Published in final edited form as:
ISSBD Bull. 2010 ; 57(1): 24–29.

The Seattle Longitudinal Study of Adult Cognitive Development

K. Warner Schaie and
University of Washington, USA, Schaie@u.washington.edu

Sherry L. Willis
University of Washington, USA, Schaie@u.washington.edu

The Seattle Longitudinal Study (SLS; Hertzog, 2010; Schaie, 1996a, b, 2000, 2005a) began as Schaie's doctoral dissertation at the University of Washington (Seattle, WA) in 1956. In an effort to resolve the discrepancies between cross-sectional and longitudinal findings in the study of adult intellectual development, Schaie designed a follow-up study, put into the field in 1963, that provided some answers, but also raised enough methodological and substantive questions to demand a continuing program of studies that is still in progress and has included eight major and several collateral data collections as well as three cognitive training studies. An important aspect of the study has been the investigation of cohort differences and their implications for the study of adult cognition. In the more recent phases of the study, a number of contextual, health, and personality variables have been identified that offer explanations for differential change and that provide a basis for possible interventions. Within the context of our monitoring of individual change, the authors therefore designed cognitive interventions that have been successful in reversing carefully documented declines in ability performance and in improving the cognitive functions of older persons who have remained stable.

Many reasonable arguments have been made for the proposition that motivational and other personality variables might have greater potency in predicting adjustment and competence in midlife than does intelligence, but the empirical evidence for this proposition is less than convincing. Questions such as who should be retired for cause (read incompetence) in the absence of mandatory retirement at relatively early ages; whether there is sufficient remaining competence for independent living; or whether persons can continue to conserve and dispose of their property all involve the assessment of intellectual functioning (see Schaie, 1988a). We need to examine at what age developmental peaks do occur and assess generational differences as well as within-generation age changes. Most important, we must determine the reasons why some individuals show intellectual decline in early adulthood, while others maintain or increase their level of intellectual functioning well into advanced old age.

Initial studies in 1949 (PMA 11–14; L. L. Thurstone & T. G. Thurstone, 1949) and 1953 (Schaie, Rosenthal, & Perlman, 1953), explored whether the factorial independence of the five abilities measured in the most advanced form of the PMA test would be retained in adulthood. In a 1963 follow-up study, in addition to tracking down and retesting as many of the individuals studied in 1956 as possible, we decided to draw a new random sample from the original population frame to provide the necessary controls for examining retest effects and began addressing the possibility that socio-cultural variation affects intellectual performance. The latter concern was stimulated by the thoughtful admonitions previously voiced by Raymond Kuhlen (1963). Our new sample therefore was extended over the original age range (22–70 years) plus an additional 7-year interval to match the age range now attained by the original sample.

NIH-PA Author Manuscript
NIH-PA Author Manuscript

The second cross-sectional study essentially replicated the findings of the base study. The short-term longitudinal study, however, disclosed substantially different information about peak levels and rate of decline. Publication of findings was therefore delayed until a theoretical model could be built that accounted for the discrepancy between the longitudinal and cross-sectional data (Schaie, 1965, 1977, 2007). These analyses suggested that comparisons of age group means needed to be conducted for the repeatedly measured samples as well as for successive independent samples drawn from the same cohort. Results were reported that called attention to substantial cohort differences and that questioned the universality and significance of intellectual decrement with advancing age in community-dwelling persons (Nesselroade, Baltes, & Schaie, 1972; Schaie & Strother, 1968).

The results from the third data collection seemed rather definitive in replicating the short-term longitudinal findings, but discrepancies between findings in the repeated-measurement and independent-sampling studies suggested the need for a replication of the 14-year longitudinal sequences, and it further seemed useful to follow the original sample for as long as 21 years, so a fourth data collection was conducted in 1977, again retesting the previous samples and adding a new random sample, this time from an expanded population frame (Schaie & Hertzog, 1983), adding collateral questions of the effects of monetary incentives on participant characteristics (Gribbin & Schaie, 1976); an examination of the aging of tests; and the beginning of causal analyses of health and environmental factors on change or maintenance of adult intellectual performance (Gribbin, Schaie, & Parham, 1980; Hertzog, Schaie, & Gribbin, 1978).

