Cognitive Abilities as Predictors of Mortality among the Elderly

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Paper presented at the 46th annual meeting of the Gerontological Society of America, November 20, 1993, New Orleans, LA.

This research was supported by grant number AG08082 from the National Institutes on Aging, Sherry L. Willis, Principal Investigator.

Running Header: Effect of Abilities

Abstract

What predicts mortality among the elderly? Intellectual functioning has not been extensively considered as a predictor of mortality. The purpose of this study was to examine cognitive predictors of mortality and morbidity . We hypothesized that the more basic cognitive abilities (i.e., Memory and Perceptual Speed), would predict mortality. A total of 454 subjects (80 males and 374 females) had complete data at first time of measurement (1979, 1986). Proportional Hazard Regression was used to predict survival time. We found that the two basic abilities (Memory Span and Perceptual Speed) as well as Verbal Comprehension, an indicator of Crystallized Abilities, predicted survival time even when controlling for the health and demographic factors of Perceived General Health Status, Perceived Vision Status, Age, Education, Gender, and Marital Status. In all three cases, higher scores on the cognitive ability predicted longer survival time.

Cognitive Abilities as Predictors of Mortality among the Elderly

Introduction

What predicts mortality among the elderly? Insurance companies, commonly use demographic variables such as age, race, and gender as predictors of mortality. Social scientists have extended the question of predictors of mortality from these index variables to psychological- and social-based areas of one's life. Much of this research has focused on health and social variables such as parents' longevity, social support networks, level of activity, perceived health status, and incidence of significant life events (e.g., Bryant & Rakowski, 1992; Frischer, Ford, & Taylor, 1991; Lee & Markides, 1990; Vaillant, 1991; and Wolinsky & Johnson, 1992). Intellectual aging, however, has not been extensively considered as a predictor of mortality. The purpose of this study is to examine cognitive predictors of mortality. We hypothesized that basic mental abilities (i.e., Memory and Perceptual Speed), as assessed at entry into the study in 1979 or 1986, would predict mortality seven to fourteen years later.

Sample

The subjects were participants in the ongoing Adult Development and Enrichment Project (ADEPT) begun in 1979. Subjects were included in this study if they completed the full battery of intellectual ability tests upon entry into the project in either 1979 or 1986. A total of 454 subjects (M = 80, F = 374) had complete data at their first time of measurement. A total of 168 (37.0%) subjects were married, 244 (53.7%) were widowed, and 42(9.3%) were single, divorced, or separated. At time of first data collection, subjects were, on average, 70.7 years old (s.d. = 6.2, range = 59 to 91 years) and had 11.5 years of education (s.d. = 2.9, range = 2 to 22). By 1993, 121 (26.7%) subjects had died.

Procedure

Ability assessment

Participants took a battery of cognitive ability tests when they entered the ADEPT project in 1979 or 1986. Multiple measures of each ability were given. Structure of the ability battery has been examined as successive data points (Baltes et al., 1980, Willis et al., 1992). Four primary abilities were the focus of this study—Figural Relations (one type of Fluid Ability), Verbal Comprehension (one type of Crystallized Ability), Memory Span, and Perceptual Speed. Each

participant received between two and three measures per ability; the average score for the tests completed at time of study entry was used as an indicator of the level of the ability. See Table 1 for a summary of the means and standard deviations of these abilities as well as for the means and standard deviations of the health and demographic variables.

Place Table 1 about here

Mortality assessment

Participants (or their relatives) were recontacted in 1992/1993 to examine their current health status. They were classified into two categories. A total of 333 individuals were still alive. A total of 121 individuals were classified as dead based on reports from their family or as indicated in Social Security Administration records (United States Social Security Administration, 1990).

Analyses

Proportional Hazard Regressions were performed on each of the cognitive abilities for the dichotomous outcome variable, alive versus dead. Number of years surviving was determined by subtracting date of entry into the ADEPT project from date of death. For individuals who were still alive in 1993, a

censored date of "death" was determined by subtracting date of entry into the ADEPT project from December 31, 1993. The regression models were built following a three-step procedure. In the first step, the cognitive ability of interest (Figural Relations, Verbal Comprehension, Memory Span, or Perceptual Speed) was entered into the model. In the second step, the ability from Step 1 was retained and self-rated health, eyesight, and hearing were added. In the third step, significant predictors from Steps 1 and 2 were retained and personal variables (gender, age, education, and marital status) were entered.

