Interdisciplinary Aspects of the Seattle Longitudinal Study

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Abstract

The primary focus of the Seattle Longitudinal Study (SLS) has always been the monitoring of age changes and generational differences in adult cognitive development. However, we have progressively added other domains as independent variables in order to understand individual and group difference patterns in cognitive development. These domains include studying the influence of chronic diseases and use of prescription medication, the careful description of family environments in the family of origin and the current family to consider behavior genetic factors, the description of participants micro-environments, and the assessment of ApoE genotypes and neuro-psychological status in our older study participants. We will discuss the inter-disciplinary implications of these expansions for our study design and present an integrative model for our broadened inquiries.

INTERDISCIPLINARY ASPECTS OF THE SEATTLE LONGITUDINAL STUDY

Introduction

The Seattle Longitudinal Study (SLS) which began in 1956 was originally designed quite narrowly to chart the course of selected cognitive abilities from young adulthood through old age utilizing the Thurstonian approach to the measurement of psychometric abilities (Thurstone, 1938). These were questions of central interest to cognitive-developmental psychologists and the emerging field of geropsychology. The empirical work, moreover, was strongly motivated by our anecdotal experience that some individuals showed intellectual decline in late mid-life while others retained their intellectual competence into advanced old age. These concerns motivated the immediate introduction of the cognitive style of flexibility-rigidity as described by social psychologists (cf. Schaie, 1962).. Hence, The initial conceptual focus of the SLS was upon the investigation of individual differences in the primary mental abilities, their possible mediators, and the discovery of differential patterns of intra-individual change (cf. Schaie, 1996a, 1996b).

It should be noted also that the model of intelligence that we have subscribed to has been a hierarchical model. That we think of intelligence as having information processing components at a basic process level. The combinations and permutations of processing skills result as well as culturally acquired information result in the products represented by the traditional work on psychometric intelligence. Combinations and permutations of mental abilities in turn represent the basic components underlying practical intelligence as expressed in specific everyday tasks. This hierarchical model has only recently been explicated more formally (cf. Schaie & Willis, 1999; Willis & Schaie, 1993). Because of the more general nature of psychometric abilities and their strong relationship to everyday performance, we elected to concentrate our efforts at the middle level of exploring the primary mental abilities.

We will begin this paper by summarizing our successive interdisciplinary involvements, illustrate the consequences for our study design, and specify a

unifying model of adult cognitive development that helps to integrates the many components of our study, and then

Interdisciplinary Involvements

From the very beginning, however, our work was impacted by colleagues from other disciplines and has in turn served to inform other disciplines. Indeed, given the small gerontological community at the inception of our studies, it would have been foolish to restrict ourselves to narrow disciplinary borders. We have therefore always sought input from and collaboration with colleagues from the biomedical and social sciences research communities. Table 1 lists the various components of the SLS, their dates of inception, and the disciplines (other than cognitive-developmental psychology) that have either impacted our study or which have been able to apply our findings.

Table 1. Components of the Seattle Longitudinal Study and Their Interdisciplinary Implications

Component	Year(s) Implemented	Disciplines other than CognitiveDevelopmental Psychology
Cognitive Development	1956, 1963, 1970, 1977, 1984, 1991, 1998	Industrial Psych., Human Resources Clinical Psychology
Cohort Studies	1956, 1963, 1970, 1977, 1984, 1991, 1998	Sociology
Health History Studies	1977, 1984, 1991, 1998	Epidemiology, Internal Medicine
Cognitive Training	1983, 1990, 1997	Clinical Psychology, Adult Education
Medication Studies	1984, 1991, 1998	Pharmacology, Internal Medicine
Family Studies	1989, 1996, 2001	Behavior Genetics, Family Sociology
Neuropsychology Studies	1997, 2000	Neuropsychology, Geriatrics
ApoE, Lipid & Autopsies	1997	Neuropathology, Genetics

Perhaps added to this list should be the impact of methodological advances such as the introduction of restricted factor analysis and latent growth modeling.

