Three

Longitudinal Studies in Aging Research

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I. Introduction

The purpose of this chapter is to review the current status and role of longitudinal studies in the psychology of aging. There seems to be wide recognition now of the importance of longitudinal studies if we are to go beyond the description of age-related differences in behavior to the discovery of mechanisms that explain the human progression from young adulthood to old age. We will begin our discussion by reminding the reader why longitudinal studies are such important contributors to the aging literature. We then turn to the problems of longitudinal studies as quasi-experiments. There follows a brief discussion of other issues that plague longitudinal inquiries, such as the matter of invariance of the relation between latent constructs and observed variables over time and cohorts, issues of unequal intervals and missing data, and retesting effects. The contributions of relevant recent methodological advances that can address these problems will then be discussed. Finally, we provide a review of current long-term as well as recently initiated longitudinal studies that should be brought to the attention of serious aging researchers.

Only in the past decade or so has there been an increased recognition that it is possible to apply longitudinal methodologies over relatively short intervals and that data sets already in existence can readily be converted into longitudinal studies by another wave of data collection. Funding agencies have been more willing to support such efforts, and archived long-term data sets are becoming available for secondary analyses by the broader scientific community. It seems timely, therefore, to review some of the principal methodological concerns that become important in the analysis of longitudinal data in aging research and to provide a review of the major longitudinal studies that have impacted the aging literature during the past decade.

For several decades the aging literature has been replete with exhortations that longitudinal studies are the methods of choice for data collections designed to contribute towards issues of behavioral change and decline of functions from young adulthood to old age. Nevertheless, the aging literature has continued to be largely dominated by cross-sectional age-comparative studies. Many reasons have been cited for this disconnect in theoretical understanding and research practice.
They include practical issues, such as the need to complete theses and dissertations (and publishable projects by tenure-seeking junior scientists) in a timely fashion, the reluctance of funding agencies to enter into long-term commitments, as well as difficulties in managing archives over long time periods. Experimentally trained scientists also tend to prefer short-term experiments rather than the long-term quasi-experiments represented by the longitudinal approach. It is our hope that this chapter will encourage better understanding of the longitudinal approach in aging research and reassure those who contemplate designing new longitudinal studies.

II. Why Should One Conduct Longitudinal Studies?

Early empirical inquiries in the study of adult development were conducted primarily in the areas of intelligence and personality traits. Investigators interested in the age-related aspects of learning and memory largely adopted the paradigms popular in early experimental child psychology and thus limited themselves to age-comparative studies of young and old adults. Only recently have we seen studies that investigate developmental mechanisms by use of longitudinal paradigms (see Salthouse, 1999). Even in the study of intellectual development, cross-sectional studies predominated until the late 1930s and clouded our understanding of adult development due to the confusion of age-related development with secular changes expressed as cohort effects (also see Schaie, 2000).

Although the explicit differences in information from cross-sectional and longitudinal inquiries were not fully explicated until the 1960s (cf. Mason, Mason, Winsborough, & Poole, 1973; Ryder, 1965; Schaie, 1965), it has always been clear that longitudinal data are needed in order to study intraindividual development, to elucidate antecedent-consequent relationships in time-bound developmental mechanisms, and to distinguish typologies of alternative courses of development (Baltes & Nesselroade, 1979). Longitudinal data are also essential to decompose different influences that impact age-related change. By contrast, cross-sectional studies provide data and allow inferences only about interindividual differences. Even successive independent samples drawn over time from the same population cohort would allow inferences only about changes in level for the population examined. Of course, longitudinal studies also provide information on interindividual differences.

Five rationales have been identified for the utility of longitudinal study of behavioral development. Three of these involve descriptions of the course of development whereas two are concerned with explanatory issues (cf. Baltes & Nesselroade, 1979; Schaie, 1983):

1. Direct identification of intraindividual change. Changes within individuals may be continuous or may involve transformation of one behavior into another. They may also involve changes in the relation of observed variables to the underlying theoretical constructs. Singleoccasion observations would be inappropriate for the identification of such changes.

2. Identification of interindividual variability in intraindividual change. Different individuals vary in their behavioral course over time. The identification of typologies of growth curves requires the examination of similarities and differences in developmental change within individuals. Without such data, it would be impossible to determine whether group parameters were characteristic of the development of any particular individual.
3. Relationships among intraindividual changes. Longitudinal studies allow the discovery of structural relationships among behavior changes occurring over more than a single variable. Longitudinal data are therefore essential to the discovery of constancies and change for the entire organism. They are also required for tests of differentiation and de-differentiation of functional capabilities (see below).

4. Determinants of intraindividual change. Longitudinal studies are also required to identify time-ordered antecedents to provide the necessary conditions for causal interpretations. Only longitudinal studies can provide data that show whether a causal process involves discontinuities, whether causal chains are multidirectional, or whether multivariate patterns of influence are implicated.

5. Interindividual variability in determinants of intraindividual change. Longitudinal data also permit inferences regarding whether individuals who have similar patterns of intraindividual change are determined by different change processes. Variations in interindividual patterns of change may be attributable to alternative combinations of causal sequences, or differential patterns related to different levels of social, psychological, or biological attributes.