Results

Because of our focus on the direct effects of cognitive ability on mortality, the results are presented separately for each ability. A single ability was included in each analysis due to the high multi-collinearity among the abilities. The results are limited to three issues: 1) the direct effects of ability on mortality (shown in Model 1 of Tables 2 to 5); 2) the effect of ability on mortality when self-perceived health is considered (Model 2); and 3) the net contribution of ability to the overall fit of the final model, including demographic variables (Model 3).

Place Tables 2-5 about here

Memory Span

Memory Span performance (in 1979 or 1986) directly predicts mortality (See Table 2, Model 1). Individuals with higher scores on Memory Span survive longer than individuals with lower scores. This relationship remains true when self-perceived health is added (Model 2). The significance of Memory Span to Mortality diminishes, but still remains significant when the full model, including the demographic variables of age, gender, and marital status, is considered (Model 3). In addition to Memory Span, better health, poorer vision, younger age, being female, and being married at time of entry into the study predicted longer survival time. Figure 1 shows the net effect of Memory Span on mortality when these other variables are taken into account.

Place Figure 1 about here

Perceptual Speed

Perceptual Speed performance (1979 or 1986) directly predicts mortality (See Table 3, Model 1). Individuals with higher scores on Perceptual Speed survive longer than individuals with lower scores. Although level of significance is diminished, this relationship remains true when self-perceived health is added (Model 2) and when the full model, including the demographic variables of age, gender, and marital status, is considered (Model 3). In addition to Perceptual Speed, better health, poorer vision, younger age, being female, and being married at time of entry into the study predicted longer survival time. Figure 2 shows the net effect of Perceptual Speed on mortality when these other variables are taken into account.

Place Figure 2 about here

Verbal Comprehension

Verbal Comprehension performance (in 1979 or 1986) directly predicts mortality (See Table 4, Model 1). Individuals with higher scores on Verbal Comprehension survive longer than individuals with lower scores. Although significance is diminished, this relationship remains true when self-perceived health is added (Model 2) and when the full model, including demographic variables of age, gender, marital status, and education, is considered (Model 3). Verbal Comprehension, better health, poorer vision, younger age, higher educational level, being female, and being married at time of entry into the study predicted longer survival time. Figure 3 shows the net effect of Verbal Comprehension on mortality when these other variables are taken into account.

Place Figure 3 about here

Figural Relations

Figural Relations performance (in 1979 or 1986) directly predicts mortality (See Table 5, Model 1). Individuals with higher scores on Figural Relations survive longer than individuals with lower scores. Figural relations remains a significant predictor when self-perceived health is considered (Model 2). However, with the introduction of the demographics, the effect of Figural Relations on mortality diminishes to non-significance. Better health, poorer vision, younger age, being female, and being married at time of entry into the study predicted longer survival time.

Discussion

The principal finding of this study is that cognitive abilities do play a role in the prediction of survival time even after controlling for health and demographic factors. Our focus was on both basic information processing abilities (Memory, Perceptual Speed) and on the acculturated abilities of Verbal Comprehension and Figural Relations (a fluid ability). We found that the two basic abilities as well as Verbal Comprehension, an indicator of Crystallized Abilities, predicted survival time even when controlling for health and

demographic factors. In all three cases, higher scores on the cognitive ability predicted longer survival time.

Verbal Comprehension indicates a greater command of the language. Memory and Perceptual Speed are the more basic, information-processing cognitive abilities (Salthouse, 1991). It could be that individuals with higher skills in these area are better able to put their health-related concerns into words and ideas more quickly and thus are able to express their needs for preventative health care. They may also be able to read more complex literature related to preventative health behaviors, thus enabling them to learn about and practice behaviors that are conducive to longer survival time.

Other research has shown that basic abilities and mental processes are the cognitive mechanics underlying the pragmatics of everyday task performance (Baltes, Dittmann-Kohli, & Dixon, 1984; Willis & Schaie, 1986; Willis, 1990). Long-term survival requires an ability to do these everyday activities in order to obtain the basic necessities for survival — food, shelter, transportation, and medical care. Thus cognitive abilities are one of the bases upon which an individual can build a daily structure that results in a longer life.