Influences from Neighboring Sciences

The early introduction to the issues of cohort differences and secular trends led to serious questions as to what the meaning of these effects might be beyond their role as control variables or as bothersome design confounds. Increased attention was therefore given to the impact of social structures and microenvironments on cognitive change (Schaie, 1974). This work was influenced early on by the writing of Matilda Riley (Riley, Johnson, & Foner, 1972) and later by the work of Carmi Schooler (1987; Schooler & Mulatu, 2005), as well as many other sociologists, anthropologists, and epidemiologists who have contributed to the Penn State social structure conference series (e. g., Bengtson, Schaie, & Burton, 1995; Kertzer & Schaie, 1989; Schaie & Abeles, 2008; Schaie & Elder, 2005; Schaie & Hendricks, 2000; Schaie, Krause, & Booth, 2004; Schaie & Schooler, 1998; Schaie & Uhlenberg, 2007).

The Study of Latent Constructs

Until the fourth (1977) cycle of the SLS, we followed the then-conventional wisdom of assessing each primary ability with the observable marker variable deemed to be the most reliable and valid measure of the latent construct to be estimated. With the widespread introduction of modern methods of confirmatory (restricted) factor analysis into the behavioral and social sciences, it became obvious that we needed to extend our concern with changes in level of intellectual functioning in adulthood to the assessment of structural relationships within the ability domain. This concern argued for collecting further data with a much expanded battery in which each ability would be multiply marked (Schaie, Dutta, & Willis, 1991; Schaie, Maitland, Willis, & Intrieri, 1998). We took this opportunity also to add marker tests for the ability domains of Perceptual Speed and Verbal Memory. The original battery of five mental ability tests was therefore expanded to 20 tests beginning with the 5th study wave.

Introducing Cognitive Interventions

The fifth (1984) SLS cycle also marked the assumption of a major role in the SLS by Sherry L. Willis, who brought to this project her skills in designing and implementing cognitive training paradigms. Thus, a major part of the fifth cycle included the implementation of a cognitive training study with our long-term participants aged 64 years or older, designed to assess whether cognitive training in the elderly serves to remediate cognitive decrement or increase levels of skill beyond those attained at earlier ages (Schaie & Willis, 1986; Willis, 1987, 1989, 1990; Willis & Nesselroade, 1990; Willis & Schaie, 1986b, 1988).

The database available through the fifth cycle also made it possible to update the normative data on age changes and cohort differences (Schaie, 1990a, 1990b, 1990c; Schaie & Willis, 1993) and to apply sequential analysis designs controlled for the effects of experimental mortality and practice (Cooney, Schaie, & Willis, 1988). Finally, this cycle saw the introduction of measures of practical intelligence (Willis & Schaie, 1986a), analyses of marital assortativity using data on married couples followed over as long as 21 years (Gruber-Baldini, Schaie, & Willis, 1995), and the application of event history methods to hazard analysis of cognitive change with age (Schaie, 1989).

Excursions into Behavior Genetics and Chronic Diseases

The sixth (1989–1991) SLS cycle included a set of four related studies. First, with the collaboration of Robert Plomin, a noted developmental behavior geneticist, we took advantage of the longitudinal database to collect data to implement a study of cognitive family resemblance in adulthood. We did this by recruiting the participation of a large number of adult offspring and siblings of our longitudinal panel members (Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992; Schaie & Willis, 1995). Second, we abstracted the health histories of our panel members and conducted more detailed investigations of the relationship between health and maintenance of intellectual functioning (Bosworth & Schaie, 1997). Third, we conducted a 7-year follow-up of the cognitive training study and replicated the study with a more recent cohort of older persons (Willis, 2001). Fourth, we were able to conduct longitudinal analyses of cognitive ability structures and further update our normative database with the collection of a sixth (1991) wave using the standard approach of retesting and drawing a sixth new independent sample (Schaie, 1994, 1996a). Finally a seventh cycle conducted in 2005 resulted in the retesting of 1207 previous study participants.