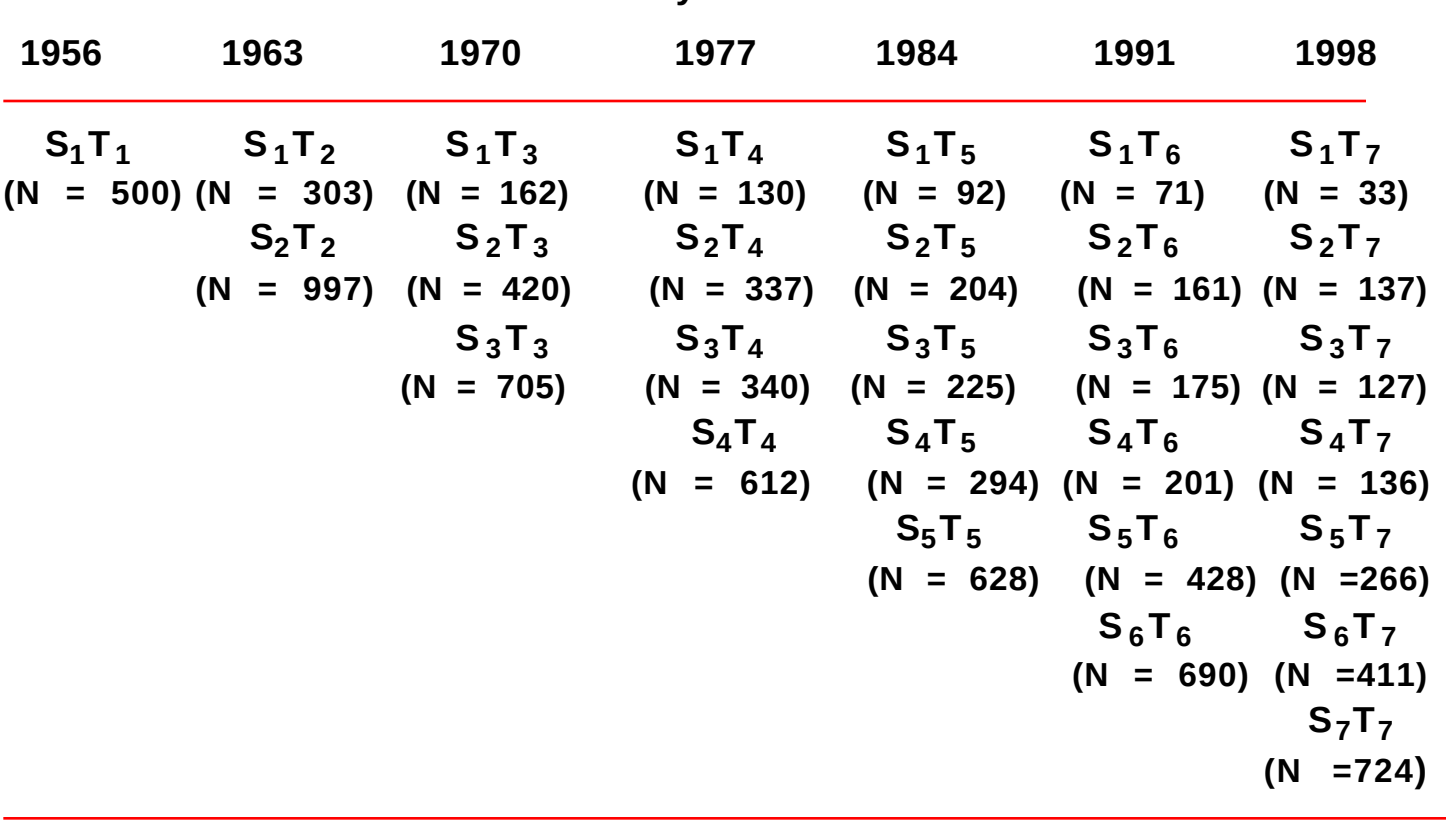
Cohort Differences

An important early aspect of the SLS was the investigation of cohort differences and their implications for the study of adult cognition. The concept

of cohort has received .wide attention in the sociological literature (cf. Riley, Foner & Riley 1999; Ryder, 1965). However, the senior author was the first to introduce and apply this concept to behavioral science research (Schaie, 1965).