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Table 1. Means, Standard Deviations, and Coding Algorithms of the Variables at Time of Entry into ADEPT Project That Were Used to Predict Mortality Seven to Fourteen Years Later.

Predictor	M	SD	Coding Algorithm
Ability			
Memory Span	51.78	8.72	Standardized t-score, high score = high ability
Perceptual Speed	52.28	8.75	Standardized t-score, high score = high ability
Verbal Comprehension	48.86	8.83	Standardized t-score, high score = high ability
Figural Relations	49.65	8.22	Standardized t-score, high score = high ability
Perceived Health Status			
General Health	2.07	0.94	6-point scale, 1 = Very Good, 6 = Very Poor
Vision	2.41	0.92	6-point scale, 1 = Very Good, 6 = Very Poor
Hearing	2.41	1.05	6-point scale, 1 = Very Good, 6 = Very Poor
Demographic Characteristics			
Age	70.72	6.18	Actual number of years
Education	11.48	2.90	Actual number of years
Gender	1.82	0.38	1 = Male, 2 = Female
Marital Status	1.72	0.62	1 = Married, 2 = Widowed, 3 = Divorced, Single, Separated

Table 2. Memory Span: Conditional Risk Ratios and 95% Confidence Limits Obtained from the Hierarchical Proportional Hazard Regression Modeling.

Predictor	Model 1 Ability	Model 2 Ability + Health	Model 3 Ability + Health + Demo
Ability at Time 1			
Memory Span	0.965 (0.944, 0.987)**	0.969 (0.947, 0.991)**	0.975 (0.952, 0.998)*
Perceived Health Status at Time 1			
Health Status		1.573 (1.310, 1.890)****	1.701 (1.390, 2.082)****
Vision Status		0.796 (0.641, 0.988)*	0.755 (0.610, 0.936)*
Hearing Status			
Demographics at Time 1			
Age			1.045 (1.017, 1.075)**
Education			0.524 (0.344, 0.796)**
Gender			1.455 (1.092, 1.940)*
Marital Status			
Model X^2, df	9.991, 1**	31.168, 3****	59.766, 6****

Note: Conditional risk ratios not significantly different from one at the $p < .10$ level are omitted for clarity.
* $p < .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$.

Table 3. Perceptual Speed: Conditional Risk Ratios and 95% Confidence Limits Obtained from the Hierarchical Proportional Hazard Regression Modeling.

Predictor	Model 1 Ability	Model 2 Ability + Health	Model 3 Ability + Health + Demo
Ability at Time 1			
Perceptual Speed	0.962 (0.942, 0.982)***	0.965 (0.944, 0.986)**	0.978 (0.955, 1.001)[a]
Perceived Health Status at Time 1			
Health Status		1.558 (1.291, 1.880)****	1.703 (1.388, 2.089)****
Vision Status		0.772 (0.622, 0.959)*	0.746 (0.602, 0.924)**
Hearing Status			
Demographics at Time 1			
Age			1.045 (1.016, 1.074)**
Education			
Gender			0.567 (0.374, 0.861)**
Marital Status			1.433 (1.074, 1.912)*
Model X^2, df	13.443, 1***	33.510, 3****	58.286, 6****

Note: Conditional risk ratios not significantly different from one at the $p < .10$ level are omitted for clarity.
[a] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$.

Table 4. Verbal Comprehension: Conditional Risk Ratios and 95% Confidence Ratios Obtained from the Hierarchical Proportional Hazard Regression Modeling.

