The Impact of Disease upon Cognitive Ability Functioning in the Elderly.

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Abstract

This study investigated the role that diseases such as cardiovascular disease (CVD), diabetes mellitus, and osteoarthritis have upon the level and magnitude of longitudinal change in cognitive ability performance in the elderly. Subjects included 195 participants in the Seattle Longitudinal Study assessed over the ages of 53, 60, and 67. Disease was assessed via HMO medical records coded by ICDM diagnostic categories. Subjects were assessed on the Thurstone Primary Mental Abilities. Scores were standardized to T-score units (mean=50, SD=10) referent to the overall SLS sample (n=2810). Subjects were coded for the presence of cardiovascular disease (CVD; restricted to atherosclerosis, atherosclerosis with hypertension, and cerebrovascular disease), osteoarthritis, and diabetes mellitus prior to age 67.

Of the 195 subjects with longitudinal data from ages 53 to 67, only 52 were free from CVD, diabetes, and osteoarthritis. Of the 9 people with diabetes, four were free from CVD. There were 113 people with osteoarthritis, of whom 39 had concurrent CVD diagnosis, and 6 had diabetes along with CVD and arthritis. There were 25 people with CVD diagnosis only, and 1 person with CVD and diabetes.

The level and magnitude of change on the 5 PMA subtests was examined for the various combinations of diseases. MANOVA results suggested a multivariate effect for age, but not for the health variables. Univariate results reveal a significant effect of diabetes and osteoarthritis on mean levels of Verbal Meaning and Inductive Reasoning, and on age changes in Verbal meaning from ages 53 to 67. Decline from ages 53 to 67 was negligible (less than 1/2 a standard deviation) for subjects free from CVD, diabetes, and osteoarthritis..

Results argue for the consideration of the impact of major diseases, and the comorbidity of diseases, upon the level of and magnitude of change in cognitive functioning in the elderly.

Many previous studies have investigated the influence of illness on cognitive abilities in adulthood, and this research has focused on diseases that increase in frequency in the elderly. The impact of cardiovascular disease (CVD) on cognitive functioning has been well documented (Goldman, Kleinman, Snow, Bidus, & Koral, 1974; Hertzog, Schaie, & Gribbin, 1978; Stone, 1980). Diabetes mellitus has also been shown to have a major impact on cognitive functioning (Perlmuter, Tun, Sizer, McGlinchey, & Nathan, 1987; Tun, Perlmuter, Russo, & Nathan, 1987). However, research on the effects of diabetes has been largely cross-sectional, and has failed to consider comorbidity with CVD (Sands, 1990). Osteoarthritis is another disease common to the elderly that might affect cognitive performance, either through the impairment of test-taking ability or through the limitation of abilities that may have an impact upon the maintenance of cognitive functioning (see Gribbin, Schaie, & Parham, 1980). Few studies have investigated the influence of arthritis on cognitive performance (Schaie, 1990).

The purpose of this study was to investigate the impact of diseases common to an elderly population on cognitive functioning across a 14-year age range.

Method

Subjects

This study employs an older sample from the Seattle Longitudinal Study (SLS—Schaie, 1983; Schaie & Willis, 1986; Willis & Schaie, 1986). All subjects were born between 1900 and 1920 and were studied over three time periods which cover the mean ages of 53, 60, and 67. The SLS testing occurs at 7-year intervals (1956, 1963, 1970, 1977, 1984); subjects were grouped into 7-year age cohorts. In order to obtain maximum cell sizes, subjects are collapsed across time of entry in the study. Subjects included 195 subjects (109 females and 86 males) for whom complete medical and 14-year cognitive data was available. The sample had a mean educational level of

13.3 years. The overall mean income level of the sample at age 53 was approximately $20,000. All of the participants were community dwelling, and most of the subjects were Caucasian. Of the 195 who had complete medical data for ages 53 to 67, 70 entered the SLS in 1956, 87 entered in 1963, and 37 entered in 1970; the 1970 sample is smaller since we are still in the process of updating health records from 1977 to 1984.

