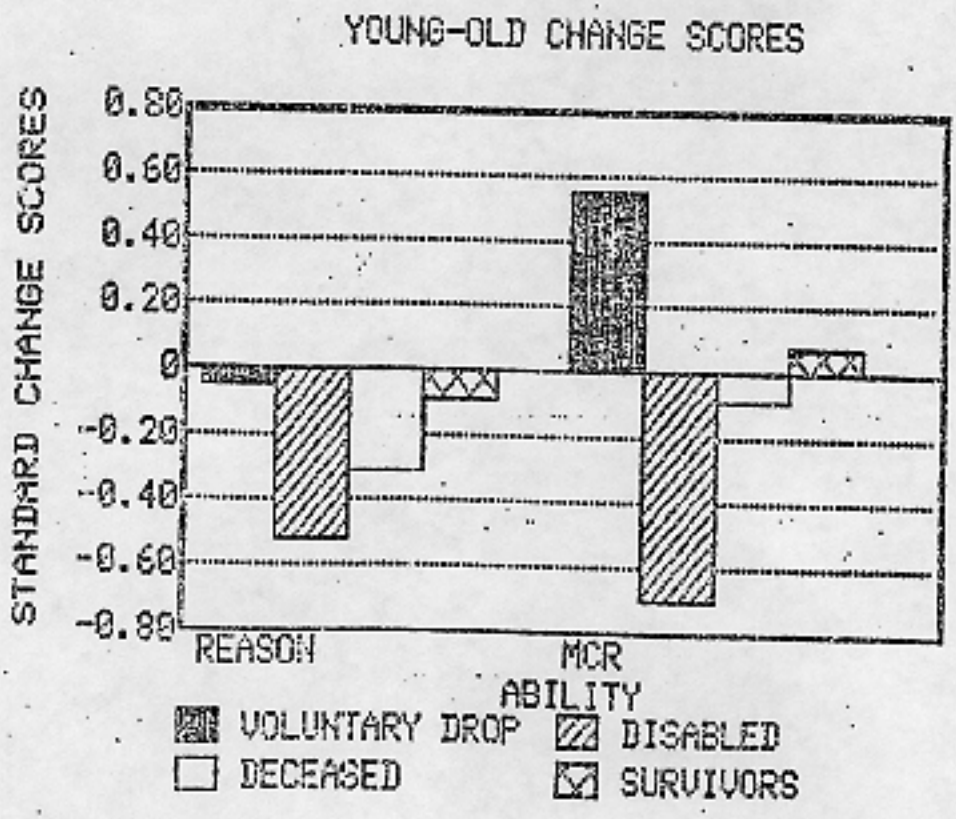


TABLE 1

Summary of Analyses of Variance: F Ratios

Source	Variable							
	Verbal Meaning	Space	Reason	Number	Word Fluency	NCR	PF3	PF5
Group Status (D)	4.25**	.63	4.61**	.49	1.68	2.14	2.36	4.54**
Group x Cohort (DxC)	3.35*	.23	1.50	.99	2.66*	1.29	3.60*	3.49*
Group x Occasion (DxO)	6.77***	2.56*	2.04	4.69***	3.29*	.97	.63	1.63
Group X Cohort x Occasion (DxCxO)	1.02	2.51	2.23	1.7	.60	4.12**	3.01*	.489

* ($p < .05$)

** ($p < .01$)

*** ($p < .001$)