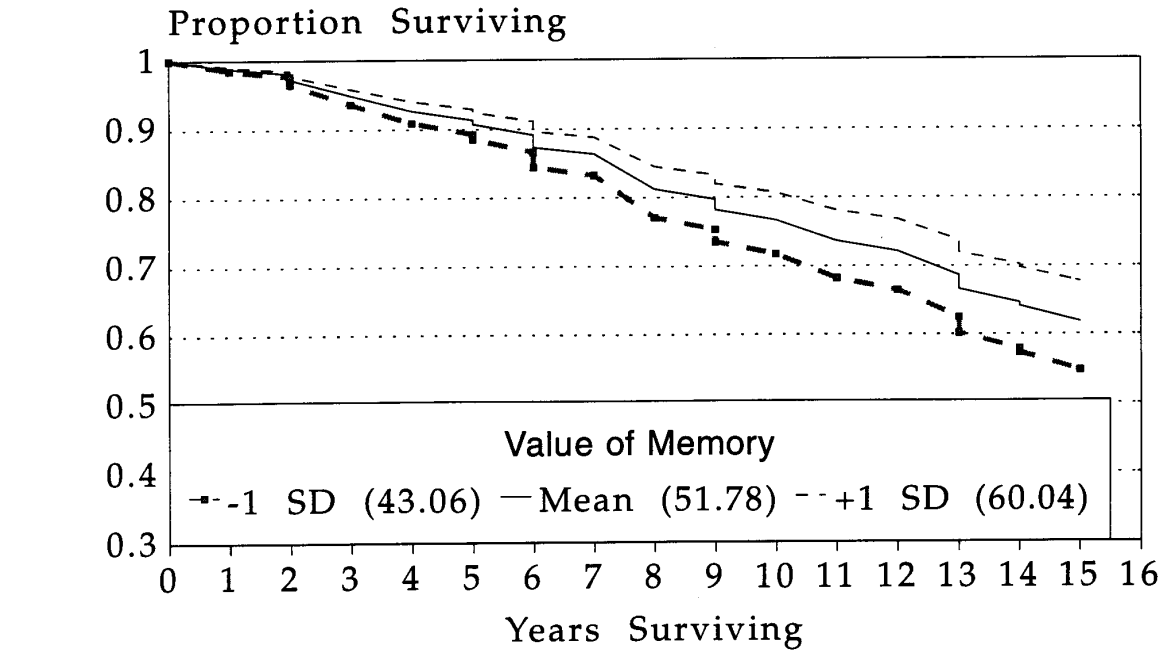
Predictor	Model 1 Ability	Model 2 Ability + Health	Model 3 Ability + Health + Demo
Ability at Time 1			
Verbal Comprehension	0.969 (0.950, 0.989)**	0.978 (0.957, 0.998)*	0.968 (0.942, 0.995)*
Perceived Health Status at Time 1			
Health Status		1.550 (1.282, 1.875)****	1.725 (1.398, 2.129)****
Vision Status		0.806 (0.649, 1.001) [a]	0.758 (0.609, 0.943)*
Hearing Status			
Demographics at Time 1			
Age			1.051 (1.022, 1.080)***
Education			1.072 (0.992, 1.159)[a]
Gender			0.522 (0.342, 0.797)**
Marital Status			1.473 (1.106, 1.962)**
Model X^2, df	9.383, 1**	27.961, 3****	60.266, 7****

Note: Conditional risk ratios not significantly different from one at the $p < .10$ level are omitted for clarity.
[a] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$.

Table 5. Figural Relations: Conditional Risk Ratios and 95% Confidence Limits Obtained from the Hierarchical Proportional Hazard Regression Modeling.

Predictor	Model 1 Ability	Model 2 Ability + Health	Model 3 Ability + Health + Demo
Ability at Time 1			
Figural Relations	0.965 (0.944, 0.987)**	0.973 (0.950, 0.995)*	0.985 (0.961, 1.010)
Perceived Health Status at Time 1			
Health Status		1.563 (1.292, 1.891)****	1.710 (1.390, 2.104)****
Vision Status		0.799 (0.643, 0.991) *	0.760 (0.614, 0.942)*
Hearing Status			
Demographics at Time 1			
Age			1.045 (1.016, 1.076)**
Education			
Gender			0.528 (0.346, 0.805)**
Marital Status			1.446 (1.081, 1.933)*
Model X^2, df	9.877, 1**	29.108, 3****	56.249, 6****

Note: Conditional risk ratios not significantly different from one at the $p < .10$ level are omitted for clarity. The one exception is the conditional risk ratio for the Figural Relations in Model 3, where $p < .2405$.
[a] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$.