Measures

Subjects were assessed at ages 53, 60, and 67 on the Primary Mental Abilities (PMA—Thurstone & Thurstone, 1949) and the Test of Behavioral Rigidity (TBR—Schaie, 1955; Schaie & Parham, 1975). The 1948 PMA 11-17 version of the Thurstone PMA used in this study includes the following subtests: Verbal Meaning, a measure of recognition vocabulary; Spatial Orientation, a test requiring visualization of object rotation in two dimensions; Inductive Reasoning, at test of rule induction from letter series; Number, a measure of simple addition skills; and Word Fluency, a measure of semantic retrieval based on a lexical rule. Scores were standardized to T-score units (mean of 50, standard deviation of 10) referenced to the overall SLS sample (n=2810).

Medical records were based on ICDM-8 diagnostic classifications (USPHS, 1968). Diseases were classified as to their occurrence prior to age 67. Cardiovascular disease (CVD) was defined as any cardiovascular-related condition excluding such benign conditions as hemorrhoids and varicose veins, miscellaneous CVD, and essential hypertension (CVD included atherosclerosis, atherosclerosis with hypertension, and cerebrovascular disease; see Table 1 for more information). A subject who had only essential hypertension was not included as having CVD, but was categorized as having hypertension. Preliminary analyses revealed no difference for PMA means or change due to the presence of essential hypertension and this variable was not

included in further analyses. Diabetes was restricted to late onset diabetes mellitus (code 250.9), and arthritis was restricted to osteoarthritis (code 713).

Insert Table 1 about here

Results

Frequency of Disease

Of the 195 people with complete data, only 52 lacked evidence of either CVD, diabetes, or osteoarthritis prior to age 67. Of the 9 people with diabetes, 4 were free from CVD. There were 113 people with osteoarthritis, of whom 39 had concurrent CVD diagnosis, and 6 had diabetes along with CVD and arthritis. There were 25 people with CVD diagnosis only, and 1 person with CVD and diabetes (see Table 2).

Insert Table 2 about here

Disease and Cognitive Performance

Figures 1 to 5 present the longitudinal data for the 5 PMA subtests separately for persons in the six possible combinations of these three diseases. A multivariate analyses of variance (MANOVA), involving a multivariate profile analysis, was conducted for the PMA tests. The main effects and interactions of these diseases on mean level and change over the 14-year period were examined. Change was defined as changes over age 53 to 67 and over 60 to 67 (a simple contrast to the last time of measurement), and a constant representing overall age changes was included in the model. The unique sums of squares options was used. Following a significant multivariate F test, each univariate F was examined to locate effects for the

individual subtests. Given that similar profiles were not expected to be found across these tests, significant univariate F tests are reported and examined, even in the absence of multivariate significance.

Insert Figures 1-5 about here

The multivariate test results were not significant for any of the health variables, only age was significant over both periods, from 53 to 67 ($F_{(5,184)}=6.74$, $p<.001$) and from 60 to 67 ($F_{(5,184)}=2.53$, $p<.05$). Significant univariate post-hoc tests of age were observed for Verbal Meaning ($F_{(1,188)}=20.91$, $p<.001$), Spatial Orientation ($F_{(1,188)}=8.47$, $p<.01$), and Number ($F_{(1,188)}=11.24$, $p<.001$), reflecting overall decline from ages 53 to 67; significant decline from 60 to 67 was observed for Verbal Meaning ($F_{(1,188)}=4.48$, $p<.05$) and Number ($F_{(1,188)}=7.74$, $p<.01$).

For the health variables, significant univariate effects were found for the interaction of Diabetes and Osteoarthritis on Verbal Meaning ($F_{(1,188)}=6.80$, $p<.01$) and Inductive Reasoning ($F_{(1,188)}=4.95$, $p<.05$) mean levels. People with osteoarthritis only did better than people with diabetes (with or without osteoarthritis). Univariate results were found for Osteoarthritis on Verbal Meaning ($F_{(1,188)}=5.45$, $p<.05$) and Inductive Reasoning ($F_{(1,188)}=4.06$, $p<.05$).