Explorations of Neuropsychology, the APOE Gene, and the NEO

From 1997 to 1999, we conducted a follow-up of all previous participants who could be retrieved as well as a new seventh (1998) wave. In addition, we began to collect blood for genotyping on the *APOE* gene and administered a neuropsychological test battery to participants aged 60 years or older (cf. Schaie, 2005a, chapter 17; Schaie, Caskie, Revell, Willis, Kaszniak, & Teri, 2005). This battery continues to be administered in a 3-year follow-up cycle. We also conducted a 14-year follow-up for members of the family study and recruited additional eligible participants.

Between study waves, in 1993, we conducted a mail survey of health behaviors for those persons who had participated in the 1989 family study and the 1991 longitudinal and sixth-wave studies. This survey was used to develop a set of latent dimensions for the study of health behaviors (Maier, 1995; Maitland, 1997). Another mail survey, collecting data on the NEO scales (Costa & McCrae, 1992) was conducted in 2001 (cf. Schaie, 2005a, chapter12; Schaie, Willis, & Caskie, 2004). Finally, we recruited several hundred third-generation members (those with at least one parent and one grandparent in the study) to expand the

NIH-PA Author Manuscript

NIH-PA Author Manuscript

family analyses. Currently in progress are structural MRI studies of a sub-sample of 165 individuals on whom we had previously obtained cognitive data in midlife.

Objectives of the Seattle Longitudinal Study

Throughout the history of the SLS, an effort now extending over 47 years, our focus has been on five major questions, which we have attempted to ask with greater clarity and increasingly more sophisticated methodologies at each successive stage of the study. These are elaborated next.

Does Intelligence Change Uniformly Through Adulthood, or Are There Different Life Course Ability Patterns?

Our studies have shown that there is no uniform pattern of age-related changes across all intellectual abilities, and that studies of an overall Index of Intellectual Ability (IQ) therefore do not suffice to monitor age changes and age differences in intellectual functioning for either individuals or groups. Our data do lend some support to the notion that fluid abilities tend to decline earlier than crystallized abilities. There are, however, important ability-by-age, ability-by-gender, and ability-by-cohort interactions that complicate matters. Moreover, whereas fluid abilities begin to decline earlier, crystallized abilities appear to show steeper decrement once the late 70s are reached.

Although cohort-related differences in the rate and magnitude of age changes in intelligence remained fairly linear for cohorts who entered old age during the first three cycles of our study, these differences have since shown substantial shifts. For example, rates of decremental age change have abated somewhat, and at the same time modestly negative cohort trends are beginning to appear as we begin to study members of the baby boom generation. Also, patterns of socialization unique to a given gender role in a specific historical period may be a major determinant of the pattern of change in abilities. More fine-grained analyses suggested, moreover, that there may be substantial gender differences as well as differential changes for those who decline and those who remain sturdy when age changes are decomposed into accuracy and speed.

With multiple markers of abilities, we have conducted both cross-sectional and longitudinal analyses of the invariance of ability structure over a wide age range. In cross-sectional analyses, it is possible to demonstrate configural but not metric factor invariance across wide age/cohort ranges. In longitudinal analyses, metric invariance obtains within cohorts over most of adulthood, except for the youngest and oldest cohorts. Finally, we examined the relationship of everyday tasks to the framework of practical intelligence and perceptions of competence in everyday situations facing older persons.

At What Age Is There a Reliably Detectable Decrement in Ability, and What Is Its Magnitude?

We have generally shown that reliably replicable average age decrements in psychometric abilities do not occur prior to age 60, but that such reliable decrement can be found for all abilities by 74 years of age. Analyses from the most recent phases of the SLS, however, suggested that small but statistically significant average decrement can be found for some, but not all, cohorts beginning in the sixth decade. However, more detailed analyses of individual differences in intellectual change demonstrated that even at age 81, fewer than half of all observed individuals have shown reliable decremental change over the preceding 7 years. In addition, average decrement below age 60 amounts to less than 0.2 of a standard deviation; by 81 years of age, average decrement rises to approximately 1 population standard deviation for most variables.