The concerns regarding societal changes that interacted with individual development were met early on by deciding that any attempt to diaggregate these influences would require a design that replicated the age spans to be studied across successive generations. Figure 1 depicts the design of the SLS which represents seven waves of samples covering the initial age range from 22 to 84 years of age, with members of each wave being followed as long as they can be retrieved.

Figure 1. Basic Design of the Seattle Longitudinal Study (SLS)



S = Sample; T = Time of Measurement

This design allows us to study differences in rates of age change across successive cohort, information which will become critical in informing attempts to reform retirement eligibility rules.

Health Influences

Given that our sampling frame was one of the early health maintenance organizations we next took advantage of the availability of health history information to study the impact of chronic diseases on cognitive aging (Hertzog, Schaie, & Gribbin, 1978). These efforts required interactions with specialists in the fields of internal medicine, epidemiology, and medical records technology in an effort to develop efficient methods of characterizing occurrence of disease incidents and episodes that could me mapped over the periods of time that we were monitoring individual cognitive change (also see.Bosworth & Schaie, 1997; Bosworth, Schaie, Willis, & Siegler, 1999). These studies have informed us that the chronic diseases of midlife and old age accelerate cognitive decline, but also that high levels of cognitive ability are likely to result in life styles that delay the onset of chronic diseases and mitigate their effects when they occur.