Significant univariate change was found from ages 53 to 67 on Verbal Meaning for Diabetes ($F_{(1,188)}=4.96$, $p<.05$), Osteoarthritis ($F_{(1,188)}=7.89$, $p<.01$), and for the interaction of Diabetes and Osteoarthritis ($F_{(1,188)}=6.33$, $p<.05$). The interaction was such that the presence of both diseases had a more detrimental effect on change.

The magnitude of decline over the 14-year period is minimal for those people who are free of cardiovascular disease, diabetes mellitus, and osteoarthritis (see Figures 1-5). Declines of less than 5 T-score units (1/2 a standard deviation) are found for Verbal Meaning, Spatial Orientation, Inductive Reasoning, Number, and

Word Fluency for persons free of these diseases. The largest observed decline on Verbal Meaning was 4 T-score points from ages 60 to 67 for those with CVD only. The largest decline on Spatial Orientation was 4.8 T-score points from ages 53 to 67 for those with Diabetes only. The largest decline on Inductive Reasoning was 5.25 points from 53 to 67 (with 4.25 of it from 60 to 67) for those people with all diseases. The largest decline on Number was 9 T-score points for the person who had both diabetes and CVD. The largest decline for Word Fluency was 5 T-score points from 60-67 for the person with diabetes and CVD (and that person had shown a 7-point increase from 53 to 60).

Discussion

Overall results suggest that statistically significant age decline is observed over the age range from 53 to 67, albeit not a decline of a great magnitude (less than 1/2 a standard deviation on average). Diabetes mellitus had a deleterious effect on mean level and rates of decline for Verbal Meaning and Inductive Reasoning. Osteoarthritis appeared to have less of a detrimental effect than diabetes, but the combination was more negative.

A major limitation of these analyses is the small sample size in the diabetes groups, especially when there was only one person with diabetes and CVD who did not have osteoarthritis. This person consistently scored lower on the PMA tests, but there wasn't enough power to obtain a true test of the interaction of diabetes with CVD.

Results argue for the consideration of the impact of major diseases, and the comorbidity of diseases, upon the level of and magnitude of change in cognitive functioning in the elderly.

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Table 1: CVD Group Classifications

ICDA Code	Description
Hypertension	
401	Essential Hypertension
403	Renal hypertension
Atherosclerosis	
410.9	Acute myocardial infarction
411.9	Acute ischemic heart disease
412.9	Chronic ischemic heart disease
413.9	Angina pectoris
426	Pulmonary heart disease
427.0	Congestive heart failure
427.1	Left ventricular failure
427.2	Cardiac arrest
427.3	Other heart block
428	Other myocardial insufficiency
440.0	Arteriosclerosis of aorta
440.9	Arteriosclerosis (generalized)
Hypertension and Atherosclerosis	
402	Hypertensive heart disease
411.0	Acute ischemic heart disease, with hypertension
412.0	Chronic ischemic heart disease, with hypertension
413.0	Angina pectoris, with hypertension
Cerebrovascular Disease	
430.0	Subarachnoid hemorrage, with hypertension
431.9	Cerebral hemorrage
431.0	Cerebral hemorrage, with hypertension
432.9	Occlusion of precerebral arteries
432.0	Occlusion of precerebral arteries, with hypertension
433.9	Cerebral thrombosis
433.0	Cerebral thrombosis, with hypertension
434.9	Cerebral embolism
435.9	Transient cerebral ischemia
436.9	Acute, ill-defined cerebrovascular disease
436.0	436.9, with hypertension
437.9	Generalized ischemic cerebrovascular disease
438.9	Other ill-defined cerebrovascular disease
438.0	438.9, with hypertension
Miscellaneous CVD	
394.0-394.9	Mitral valve disease, rheumatic
395.0-395.9	Aortic valve disease, rheumatic
396.0-396.9	Both 394 and 395
398	Rheumatic heart disease
424.1, 424.9	Chronic disease of endocardial structures
427.4-427.9	Disorders of heart rhythm
429.0	Cardiac enlargement and hypertrophy
429.9	Other ill-defined heart disease
440.2	Arteriosclerosis of extremities
441.2	Aneurysm of abdominal aorta
443.0, 443.9	Peripheral vascular disease
444.4, 444.9	Embolism and thrombosis of minor arteries
445	Gangrene
447	Other diseases of arteries and arterioles
448	Diseases of capillaries
450	Pulmonary embolism and infarction
451.0, 451.9	Phlebitis and thrombophlebitis
453	Other venous embolism and thrombitis
458.0	Hypotension
Benign CVD	
454.0-454.9, 456.0-456.9	Varicose veins (assorted sites)
455	Hemorrhoids
458.9	Other and unspecified circulatory disorders