As data from the SLS cover more cohorts and wider age ranges within individuals, they attain increasing importance in providing a normative base to determine at what ages declines reach practically significant levels of importance for public policy issues. Thus, our data have become relevant to issues such as mandatory retirement, age discrimination in employment, and prediction of proportions of the population that can be expected to live independently in the community. These bases will shift over time because we have demonstrated in the SLS that both level of performance and rate of decline show significant age-by-cohort interactions.

What Are the Patterns of Generational Differences, and What Is Their Magnitude?

Results from the SLS have conclusively demonstrated the prevalence of substantial generational (cohort) differences in psychometric abilities. These cohort trends differ in magnitude and direction by ability and therefore cannot be determined from composite IQ indices. As a consequence of these findings, it was concluded that cross-sectional studies used to model age change would overestimate age changes prior to the 60s for those variables that show negative cohort gradients and underestimate age changes for those variables with positive cohort gradients.

Our studies of generational shifts in abilities have in the past been conducted with random samples from arbitrarily defined birth cohorts. As a supplement and an even more powerful demonstration, we have also conducted family studies that compared performance levels for individuals and their adult children. By following the family members longitudinally, we are also able to provide data on differential rates of aging across generations. In addition, we have also recruited siblings of our longitudinal participants to obtain data that allow extending the knowledge base in the developmental behavior genetics of cognition to the adult level by providing data on parent-offspring and sibling correlations in adulthood.

What Accounts for Individual Differences in Age-Related Change in Adulthood?

The most powerful and unique contribution of a longitudinal study of adult development arises from the fact that only longitudinal data permit the investigation of individual differences in antecedent variables that lead to early decrement for some persons and maintenance of high levels of functioning for others into very advanced age. A number of factors that account for these individual differences have been implicated; some of these have been amenable to experimental intervention. The variables that have been implicated in reducing risk of cognitive decline in old age have included (a) absence of cardiovascular and other chronic diseases; (b) a favorable environment mediated by high socioeconomic status; (c) involvement in a complex and intellectually stimulating environment; (d) flexible personality style atmidlife; (e) high cognitive status of spouse; and (f) maintenance of high levels of perceptual processing speed.

Can Intellectual Decline with Increasing Age Be Reversed by Educational Intervention?

Because longitudinal studies permit tracking stability or decline on an individual level, it has also been feasible to carry out interventions designed to remediate known intellectual decline as well as to reduce cohort differences in individuals who have remained stable in their own performance over time but who have become disadvantaged when compared with younger peers. Findings from the cognitive training studies conducted with our longitudinal subjects (under the primary direction of Sherry L. Willis) suggested that observed decline in many community-dwelling older people might well be a function of disuse and is clearly reversible for many. Indeed, cognitive training resulted in approximately two-thirds of the experimental subjects showing significant improvement; and about 40% of those who had declined significantly over 14 years were returned to their predecline level. In addition, we were able to show that we did not simply “train to the test” but rather trained at the ability (latent construct) level, and that the training did not disturb the ability structure. We have now extended these studies to include both a 7-year and a 14-year follow-up that suggest the long-term advantage of cognitive interventions.

Methodological Issues

The dialectical process between data collection and model building that has been part of the SLS has made possible substantial methodological advances in the design and analysis of studies of human development and aging. In addition, the study has provided baselines for clinical assessment and has made contributions relevant to education, basic instruction in psychological aging, and a variety of public policy issues (Schaie, 2008; Schaie, Willis, & Panek, 2005; Schaie & Zanjani, 2006). Within the context of the Seattle Longitudinal Study there have been a significant number of methodological advances, particularly with respect to the design of sequential studies and the relationship between cross-sectional age differences and longitudinal age changes (Schaie, 1965, 1974, 1977, 2005a, b, 2006; Schaie & Caskie, 2005; Schaie & Willis, 2001, chapter 5;). We have also repeatedly addressed the issues of participant attrition (Baltes, Schaie, & Nardi, 1971; Cooney, Schaie, & Willis, 1988; Gribbin & Schaie, 1979; Schaie, Labouvie, & Barrett, 1973; Schaie, 2005a), and that of the problem of practice effects (Schaie, 1977, 1988b).