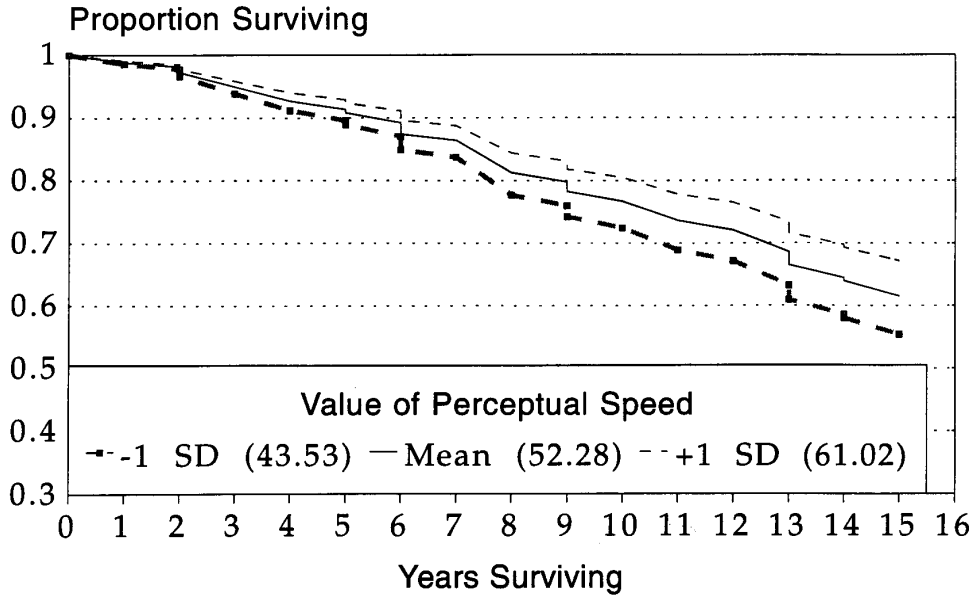


Memory is significant at the $p < .0299$ level.

Figure 1.

Survival Curve for Perceptual Speed

Accounting for Health, Vision, Age, Gender, & Marital Status

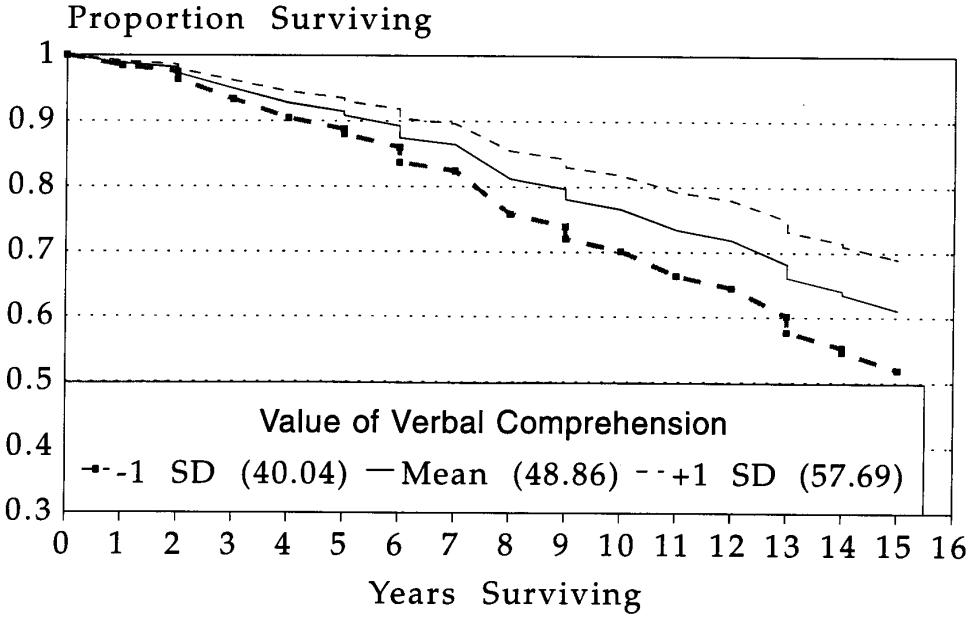


Perceptual Speed is significant at the $p < .0648$ level.

Figure 2.

Survival Curve for Verbal Comprehension

Accounting for Health, Vision, Age, Education, Gender, & Marital Status



Verbal Comprehension is significant at the $p < .0223$ level.

Figure 3.