Longitudinal studies that have informed our understanding of adult development are of three different types. First, certain studies were begun to examine development and child-rearing practices in early childhood, but panel members were given continued follow-up when adulthood was reached. A classic example of this genre of studies is the follow-up of the Berkeley Growth and Guidance studies (Bayley & Oden, 1955; Eichorn, Clausen, Haan, Honzik, & Mussen, 1981). A second group of studies traced participants who had been assessed as young adults during their college experience and were reassessed in midlife or later.

An example of such studies is Owens’s (1953, 1966) follow-up of persons in their 50s who had first been assessed as ROTC members during World War I. Finally, beginning with work such as the Bonn Longitudinal Study (Rott, 1993; Schmitz-Scherzer & Thomae, 1983), the Duke Longitudinal Study (Palmore, Busse, Maddox, Nowlin, & Siegler, 1985), and the Seattle Longitudinal Study (Schaie, 1958, 1996), a concerted effort was made to obtain reasonably representative samples selected from adult populations.

III. Longitudinal Studies as Quasi-Experiments

Campbell and Stanley (1963) have described a number of threats to the internal validity of quasi-experiments such as longitudinal studies. These include maturation, effects of history, reactivity, instrumentation, statistical regression, experimental mortality, selection, and the selection–maturation interaction. The first two, history and maturation, have special meaning for scientists studying individual development. Maturation, quite obviously, is not a threat to the validity of developmentally oriented longitudinal studies, but rather is the topic of primary interest to the investigator. Maturation here is simply the normal developmental course of individuals over their life span, given their genetic predispositions and the characteristic demands of the culture and environment within which such maturation occurs.

On the other hand, historical effects can be seen as the primary internal validity problem of longitudinal studies. History is directly involved in both cohort and time-of-measurement (period) effects. Cohort effects represent the impact of historical influences upon a group of individuals that share similar environmental circumstances at equivalent temporal
points in their life course. By contrast, time-of-measurement effects represent common historical exposures that influence all members of a population regardless of cohort membership. Historical effects may threaten the internal validity of longitudinal designs that seek to measure effects of maturation (aging effects). In other words, effects thought to be age-dependent must be carefully disaggregated from those due to historically limited environmental impacts. This disaggregation is only possible if a minimum of two cohorts are followed over similar age ranges (Schaie, 1977, 1988).

Longitudinal studies are also affected by the other six threats to internal validity described by Campbell and Stanley. Reactivity may simply involve practice effects on performance measures to the extent that study participants spend less time figuring out problems previously solved and therefore improve their performance because of previous exposure to the experimental protocol. On the other hand, longitudinal study participants might also respond on subsequent test occasions very differently than they would if they had not been previously tested, a behavior change that could be confused with the effects of maturation. Methods for assessing practice effects are available when at least two subsamples are available at different levels of measurement exposure (cf. Schaie, 1988). Alternative designs with differing individual measurement intervals can also provide useful avenues for estimating practice effects and provide less biased estimates of maturation (McArdle & Woodcock, 1997).

The threat of instrumentation refers to differences in experimental protocols that covary with measurement occasions. Such differences are likely to occur in long-term longitudinal studies when study personnel changes, or when records regarding study protocol on previous occasions are lost and slight variations in protocol are inadvertently introduced. As a consequence, erroneous inferences might be made regarding maturational trends or the impact of societal interventions.

Statistical regression is the tendency of variables containing measurement error to regress towards the population mean from one occasion to the next. This problem is particularly serious when only two data points are available (see Baltes, Nesselroade, Schaie, & Labouvie, 1972, and Schaie & Willis, 1986, for examples of applications of the time-reversal method, which can be used to test for the effect of regression in such studies). It has been shown, however, that regression effects do not necessarily cumulate over extended longitudinal series (Nesselroade, Stigler, & Baltes, 1980). If evidence for statistical regression is found, one can either adjust for reliability of the base line scores, or model change at the latent construct level, thus permitting better control of error variance.

Members of longitudinal panels obviously cannot be coerced to continue their participation. Hence, another serious internal validity threat is that of experimental mortality. This term refers to the loss of participants between measurement occasions, whether due to biological mortality, morbidity, or simply experimenter ineptness in maintaining his or her sample. Empirical studies of experimental mortality suggest that attrition is nonrandom at least between the first and second measurement occasion (Cooney, Schaie, & Willis, 1989; Schaie, 1988, 1996). Distinctions should always be made between "natural" mortality (i.e., attrition caused by death or disability) and attrition caused by refusal to continue participation or by experimenters' failure to locate or access participants for logistical reasons.

Selection refers to the process of obtaining a sample from the population such that the observed effect is a function of
the specific sample characteristics rather than of the maturational effect we wish to estimate (cf. Nesselroade, 1986). The selection–maturation interaction refers to the case where maturational effects may be found in some samples but not in others.

It is not possible to control for or measure the effects of any of the internal validity threats in single-cohort longitudinal studies. When multiple samples are available and certain assumptions are made, however, the magnitude and significance of these effects can be estimated and appropriate corrections applied in the substantive studies. Specific designs for appropriate analyses have previously been presented by Schaie (1977, 1988, 1996).