Acknowledgments

Work on the Seattle Longitudinal Study (SLS) has been supported by grants from: The National Institute of Child Health and Human Development (HD00367, 1963–1965; HD04476, 1970–1973) and the National Institute of Aging (AG00480, 1973–1979; AG03544, 1982–1986; (AG04470, 1984–1989; AG08055, 1980–2006; AG027759, 2005–09; currently AG024102, 2005–2015). More information on the SLS including downloadable publications and conference presentations may be obtained by accessing our web site http://www.uwpsychiatrty.org/sls

References

Baltes PB, Schaie KW, Nardi AH. Age and experimental mortality in a seven-year longitudinal study of cognitive behavior. Developmental Psychology. 1971; 5:18–26.

Bengtson, VL.; Schaie, KW.; Burton, L., editors. Intergenerational issues in aging. New York: Springer Publishing Co.; 1995.

Bosworth HB, Schaie KW. The relationship of social environment, social networks, and health outcomes in the Seattle Longitudinal Study: Two analytical approaches. Journal of Gerontology: Psychological Sciences. 1997; 52B:197–205.

Cooney TM, Schaie KW, Willis SL. The relationship between prior functioning on cognitive and personality variables and subject attrition in longitudinal research. Journal of Gerontology. 1988; 43:12–17.

Gribbin K, Schaie KW. Monetary incentive age, cognition. Experimental Aging Research. 1976; 2:461–468. [PubMed: 1017461]

Gribbin, K.; Schaie, KW. Selective attrition in longitudinal studies: A cohort sequential approach. In: Orino, H.; Shimada, K.; Iriki, K.; Maeda, D., editors. Recent advances in gerontology. Amsterdam, The Netherlands: Excerpta Medica; 1979. p. 549-551.

Gribbin K, Schaie KW, Parham IA. Complexity of life style and maintenance of intellectual abilities. Journal of Social Issues. 1980; 36:47–61.

Gruber-Baldini AL, Schaie KW, Willis SL. Similarity in married couples: A longitudinal study of mental abilities and rigidity-flexibility. Journal of Personality and Social Psychology. 1995; 69:191–203. [PubMed: 7643300]

Hertzog C. Regarding methods for studying behavioral development: The contributions and influence of K Warner Schaie. Research on Human Development. 2010

Hertzog C, Schaie KW, Gribbin K. Cardiovascular disease and changes in intellectual functioning from middle to old age. Journal of Gerontology. 1978; 33:872–883. [PubMed: 744860]

Kertzer, D.; Schaie, KW., editors. Age structuring in comparative perspectives. Hillsdale, NJ: Erlbaum; 1989.

Kuhlen RG. Age and intelligence: The significance of cultural change in longitudinal vs. cross-sectional findings. Vita Humana. 1963; 6:113–124.

Maier, H. Unpubl. doctoral dissertation. University Park, PA: the Pennsylvania State University; 1995. Health behaviors in adults: interrelationships and correlates.

Maitland, SB. Unpubl. doctoral dissertation. University Park, PA: The Pennsylvania State University; 1997. Factorial invariance and concordance of health behaviors and health status: A study of individual differences in familial context.

Nesselroade JR, Baltes PB, Schaie KW. Ontogenetic and generational components of structural and quantitative change in adult cognitive behavior. Journal of Gerontology. 1972; 27:222–228. [PubMed: 5060726]

Riley, MW.; Johnson, MJ.; Foner, A. Aging and society: Vol. 3: A sociology of age stratification. New York: Russell Sage; 1972.