From Hertzog, Schaie & Gribbin, 1978.

Table 2: Frequency of Disease Categories

Description	N
Cardiovascular Disease only	25
Diabetes only	4
Osteoarthritis only	75
Cardiovascular Disease & Diabetes	1
Osteoarthritis & Cardiovascular Disease	34
Osteoarthritis & Diabetes	0
Osteoarthritis, Cardiovascular Disease, & Diabetes	4
No Disease	52
Total Subects	195

Figure 1: Verbal Meaning

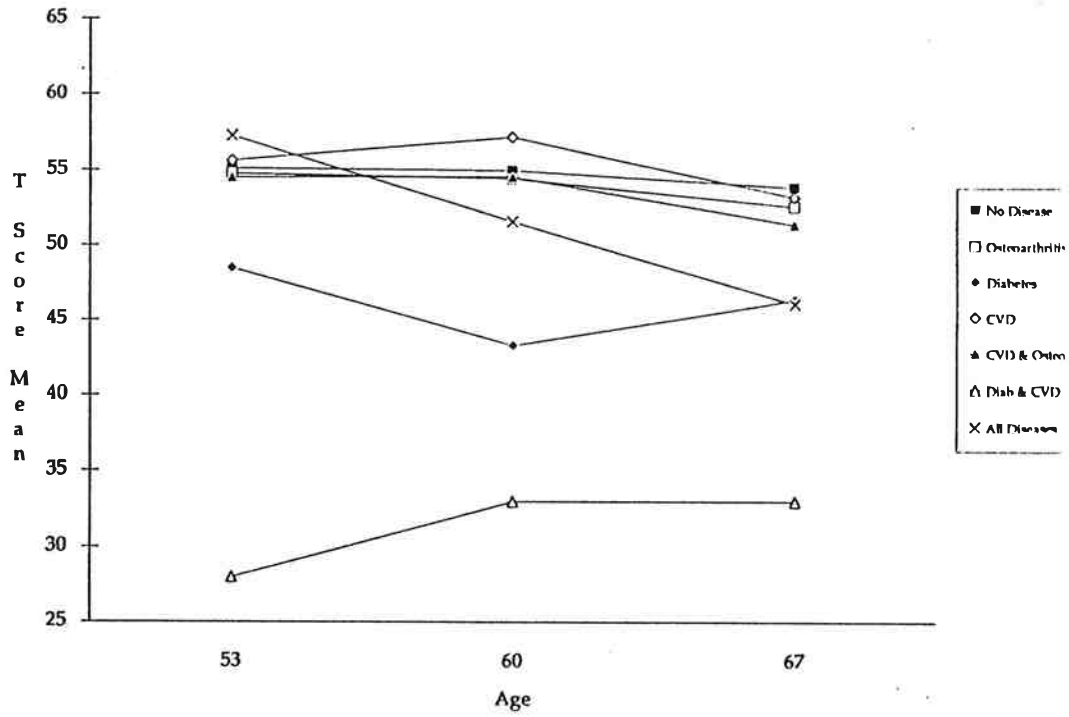