IV. Invariance of Latent Constructs across Time

When we wish to compare observations across periods of time (age) within individuals, which is the basic rationale for a longitudinal study, we make the implicit assumption that observations have the same relation to the underlying hypothetical construct at all points of measurement. This relationship is expressed technically as the equivalence across time of the factor loadings of the observed variables on the latent constructs. Only when the invariance of these relationships can be shown to hold can meaningful longitudinal inferences be drawn.

Horn, McArdle, and Mason (1983) drew attention to an important distinction between two levels of invariance in factor loadings (a distinction first introduced by Thurstone [1947, pp. 360–369]) that may have different implications for age change and age difference research: configural invariance and metric invariance. Meredith [1993] has explicated in greater detail the necessary conditions required to satisfy factorial invariance at different levels of stringency, known as weak, strong, and strict factorial invariance (see Hofer, Horn, & Eber, 1997).

For meaningful longitudinal comparisons it is necessary to show at a minimum that the factor pattern across groups or time display configural invariance. In this case, all measures marking the factors (latent constructs) have their primary nonzero loading on the same factor construct across test occasions. They must also have zero or low loadings on the same nonsalient measures for all other factor dimensions. Note, however, that it is possible that the factor loadings can differ in magnitude across groups or time, making the comparative basis for interpretation less than ideal.

A second (more satisfactory) level of factorial invariance (metric invariance, termed weak factorial invariance by Meredith, 1993) requires that the unstandardized factor pattern weights (factor loadings) can be constrained equal across time without loss of overall measurement model fit. The technical and substantive considerations for this level of factorial invariance have found extensive discussion in the literature (cf. Hofer, et al., 1997; Horn, 1991; Horn & McArdle, 1992; Jöreskog, 1971, 1979; Meredith, 1993; Schaie & Hertzog, 1985; Thurstone, 1947). Additional equality constraints on the intercepts, known as strong factorial invariance, permit the evaluation of mean differences at the factor level. If the measurements are comparable (when factorial invariance constraints do not significantly result in a model misfit), it becomes possible to test substantive hypotheses about the latent factor means, variances, and covariances over time and across groups.

However, we should stress that it is perhaps questionable whether even the assumptions of weak factorial invariance can be met in complex empirical data sets such as are found in many aging studies. In fact, Horn, et al. (1983) argued that
configural invariance is likely to be the best solution obtainable with empirical data. Nevertheless, it ought to be possible to demonstrate more stringent levels of invariance for subsystems of variables across at least some ages. Byrne, Shavelson, and Muthén (1989) have proposed therefore that one should also test for partial measurement invariance. This proposition is controversial in the factor-analytic literature because it results in factors that are not completely comparable. However, testing for partial invariance is reasonable from the point of view of the substantively oriented scientist. Inspection of the particular measures that produce the misfit in the factor model can lead to better understanding of the factor construct and measurement properties of the instruments and to further development of "age invariant" measurement instruments. Nevertheless, it should be stressed that tests of factorial invariance should precede the interpretation of longitudinal age changes whenever possible (also see Chapter 2, Rudinger & Rietz, this volume, for relevant structural equation models). In certain circumstances, departures from factorial invariance might be predicted on theoretical grounds or when measurement properties of particular instruments are out of range. Arguments might then be made that a specific analysis ought to be restricted over that age range where the specific construct of interest remains invariant.

V. The Issue of Dedifferentiation in Advanced Old Age

A related issue here is the possibility of changes in the factor space of the domains covered in a given longitudinal study. Considerable attention has recently been devoted to observations that performance on many behavioral attributes and measures of sensory capabilities converge in advanced old age (cf. Baltes & Lindenberger, 1997). One interpretation of this phenomenon might be to suggest that the study of physiological processes should be given priority as outcome events in old age, even though behavioral dimensions might have greater salience as indicators of life quality.

The hypothesized convergence of factor space in old age has a long history. Its conceptual basis comes from the theorizing of Kurt Lewin (1935; also see Schaie, 1962) and particularly Heinz Werner (1948), who argued that the cognitive structures of young children were amorphous and undifferentiated, but that the process of development would lead to a greater differentiation of distinct mental processes. The reason for the original lack of differentiation was attributed to the fact that all psychological processes are heavily dependent on their physiological infrastructures during early development and hence would need to develop in an undifferentiated tandem with the physiological development. As adulthood is reached, however, environmental and experiential phenomena come to dominate the psychological processes, with much less dependence on their physiological bases. However, once late midlife is reached, the decline of sensorimotor and central nervous system functions are presumed to lead to a renewed dependence of individual differences on physiological infrastructures. Hence, a reversal of the earlier differentiation is to be expected, as psychological processes increasingly depend on the physiological infrastructure (cf. Baltes & Lindenberger, 1997). This dedifferentiation can be expressed in statistical terms as the progressive increase of individual differences covariances and the corresponding decrease in variances. Other substantive domains such as personality, self-concepts, or values might, of course, experience alternate forms of structural reorganizations with age, but data are relatively
sparse as yet with respect to the latter domains.