Saczinski JS, Willis SL, Schaie KW. Strategy use in reasoning training with older adults. Aging, Neuropsychology and Cognition. 2002; 9:48–60.

Schaie KW. A general model for the study of developmental problems. Psychological Bulletin. 1965; 64:92–107. [PubMed: 14320080]

Schaie KW. Translations in gerontology - From lab to life: Intellectual functioning. American Psychologist. 1974; 29:802–807. [PubMed: 4440934]

Schaie, KW. Quasi-experimental designs in the psychology of aging. In: Birren, JE.; Schaie, KW., editors. Handbook of the psychology of aging. New York: Van Nostrand Reinhold; 1977. p. 39-58.

Schaie, KW. The delicate balance: Technology, intellectual competence, and normal aging. In: Lesnoff-Caravaglia, G., editor. Aging in a technological society. Vol. Vol. 6. New York: Human Sciences Press; 1988a. p. 155-166.

Schaie, KW. Internal validity threats in studies of adult cognitive development. In: Howe, ML.; Brainerd, CJ., editors. Cognitive development in adulthood: Progress in cognitive development research. New York: Springer-Verlag; 1988b. p. 241-272.

Schaie KW. The hazards of cognitive aging. The Gerontologist. 1989; 29(4):484–493. [PubMed: 2521108]

Schaie, KW. Intellectual development in adulthood. In: Birren, JE.; Schaie, KW., editors. Handbook of the psychology of aging. 3rd ed.. New York: Academic Press; 1990a. p. 291-309.

Schaie, KW. Late life potential and cohort differences in mental abilities. In: Perlmutter, M., editor. Late life potentials. Washington, DC: Gerontological Society of America; 1990b. p. 43-61.

Schaie, KW. The optimization of cognitive functioning in old age: Predictions based on cohort-sequential and longitudinal data. In: Baltes, PB.; Baltes, MM., editors. Successful aging: Perspectives from the behavioral sciences. Cambridge, UK: Cambridge University Press; 1990c. p. 94-117.

Schaie KW. The course of adult intellectual development. American Psychologist. 1994; 49:304–313. [PubMed: 8203802]

Schaie, KW. Intellectual development in adulthood: The Seattle Longitudinal Study. New York: Cambridge University Press; 1996a.

Schaie, KW. The natural history of a longitudinal study. In: Merrens, M.; Brannigan, G., editors. The developmental psychologists. New York: McGraw-Hill; 1996b. p. 233-249.

Schaie, KW. Living with gerontology. In: Birren, JE.; Schroots, JJF., editors. A history of geropsychology in autobiography. Washington, DC: American Psychological Association; 2000. p. 233-248.

Schaie, KW. Developmental influences on adult intellectual development: The Seattle Longitudinal Study. New York: Oxford University Press; 2005a.

Schaie KW. What can we learn from longitudinal studies of adult intellectual development? Research in Human Development. 2005b; 2:133–158. [PubMed: 16467912]

Schaie, KW. The concept of event time in the study of aging. In: Baars, J.; Visser, H., editors. Concepts of time and aging. Amityville, NY: Baywood Publishing Co; 2006. p. 121-135.

Schaie, KW. Generational differences; the age-cohort-period model. In: Birren, JE., editor. Encyclopedia of gerontology: Age, aging, and the aged. 2nd edit.. Oxford, UK: Elsevier; 2007. p. 601-609.

Schaie, KW. Historical processes and patterns of cognitive aging. In: Hofer, SM.; Alwin, DF., editors. Handbook on cognitive aging: Interdisciplinary perspective. Thousand Oaks, CA: Sage; 2008. p. 368-383.

Schaie, KW.; Abeles, RA., editors. Social structures and aging individuals: Continuing challenges. New York: Springer Publishing Co.; 2008.

Schaie, KW.; Caskie, GIL. Methodological issues in aging research. In: Teti, DM., editor. Handbook of research methods in developmental psychology. Cambridge, UK: Blackwell; 2005. p. 21-69.