Figure 2: Spatial Orientation

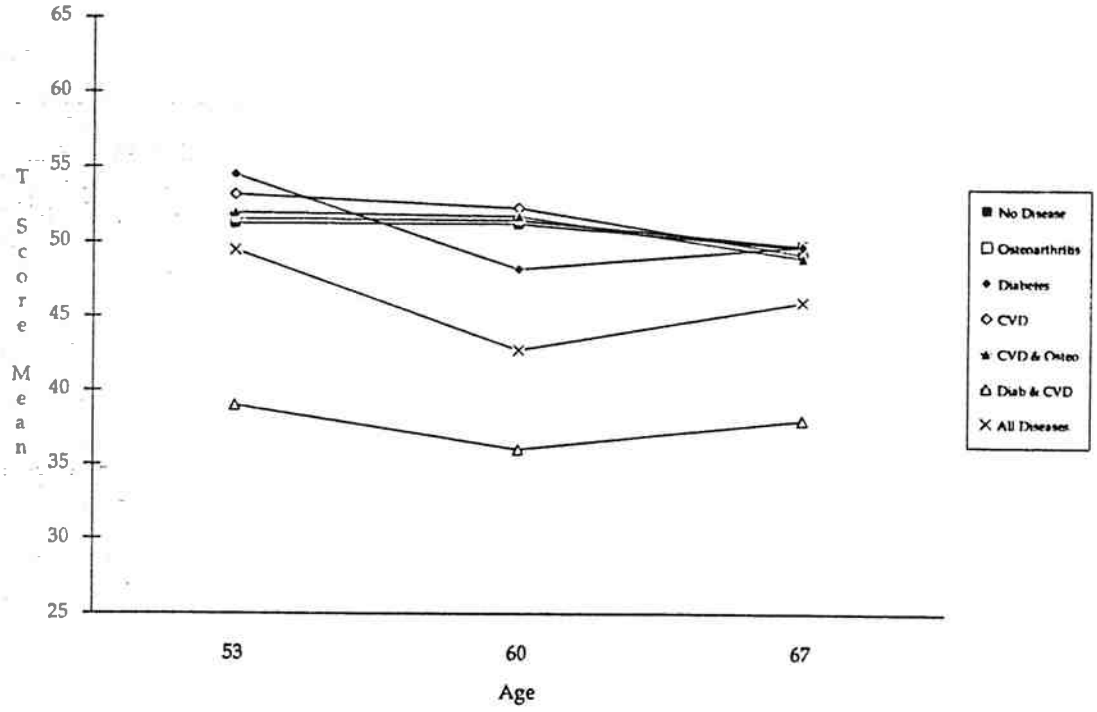

Figure 3: Inductive Reasoning

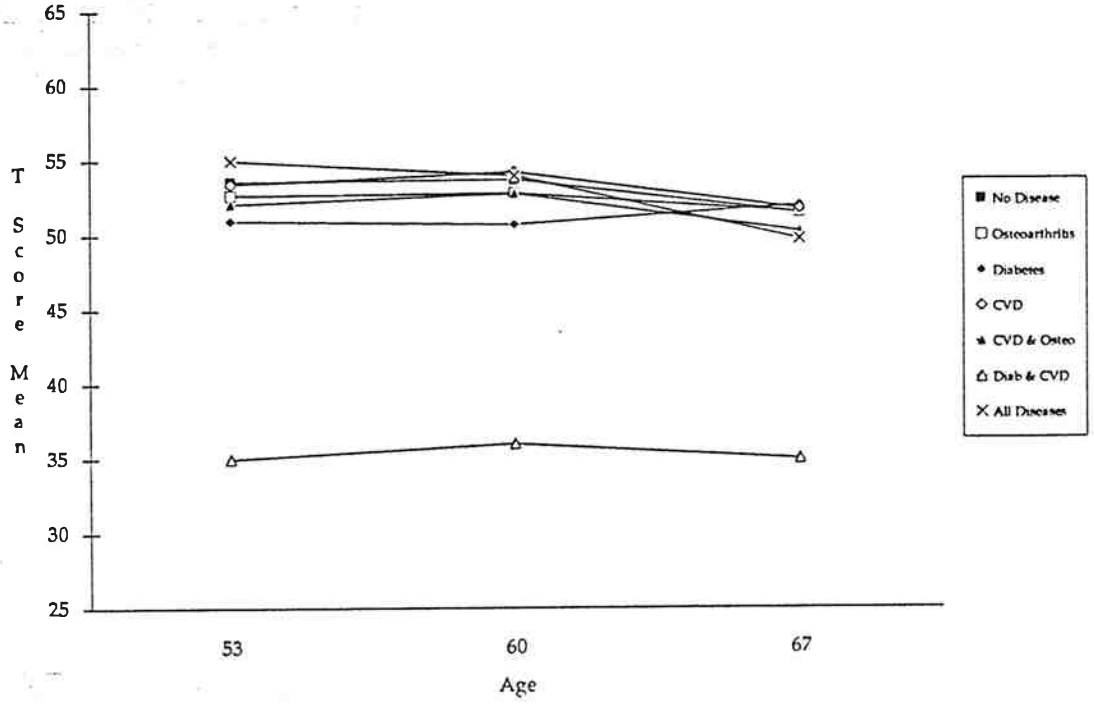

Figure 4: Number

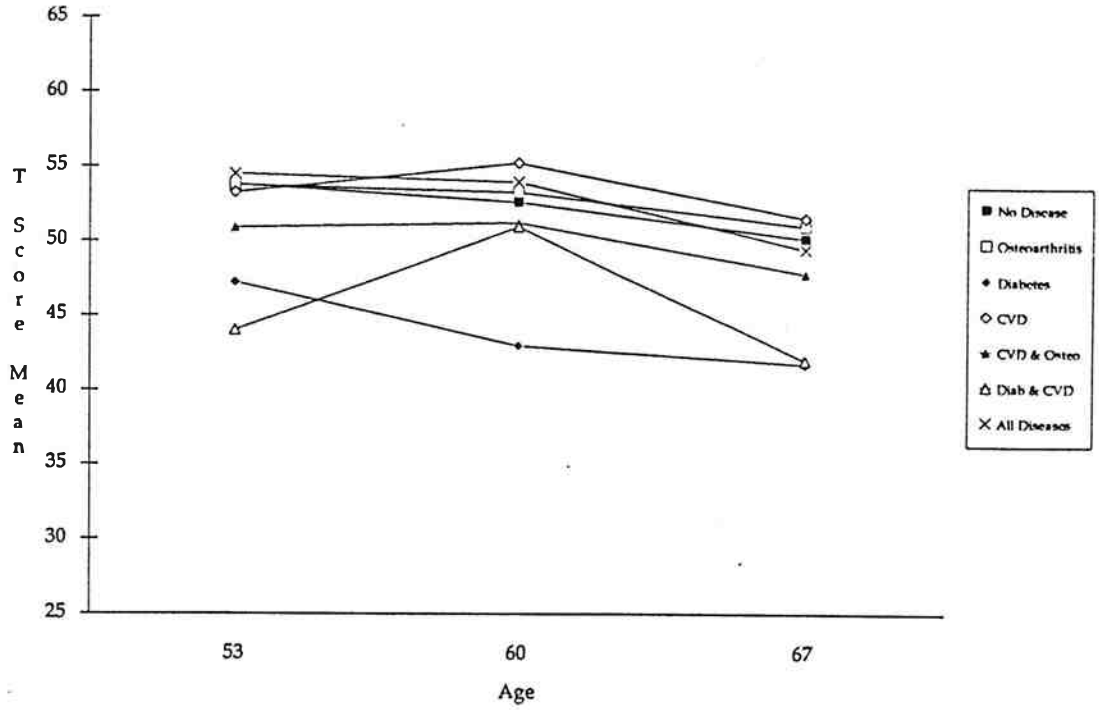

Figure 5: Word Fluency