Evidence for the dedifferentiation phenomenon has been reported for individual variables since the 1940s (e.g., Balinsky, 1941; Cornelius, Willis, Nesselroade, & Baltes, 1983; Garrett, 1946; Reinert, 1970). More recent work has also demonstrated increases in correlations between cognitive and sensory functions (e.g., Lindenberger & Baltes, 1997; Salthouse, Hancock, Meinz & Hambrick, 1996). Much of this work, however, has either been at the level of individual marker variables or has relied heavily on cross-sectional data (e.g., Schaie, Willis, Jay, & Chipuer, 1989). However, there is now work, particularly in the Seattle Longitudinal Study (Maitland, Intrieri, Schaie, & Willis, 2000; Schaie, Maitland, Willis, & Intrieri, 1998) as well as the Victoria Longitudinal Study (Hultsch, Herzog, Dixon, & Small, 1998), suggesting that dedifferentiation can also be demonstrated at the latent construct level. The literature is not yet clear, however, whether the dedifferentiation phenomenon can be demonstrated to hold across all domains of behavior. Latent factor analysis allows a formal test of this hypothesis.

Once factorial invariance across time has been demonstrated at least at the configural invariance level, it is then possible to proceed with a formal test of the dedifferentiation hypothesis. This test requires that the variance–covariance matrices for successive ages be constrained equal across time. If there is no loss in model fit over a competing model that allows independent estimates of the different variance–covariance matrices, then the hypothesis would be disconfirmed. It is most likely that a subset of variables can be constrained to be equal across age groups. Evaluation of models such as these have important substantive implications because it would specify the latent dimensions for which convergence of factor space can or cannot be demonstrated.

VI. Missing Data and Unequal Intervals

Longitudinal studies extending over long time intervals typically experience participants attrition (or dropping out and returning at a later date) as well as failure to respond to certain variables (i.e., sparse missing data). Fortunately, substantial advances have been made in conducting missing data analyses, and the application of statistical methods for treating missing data using maximum likelihood (e.g., structural equation modeling) or multiple imputation (Schafer, 1997) methods is becoming routine. These new methods provide more consistent and efficient estimates of population parameters than otherwise might be obtained with traditional methods relying on complete cases, available pairwise, mean imputation, or single-imputation regression methods (e.g., Graham, Hofer, & MacKinnon, 1996; Graham, Hofer, & Piccinin, 1993; Little & Rubin, 1986; Schafer, 1997).

Following the work of Little and Rubin (1987; Rubin, 1976), a distinction can be made between dropouts missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR). The key distinction is whether the cause of the missingness is related directly to levels of the outcome variable (NMAR) or whether the missingness is due to other variables that are either irrelevant (MCAR) or measured and included in the model (MAR). Whether valid inferences can be drawn from analysis of longitudinal data with participant loss depends on the relationship between the outcome variables and the dropout mechanism (i.e., the reason for dropout), whether the dropout mechanism has been measured and included in the analysis (MAR), and the method of analysis (e.g., maximum likelihood). For most studies, the measurement of the dropout mechanism is critical and may include covariates that predict dropout, such as health-related
variables, time to death, age, and numerous demographic variables. Assuming the data are MCAR or MAR, inferences derived from likelihood-based methods will be unbiased (Little & Rubin, 1987). The interpretation of these results based on missing data is as if all individuals continued participation in the study—the differences between participants and non-participants carried by the covariates and previous outcome measurements. The utility of these methods has been demonstrated in a number of studies (e.g., Graham, et al., 1993; 1996; McArdle, 1994; McArdle & Hamagami, 1991). In addition to nonparticipation, many surveys also have sparse missing values that do not allow for complete case analysis of the data without further (often substantial) loss of information. Sparse missingness can be handled using the same likelihood-based methods. Although these methods are certainly useful and represent substantial progress in dealing with selection issues, other methods of analyses (e.g., mixture models) may be more appropriate when the underlying population of individuals is considered to be different across distinct patterns of age-based non-participation.

Estimation of rates of change in longitudinal studies is often complicated by unequal schedules of data collection at either the group or individual level. Most random coefficients models, including implementations of the latent growth model, permit estimation of change curves with unequal intervals as long as all participants have the same approximate interval between test occasions (cf. Bryk & Raudenbush, 1987; Mehta & West, 2000; Rogosa, Brandt, & Zimowsky, 1982; Rogosa & Willett, 1985; Willett & Sayer, 1994). Other approaches permit unequal testing schedules at the level of the individual. McArdle and Woodcock (1997) propose a model for analyzing longitudinal data based on multiple groups with different test-retest intervals and show how such methods can permit the statistical separation of testing-practice effects, factor stability, change, and state fluctuation.