Schaie KW, Caskie GIL, Revell AJ, Willis SL, Kaszniak AW, Teri L. Extending neuropsychological assessment into the Primary Mental Ability space. Aging, Neuropsychology and Cognition. 2005; 12:245–277.

Schaie KW, Dutta R, Willis SL. The relationship between rigidity-flexibility and cognitive abilities in adulthood. Psychology and Aging. 1991; 6:371–383. [PubMed: 1930754]

Schaie, KW.; Elder, GH., Jr, editors. Historical influences on lives and aging. New York: Springer Publishing Co.; 2005.

Schaie, KW.; Hendricks, J., editors. Evolution of the aging self: Societal impacts. New York: Springer Publishing Co.; 2000.

Schaie KW, Hertzog C. Fourteen-year cohort-sequential studies of adult intelligence. Developmental Psychology. 1983; 19:531–543.

Schaie, KW.; Krause, N.; Booth, A., editors. Religious influences on health and wellbeing in the elderly. New York: Springer Publishing Co.; 2004.

Schaie KW, Labouvie GV, Barrett TJ. Selective attrition effects in a fourteen-year study of adult intelligence. Journal of Gerontology. 1973; 28:328–334. [PubMed: 4709650]

Schaie KW, Maitland SB, Willis SL, Intrieri RC. Longitudinal invariance of adult psychometric ability factor structures across seven years. Psychology and Aging. 1998; 13:8–20. [PubMed: 9533186]

Schaie, KW.; Plomin, R.; Willis, SL.; Gruber-Baldini, A.; Dutta, R. Natural cohorts: Family similarity in adult cognition. In: Sonderegger, T., editor. Psychology and aging: Nebraska symposium on motivation. Vol. 1991. Lincoln, NE: University of Nebraska Press; 1992. p. 205-243.

Schaie KW, Rosenthal F, Perlman RM. Differential deterioration of factorially “pure” mental abilities. Journal of Gerontology. 1953; 8:191–196. [PubMed: 13052913]

Schaie, KW.; Schooler, C., editors. Impact of work on older adults. New York: Springer Publishing Co.; 1998.

Schaie KW, Strother CR. A cross-sequential study of age changes in cognitive behavior. Psychological Bulletin. 1968; 70:671–680. [PubMed: 5712311]

Schaie, KW.; Uhlenberg, P., editors. Demographic influences on health and wellbeing of the elderly. New York: Springer Publishing Co.; 2007.

Schaie KW, Willis SL. Can decline in adult intellectual functioning be reversed? Developmental Psychology. 1986; 22:223–232.

Schaie KW, Willis SL. Age difference patterns of psychometric intelligence in adulthood: Generalizability within and across ability domains. Psychology and Aging. 1993; 8:44–55. [PubMed: 8461114]

Schaie, KW.; Willis, SL. Perceived family environments across generations. In: Bengtson, VL.; Schaie, KW.; Burton, L., editors. Adult intergenerational issues in aging. New York: Springer Publishing Co.; 1995. p. 174-209.

Schaie KW, Willis SL, Caskie GIL. The Seattle Longitudinal Study: Relation between personality and cognition. Aging, Neuropsychology and Cognition. 2004; 11:204–234.

Schaie KW, Willis SL, Pennak S. A historical framework for cohort differences in intelligence. Research in Hum an Development. 2005; 2:43–67.

Schaie, KW.; Zanjani, FAK. Intellectual development across adulthood. In: Hoare, C., editor. Handbook of adult development and learning. New York: Oxford University Press; 2006. p. 99-122.

Schooler, C. Psychological effects of complex environments during the life span: A review and theory. In: Schooler, C.; Schaie, KW., editors. Cognitive functioning and social structure over the life course. Norwood, NJ: Ablex; 1987. p. 24-49.

Schooler C, Mulatu MS, Oates G. The continuing effects of substantively complex work on the intellectual functioning of older workers. Psychology and Aging. 1999; 14:483–506. [PubMed: 10509702]

Thurstone, LL.; Thurstone, TG. Examiner manual for the SRA Primary Mental Abilities Test. Chicago: Science Research Associates; 1949. (Form 10–14).