Environmental Influences

Our next step in understanding cohort differences in cognition involved the characterization of our study participants' micro-environments. This effort, first implemented in 1974, involved inventory construction with guidance sought from sociologists and social psychologists to obtain information on social support systems, family constellations, work environments, quality of living arrangements, and leisure pursuits (Gribbin, Schaie, & Parham, 1980; Nguyen, 2000; O'Hanlon, 1993; Schaie & Gribbin, 1975; Schaie & O'Hanlon, 1990). Table 2 shows the correlation between clusters of environmental influences identified through factor analysis and the five primary abilities monitored throughout our longitudinal studies.

Table 2. Correlations Between Environmental Influences and the Primary Mental Abilities

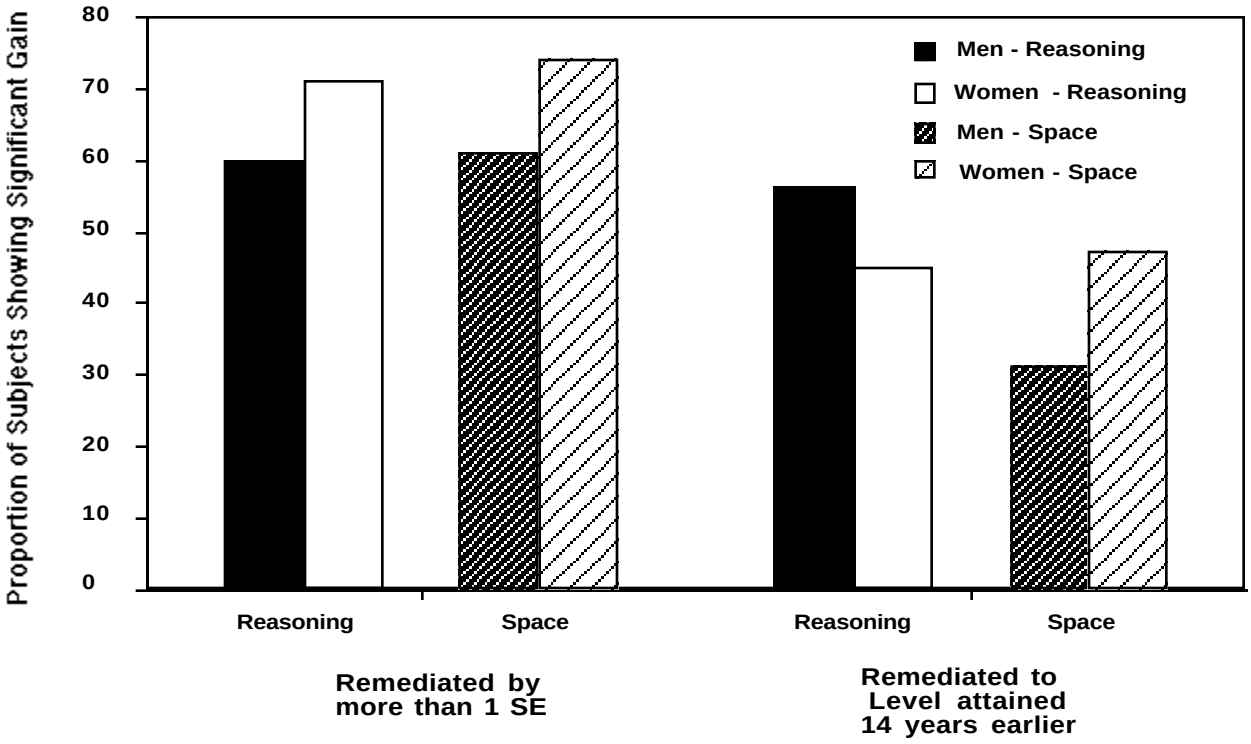
Environmental Influence	Verbal` Meaning	Spatial Orientation	Inductive Reasoning	Number	Word Fluency
Prestige	**.51**	**.28**	**.46**	**.26**	**.34**
Demographic Status	**.40**	**.36**	**.36**	**.23**	**.24**
Intellectual Environment	**.38**	**.18.**	**.31**	**.13**	**.28**
Physical Environment	**.21**	**.17**	**.20**	**.15**	**.19**
Social Network	**.03**	**.05**	**.05**	**.00**	**.01**
Leisure Activities	**.25**	**.15**	**.27**	**.08**	**.27**
Work Characteristics	**.46**	**.41**	**.47**	**.31**	**.30**
Residential and Occupational Mobility	**.15**	**.21**	**.23**	**.03**	**.12**