Important issues in longitudinal research include the description of normative aging trends and the estimation of correlations between rates of aging, concomitants, and predictors of change and consequences of changes (e.g., mortality). There are numerous challenges to obtaining proper inferences given any research design. Assuming that some process is declining over time, nonrandom dropout and retest-practice effects will have an effect of decreasing observed longitudinal changes, particularly changes measured over short intervals. Cohort effects will have the opposite effect; if assumed to be uniformly in favor of more recent generations, older individuals in the study will exhibit greater change and poorer outcomes. Both cross-sectional and longitudinal research are troubled by initial recruitment selection, typically favoring more highly functioning individuals. It is also the case that systematic intraindividual variability in performance may lead to less than optimal estimates of change over time. Nevertheless, longitudinal aging studies are the standard by which to evaluate changes in rates of aging within people. Advances in statistical methods and research designs are better equipping us for dealing with these challenges. Missing data methods for treating nonrandom attrition and sparse missing data, structural equation modeling methods that permit the analysis of reliable variance, designs using “measurement bursts” to model intraindividual fluctuation (Nesselroade & Schmidt-McCollam, 2000), and multivariate models to estimate reliable change and covariates of change offer promising ways to overcome many of these difficulties.
VII. Archiving and Data Sharing

Most long-term longitudinal studies eventually become important resources that should be shared with the broader scientific community. It is a rare that a single group of investigators will be able to exhaustively mine the rich resources that have been accumulated at great expense, time, and effort. Although the transition to a younger investigator may keep some studies alive, others will be become dormant for periods of time, to be picked up by others who discover that important questions can be addressed by follow-up of previously assessed populations. It becomes important therefore to plan the development of archives of raw data as well as derived scores on media that have the promise of preserving data over time. In long-term studies, however, one must also deal with changes of technology and make certain that records are promptly transferred to newer media when technology changes.

At some point investigators must seriously consider whether their archives should be transferred to public repositories such as the Murray Center or the National Archive of Computerized Data on Aging (NACDA). Such deposition, however, may require complex negotiation regarding the confidentiality of the individuals whose data are being deposited. Although it is relatively simple to de-identify past data for reanalysis, it is also necessary to maintain appropriate rosters of the identity of individual data if there is a likelihood that a further longitudinal follow-up may be warranted.

An alternative approach to placing entire studies into archives is to make data available to other investigators on particular variables or variable domains. This approach is particularly promising where individual investigators can acquire only relatively small data sets that provide low analytic power. An important example of this kind of data sharing is the acquisition of cross-sectional and longitudinal Wechsler Adult Intelligence Scale (WAIS) data by McArdle and associates (e.g., McArdle, 1994), demonstrating the possibility of covering larger portions of the adult life span by combining data from multiple studies.

VIII. Longitudinal Studies of Psychological Aging

The contributions of longitudinal studies to the psychology of aging have been significant but are, in many ways, only a beginning. Longitudinal studies, by definition, are necessary to address issues relating to intrapersonal change and correlates of such changes. Questions regarding individual differences in aging, whether different processes “age” at different rates and in different individuals, and, indeed, whether “aging” is a universal or multidimensional process must be answered using longitudinal designs. This is not to say that cross-sectional findings are always misleading, but rather to say that they are not conclusive. Indeed, comparison of longitudinal to cross-sectional findings provides evidence of both concordance and disagreements (either full or in part). For example, the fluid–crystallized distinction (Horn & Cattell, 1967)—the observation and explanation that certain abilities are relatively maintained with age while others exhibit declines—was initially observed across people of different ages but has since been demonstrated in both cross-sectional and longitudinal studies (Horn & Hofer, 1992; Schaie, 1996). Disagreements between cross-sectional and longitudinal findings in the fluid–crystallized distinction involve primarily the ages at which declines are first observed as well as the magnitudes of decline.
Other direct comparisons between cross-sectional and longitudinal results include some of the variables found to account for age differences in cognitive functioning. A recent review of 34 longitudinal studies by Anstey and Christensen (2000) concluded that longitudinal findings regarding the effect of education, health, cardiovascular disease, hypertension, and apolipoprotein E genotype on cognitive change were consistent with cross-sectional findings, although results regarding the effect of physical activity were mixed and considered inconclusive. Although this comparative study provides support that between-individual differences are indicating important within-individual aging-related changes, this may not be the case for all processes of change.

Certain questions can only be asked of longitudinal data, particularly where the individual’s “history” is required. Most longitudinal studies emphasize the interface between health status, change in health, and the association with psychological variables, and a major component of these studies includes the collection of extensive medical and clinical data. This is important for separating poor primary aging outcomes from insidious onset disease processes (secondary aging). A recent example of this is the study of “preclinical” dementia, which requires that preclinical cases of dementia be ascertained retrospectively. A finding from the Einstein Aging Study demonstrates decline in cognitive functioning initiating several years prior to meeting a threshold leading to diagnosis of clinical dementia (Sliwinski, Lipton, Buschke, & Stewart, 1996). An implication of this finding is that a significant proportion of “normal” cognitive change in both cross-sectional and longitudinal studies with shorter follow-up periods may be due to the preclinical phase of a dementing illness. A related research issue that requires long-term follow-up of individuals has to do with the effect of apolipoprotein E (apoE) genotype, which has been shown to have a link with the incidence of dementia and also to influence “normal” cognitive decline. The influence of apoE has been evaluated in several longitudinal studies and found to be related to declines in both memory and speed in nondemented samples (Anstey & Christensen, 2000). A major contribution of longitudinal designs is the ability to separate change in functional capabilities from disease-related processes retrospectively, thereby permitting the evaluation of patterns and rates of aging for particular subgroups and individuals.