Wechsler, D. The measurement of adult intelligence. Baltimore: Williams and Wilkins; 1939.

Willis, SL. Cognitive training and everyday competence. In: Schaie, KW., editor. Annual Review of Gerontology and Geriatrics. Vol. Vol. 7. New York: Springer Publishing Co.; 1987. p. 159-188.

Willis, SL. Improvement with cognitive training: Which dogs learn what tricks. In: Wilson, LW.; Poon, DC.; Rubin, BA., editors. Everyday cognition in adulthood and late life. Cambridge, UK: Cambridge University Press; 1989. p. 545-589.

Willis, SL. Current issues in cognitive training research. In: Lovelace, EA., editor. Aging and cognition: Mental processes, self-awareness, and interventions. Amsterdam, The Netherlands: Elsevier; 1990. p. 263-280.

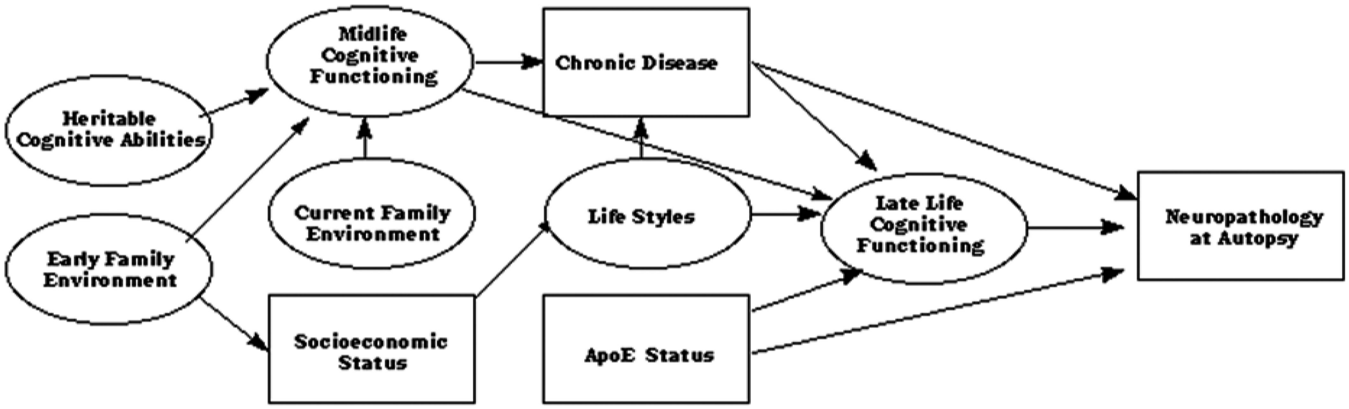
Willis, SL. Methodological issues in behavioral intervention research with the elderly. In: Schaie, JE.; Birren, KW., editors. Handbook of the psychology of aging. 5th ed.. San Diego, CA: Academic Press; 2001. p. 78-108.

Willis SL, Nesselroade CS. Long-term effects of fluid ability training in old age. Developmental Psychology. 1990; 25:905–910.

Willis, SL.; Schaie, KW. Practical intelligence in later adulthood. In: Sternberg, RJ.; Wagner, RK., editors. Practical intelligence: Origins of competence in the everyday world. New York: Cambridge University Press; 1986a. p. 236-268.

Willis SL, Schaie KW. Training the elderly on the ability factors of spatial orientation and inductive reasoning. Psychology and Aging. 1986b; 1:239–247. [PubMed: 3267404]

Willis SL, Schaie KW. Gender differences in spatial ability in old age: Longitudinal and intervention findings. Sex Roles. 1988; 13:189–203.


Midlife
Cognitive
Functioning
Chronic Disease
Heritable
Cognitive Abilities
Current Family
Environment
Life Styles
Late Life
Cognitive
Functioning
Neuropathology
at Autopsy
Early Family
Environment
Socioeconomic
Status
ApoE Status

1. .