Educational Interventions

Having identified those abilities that showed earliest age decline, we then adapted technologies from education and educational psychology to explore the possibility of remediating age-related cognitive declines as well as the disadvantages experienced by older persons (64 years of age and older) because of cohort-related obsolescence. These studies could only be done with longitudinal information about prior level of performance Our series of training studies was also designed to show by inference that age-related cognitive decline should not necessarily be seen as precursors of dementia, by showing that educational interventions could result in the remediation of carefully documented decline (Schaie & Willis, 1986; Willis, 1990; Willis & Schaie, 1994). Figure 2 shows proportions of study participants who improved my

more than one standard error of measurement and proportion of those returned to their level held fourteen years earlier.

Figure 2. Training Success

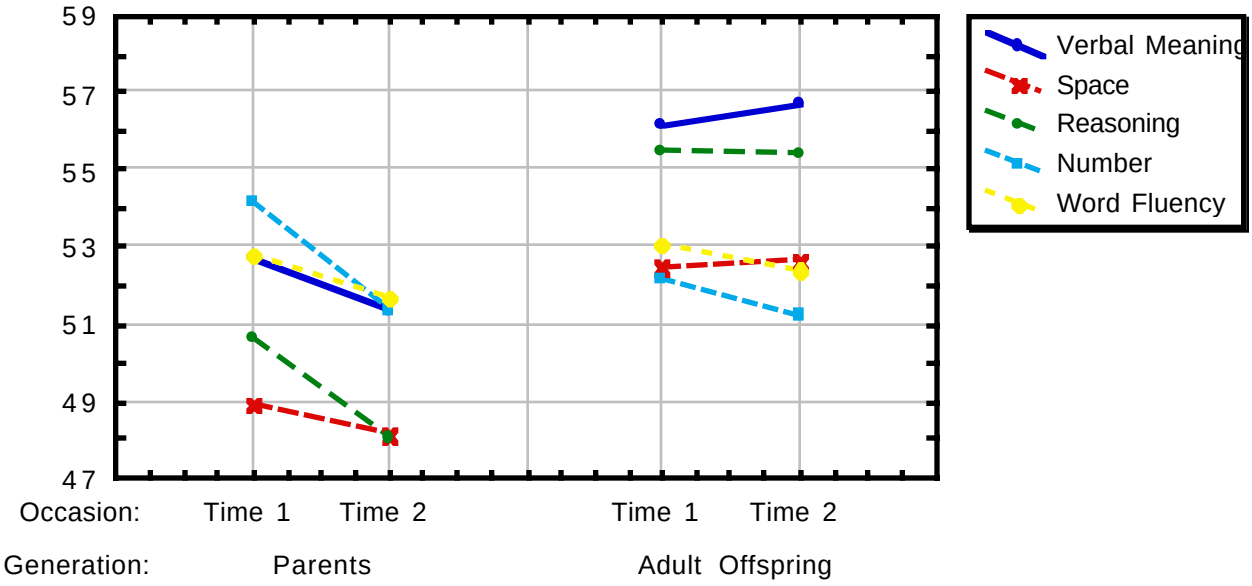


Family Studies

Renewed concern with nature-nurture issues in the study of intelligence and the paucity of relevant data next led us to pursue extensions of the SLS by recruiting collateral samples of adult offspring and siblings (and most recently grandchildren of our original study participants). These family studies of cognition were informed by behavior geneticists who had done similar work with parents and their young children (cf. Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992; Schaie, Plomin, Willis, Gruber-Baldini, Dutta, & Bayen, 1993; Schaie & Zuo, 2001). This work also required instrument construction informed by environmental psychologists (cf. Schaie & Willis, 1995). The family studies are also becoming relevant to issues of social policy as they begin to inform us on inter-generational differences in rates of

cognitive aging (Schaie & Willis, 2000). Figure 3 provides an example by showing seven-year changes observed in persons over age 60 for two generations (parents and offspring)

Figure 3. Seven Year Change in Successive Generations of Individuals 60 Years or older at First Test



Early Prediction of Risk for Dementia

Most recently, we have begun collaborations with geneticists and geriatric psychiatrists that address issues of early prediction of risk for dementia. For this purpose we started in 1997 to collect and cryo-preserve DNA material to obtain ApoE genotypes (Kennett & Schaie, 1999), and we have started an autopsy program in collaboration with the Alzheimer Center at the University of Washington. Also since 1997 we have administered an expanded CERAD battery to our older subjects, and are using this battery to obtain dementia rating with the collaboration of neuropsychological colleagues. For this purpose we have developed a screening algorism to detect individuals who should be more closely examined for earlier signs of dementia (see Figure 4).

Figure 4.
Neuropsychological Screening Algorism in Normal (nondiagnosed) Population

1. MMSE- score < 27
2. Mattis Dementia Rating Scale- score < 130
3. Trail B- score time > 180 seconds
4. Age adjusted scaled score < 7 for any of the following:
   - WAIS-R Vocabulary
   - WAIS-R Comprehension
   - WAIS-R Block Design
   - WAIS-R Digit Symbol

These persons are brought to case conference and are classified as normal, to be monitored further, probably demented, and clearly demented. Figure 5 shows the distribution of classifications assigned to those identified by our algorism.

Figure 5. Population Screened

Community Dwelling
Adults Aged 60 +
Total Screened = 61/473 (12.9%)

Neuropsychologists' Consensus:

Probably impaired:	6 (1.3%)
Borderline:	7 (1.5%)
Should be monitored:	31 (6.6%)

Another example of our interdisciplinary collaboration in this area is the distribution of ApoE alleles found in our initial screening of participants aged 60 and older (see Figure 6)

Figure 6.