The study of stability and change in personality has benefited from long-term longitudinal studies. A recent longitudinal study of participants in the Berkeley Growth Study (1928–present), Berkeley Guidance Study (1928–present), and the Oakland Growth Study (1931–present) included data from participants at 14, 18, 30, 40, 50, and 62 years of age on an index of psychological health (Jones & Meredith, 2000). Latent growth curve models indicated that psychological health is relatively stable during adolescence and increases after age 30. Individuals having greater psychological health in adolescence and early adulthood tend to show the greatest increase in middle adulthood.

Hypotheses and theories regarding psychological aging phenomenon must account for within-person changes and, if derived from between-person observations, be validated on longitudinal data. Aging is a dynamic phenomenon, and the appropriate unit of analysis is the person followed over time. However, it is the case that most evidence for theories of aging are derived from cross-sectional analysis of samples varying broadly in age with the implicit assumption that the single occasion study of individuals varying in age provides a good estimate of how individuals change over time. The focus of these studies is typically on
the amount of shared age-related individual differences and on the variables that account for most of the age-related variance (e.g., speed, sensorimotor, working memory; e.g., Salthouse, 1994). Two hypotheses of age-related mediation of cognitive functioning—the general slowing hypothesis (e.g., Birren & Fisher, 1995; Salthouse, 1999) and the “common cause” hypothesis (e.g., Lindenberger & Baltes, 1997)—have emphasized measures of processing speed and sensorimotor functioning, respectively. There have been few longitudinal evaluations of these hypotheses. In one longitudinal evaluation of the speed hypothesis, processing speed accounted for far less of the total longitudinal age effect compared to the total cross-sectional age effect (Sliwinski & Buschke, 1999).

There are, of course, numerous potential reasons for discrepancies between cross-sectional and longitudinal findings, including the relative age range available for study. Cross-sectional studies, however, must be regarded to provide a very poor basis for inference regarding whether change (aging) in one variable is associated with change (aging) in another variable. Indeed, a review of the cross-sectional literature on shared age-related effects finds that a highly diverse set of variables, all exhibiting mean differences across people of different ages, are moderately to highly associated in terms of shared age-related variance. An often overlooked reason for this is that in cross-sectional analysis of age-related variables, associations between time-dependent processes may arise simply due to average changes in the population and therefore tell us nothing about associations between rates of aging within individuals (Hofer, Berg, & Era, 1998; Hofer & Flaherty, 2000; Wohlwill, 1973). The potential for spurious associations among age-related variables is one of the major problems of cross-sectional designs for the study of associations between developmental and aging-related phenomena. The foundation for scientific hypotheses and theories of aging involving the estimation of patterns and rates of decline, associations between rates of aging, the proper account of early or initial individual differences, and predictors of such changes in patterns and rates of aging must be based on appropriate longitudinal designs. Cross-sectional designs are important, particularly for the development of measurement instruments (e.g., evaluating factorial invariance across age groups), but do not provide a strong basis for understanding within-individual aging.

In the following section we describe briefly longitudinal studies of aging that have addressed psychological constructs, whether as a central objective or as a substantial emphasis. We cannot, of course, provide an exhaustive listing or more than a cursory overview of each study. Table 3.1 shows basic design and sample characteristics for each of the longitudinal studies that include major components focusing on psychological aging. Each longitudinal study necessarily began as a cross-sectional study, and numerous publications describe this first wave of data. In several cases, longitudinal data collection is quite recent; hence, publications on the longitudinal aspects of these studies are often still in progress.

We have limited this review to studies currently in progress and provide brief descriptions and references to some of the research associated with each major study as entry points to their characteristics and findings. The date given is the year when the study commenced. Several earlier completed studies are referenced in the introductory sections of this chapter. Other completed longitudinal studies not described here in detail include the Bonn Longitudinal Study (1965–1984; Rott, 1993; Thomae, 1993), The First Duke Longitudinal Study (1955–1976;
<table>
<thead>
<tr>
<th>Study Title</th>
<th>Start yr</th>
<th>N (T1)</th>
<th>Age (T1)</th>
<th>Follow-up [yrs](^a)</th>
<th>Occ Interval</th>
<th>Curr # Occ</th>
<th>Type sample</th>
<th>New cohort?</th>
</tr>
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<td>Australian Longitudinal Study of Aging</td>
<td>1992</td>
<td>1947</td>
<td>70-85+</td>
<td>4.0</td>
<td>1</td>
<td>2</td>
<td>Stratified sample of community-dwelling and institutional care facilities</td>
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<tr>
<td>Asset and Health Dynamics Among the Oldest Old</td>
<td>1994</td>
<td>7447</td>
<td>70+</td>
<td>4.0</td>
<td>2</td>
<td>3</td>
<td>HRS Screening sample, Medicare enrollment, minority oversample</td>
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<tr>
<td>Baltimore Longitudinal Study of Aging</td>
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<td>260</td>
<td>20-96</td>
<td>42</td>
<td>2</td>
<td></td>
<td>Volunteer sample</td>
<td>y</td>
</tr>
<tr>
<td>Berkeley Older Generation Study</td>
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<td>94</td>
<td>59-79</td>
<td>14</td>
<td>14</td>
<td>2</td>
<td>Participants of Berkeley Growth and Guidance Studies</td>
<td></td>
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<tr>
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<td>2</td>
<td>4</td>
<td>Volunteer sample, former West-Berlin</td>
<td></td>
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<tr>
<td>The Berula Project</td>
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<td>3000+</td>
<td>35-80</td>
<td>10.0</td>
<td>5</td>
<td>3</td>
<td>Stratified</td>
<td>y</td>
</tr>
<tr>
<td>Canberra Longitudinal Study</td>
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<td>897</td>
<td>70-93</td>
<td>10.5</td>
<td>3.5</td>
<td>4</td>
<td>Community sample (electoral role), institutional care, oversampling of very old</td>
<td></td>
</tr>
<tr>
<td>Einstein Aging Studies</td>
<td>1980</td>
<td>488</td>
<td>70-90</td>
<td>20.0</td>
<td>1</td>
<td>20</td>
<td>Volunteer sample</td>
<td>y</td>
</tr>
<tr>
<td>Gender Study of Unlike-Sex DZ Twins</td>
<td>1995</td>
<td>498</td>
<td>69-81</td>
<td>4.0</td>
<td>2</td>
<td>2</td>
<td>Opposite sex twins in Sweden born between 1906 and 1925</td>
<td></td>
</tr>
<tr>
<td>Groningen Longitudinal Aging Study</td>
<td>1993</td>
<td>753</td>
<td>57-99</td>
<td>2.0</td>
<td>1</td>
<td>3</td>
<td>Patient population with physical limitations</td>
<td></td>
</tr>
<tr>
<td>The Gerontological and Geriatric Population Studies in Göteborg, Sweden</td>
<td>1971</td>
<td>1000</td>
<td>70</td>
<td>29.0</td>
<td>varies</td>
<td>12</td>
<td>Representative sample: Gothenburg</td>
<td>y</td>
</tr>
<tr>
<td>Health and Retirement Study</td>
<td>1992</td>
<td>12600</td>
<td>50-60</td>
<td>6.0</td>
<td>2</td>
<td>4</td>
<td>National sample, minorities oversampled</td>
<td>y</td>
</tr>
<tr>
<td>Interdisciplinary Longitudinal Study of Adult Development</td>
<td>1996</td>
<td>1384</td>
<td>45, 65</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>Former East and West Germany</td>
<td></td>
</tr>
<tr>
<td>The Kungsholmen Project</td>
<td>1987</td>
<td>327</td>
<td>75+</td>
<td>12.0</td>
<td>4</td>
<td>4</td>
<td>Population from Kungsholmen district, Stockholm</td>
<td>y</td>
</tr>
<tr>
<td>Long Beach Longitudinal Study</td>
<td>1978</td>
<td>509</td>
<td>55-87</td>
<td>21.0</td>
<td>varies</td>
<td>4</td>
<td>Recruited from Health Maintenance Organization</td>
<td></td>
</tr>
<tr>
<td>Longitudinal Aging Study Amsterdam</td>
<td>1991</td>
<td>3107</td>
<td>55-85</td>
<td>6.0</td>
<td>3</td>
<td>3</td>
<td>Urban and rural municipal registries</td>
<td>y</td>
</tr>
<tr>
<td>Lund 80+ Study</td>
<td>1988</td>
<td>80+</td>
<td></td>
<td>10.0</td>
<td>5</td>
<td>3</td>
<td>Population of Lund 80+ years old</td>
<td>y</td>
</tr>
<tr>
<td>Maastricht Aging Study</td>
<td>1992</td>
<td>2000</td>
<td>24-81</td>
<td>6.0</td>
<td>3</td>
<td>3</td>
<td>Recruitment from Registration Network Family Practices</td>
<td>y</td>
</tr>
<tr>
<td>Manchester and Newcastle Longitudinal Studies of Aging</td>
<td>1982</td>
<td>~6400</td>
<td>49-96</td>
<td>14.0</td>
<td>varies</td>
<td>4</td>
<td>Community volunteer sample</td>
<td>y</td>
</tr>
<tr>
<td>McNair Studies of Successful Aging</td>
<td>1988</td>
<td>1192</td>
<td>70-79</td>
<td>2.5</td>
<td>2.5</td>
<td>2</td>
<td>Selected from three cohorts of the Established Populations for Epidemiologic Studies of the Elderly</td>
<td></td>
</tr>
<tr>
<td>Normative Aging Study</td>
<td>1963</td>
<td>2032</td>
<td>25-75</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>Community residents</td>
<td></td>
</tr>
<tr>
<td>Nordic Research on Aging</td>
<td>1989</td>
<td>1204</td>
<td>75</td>
<td>5.0</td>
<td>5</td>
<td>2</td>
<td>Representative city samples</td>
<td></td>
</tr>
<tr>
<td>The Nun Study</td>
<td>1991</td>
<td>678</td>
<td>75-103</td>
<td>9</td>
<td>~1.5</td>
<td>6</td>
<td>American members of the School Sisters of Notre Dame</td>
<td></td>
</tr>
<tr>
<td>Octogenarian Twin Study</td>
<td>1990</td>
<td>702</td>
<td>80+</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>Swedish Twin Registry</td>
<td>y</td>
</tr>
<tr>
<td>Seattle Longitudinal Study</td>
<td>1956</td>
<td>5000+</td>
<td>22-95</td>
<td>42</td>
<td>7</td>
<td>7</td>
<td>Health Maintenance Organization</td>
<td>y</td>
</tr>
<tr>
<td>The Swedish Adoption/Twin Study of Aging</td>
<td>1984</td>
<td>1500</td>
<td>40-84</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>Swedish Twin Registry</td>
<td>y</td>
</tr>
<tr>
<td>The Victoria Longitudinal Study</td>
<td>1986</td>
<td>484</td>
<td>55-86</td>
<td>12</td>
<td>3</td>
<td>5</td>
<td>Community volunteers</td>
<td>y</td>
</tr>
</tbody>
</table>