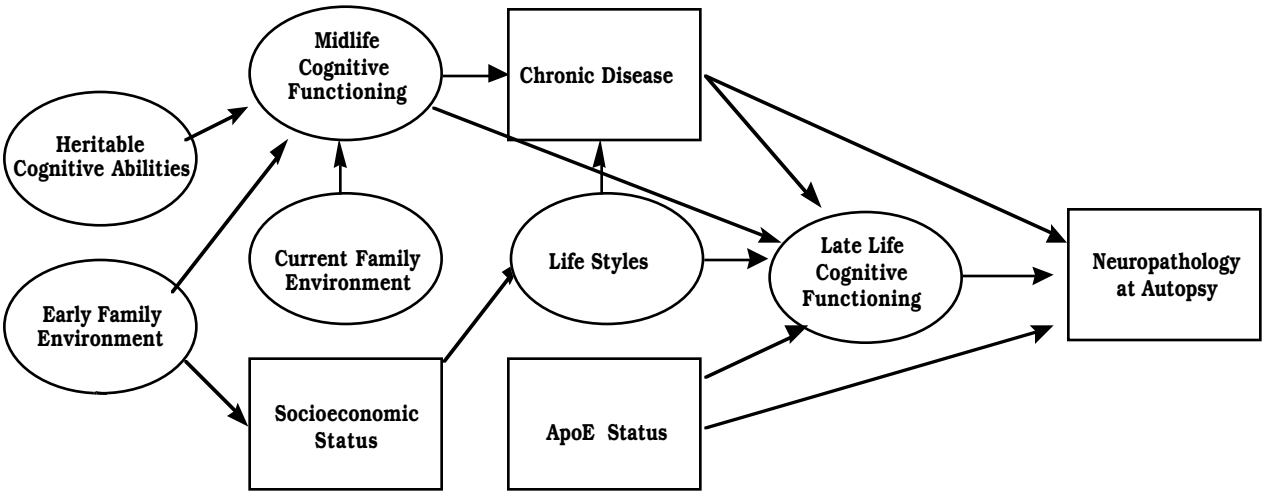
Apoprotein E Allele Distribution

22	3	(0.6%)
32	60	(12.7%)
33	289	(61.1%)
42	12	(2.5%)
43	98	(20.7%)
44	11	(2.3%)

An Integrative Model for the Seattle Longitudinal Study

The extensions of the SLS that include a broad array of inter-disciplinary contributions to the understanding of cognitive development in adulthood has demanded attention to how such diverse influences might best be integrated. Figure 7 provides a schematic that suggests how these influences might operate over the adult life course. The schematic contains two endpoints: The first is concerned with the lifelong influences that effect the level of late life cognitive functioning. The second endpoint is represented by the status of the cortical infra-structure relevant to the maintenance of cognitive functioning but which can only be determined post mortem. As in any path model, rectangles indicate directly observed indicators while ovals indicate latent constructs.

Figure 7. An Integrative Model for the Seattle Longitudinal Study



The astute listener might argue that the arrows in Figure 7, other than those directed towards the endpoints, may be too simplistic. Indeed, one could have posited several reciprocal relationships. Since the utility of this model lies primarily in its heuristic value, however, it has been kept rather simple. However, we would like to suggest that all of the causal paths specified in the model stem from investigations in our own laboratory or the work of other cognitive developmentalists.

Let us now try to explicate some of the attributes of the heuristic model. The initial bases for adult cognitive functioning must, of course, be attributed to both heritable (genetic) influences as well as early environmental influences typically experienced within the home of the biological parents. Although some of the behavior genetic literature suggests that much of the early environmental variance is non-shared (e.g., Plomin & Daniels, 1987), we have at least recent retrospective evidence that there is some early shared environmental influences upon later cognitive performance (Schaie & Zuo, 2000). Both generic and early environmental factors are thought to influence midlife cognitive functioning. The early environmental influences will, of course, also exert influences on midlife social status (Nguyen, 2000). By

contrast, virtually no correlations have been found between retrospective accounts of family environment in the family of origin, and that in the current family (Schaie & Willis, 1995). However, the current family environment does seem to influence midlife cognitive performance. Genetic factors are also likely to be implicated in the rate of cognitive decline in adulthood. Thus far the best-studied gene in this context is the Apo-E gene, one of whose alleles is thought to be a risk factor for Alzheimer's disease. Apo-E status is therefore added as a factor; the expression of the gene is probably not at issue prior to midlife.

The direct causal influences that determine level of cognitive function in late life as well as of the cortical status at autopsy, other than genes whose expression is turned on in late life, most likely originate in midlife. They include level of cognitive functioning in midlife life styles, and the incidence and severity of chronic disease. But there are indirect influences attributable to the effects of midlife cognitive function and life styles upon chronic disease, as well as shared family influences on midlife cognition and of social status upon midlife life styles.

Conclusion

As has become apparent, our interdisciplinary involvements in may ways generated opportunities for us to ask novel questions which extended far beyond our possible reach at the inception of the study. A longitudinal study at its best should be seen as a living system that grows and learns from experience. This is why embracing new methodological and substantive paradigms has allowed us to take advantage of and design logical extensions of our early efforts in a variety of interdisciplinary directions.

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