\(^a\)Total follow-up is as of year 2000.

IX. Ongoing Longitudinal Studies

A. Australian Longitudinal Study of Aging (1992)

This study aims to determine features of successful aging in regards to physical, mental, and social variables. The participants include both community-dwelling and institutionalized individuals obtained using stratified sampling of 5-year age and sex groups over 70 years of age. Cross-sectional analysis of individual differences in memory performance found that processing speed was the major mediator of age-related variance in memory, with measures of depression, activity, gender, and health having minimal influence (Luszcz, Bryan, & Kent, 1997). In longitudinal analyses of the Australian Longitudinal Study of Aging (ALSA) data, Luszcz (1998) reported decline in speed, picture memory, depression, morale, and self-esteem over the 2-year period.

B. Baltimore Longitudinal Study of Aging (1958)

Participants include healthy, community-dwelling, middle-to upper-middle-class volunteers aged 40–89 at the first occasion. The study began with men in 1958, with the additional inclusion of women in 1978. The findings include age-related changes for tests of paired associate learning and serial recall (Arenberg, 1983) and on the Benton Visual Retention test (Giaibra, Arenberg, Zonderman, Kawas, & Costa, 1995).

C. Berkeley Older Generation Study (1958)

Members of this study began as participants in the earlier Berkeley Guidance and Berkeley Growth Studies. Evidence for continuity in friendships was found from young-old to old-old age, particularly among women, where the number of new friends and the desire for close and intimate friendships exhibited was stable, with some decline in these found for men (Field, 1999). Family involvement was found to increase with age, while beyond-family contacts declined for men but not for women (Field & Minkler, 1988). Health and socioeconomic status were found to account for the largest proportion of variance in family contact, with participants in better health having greater amounts of contact (Field, Minkler, Falk, & Leino, 1993).

D. Berlin Aging Study (1990)

The sample for this multidisciplinary study of persons over age 70 (Baltes & Mayer, 1999) includes 516 individuals drawn from former West Berlin (1990–1993) who participated in the intensive assessments (14 sessions). Of the cross-sectional findings, sensory and sensorimotor functioning have been shown to account for most of the age-related declines in cognitive functioning cross-sectionally (Lindenberger & Baltes, 1994). These findings were further replicated in a larger sample of older adults over 70 years of age and extended to younger adults between 25 and 69 years old (Baltes & Lindenberger, 1997).
E. The Betula Project (1988)

This prospective study of aging and dementia focuses on memory changes with age, with particular emphasis on risk factors and signs of preclinical dementia (Nilsson, et al., 1997). This study includes extensive memory measures, health indicators (e.g., clinical interviews, blood samples) and measures of social factors. Over 3000 participants from Umea, Sweden, born between the years 1908 and 1960 make up the sample. Stability for verbal fluency and vocabulary was found from age 35 to 50, followed by gradual decline, and education was a key factor associated with level of semantic memory (Bäckman & Nilsson, 1996).

F. Canberra Longitudinal Study (1991)

This prospective study of cognitive functioning and dementia is composed of a random sample of people aged 70 years and older drawn from the electoral roll for Canberra and the neighboring town of Queanbeyan, Australia (Korten, et al., 1997). Longitudinal results include the finding that education is associated with long-term individual differences in cognitive functioning but has little influence on timing or amount of cognitive change in late life (Christensen, et al., 2001). Changes in memory and speed functioning over 3.5 years were associated with decline in grip strength, more illnesses, and higher depression (Christensen, et al., 1999).

G. Einstein Aging Studies (1980)

The Einstein Aging Study has emerged from several longitudinal aging studies that began more than 20 years ago. These studies include the Bronx Aging Study, a longitudinal study of community-residing elderly individuals focused on assessing risk factors for dementia and the incidence of dementia; the Teaching Nursing Program Project examined age-associated memory impairment and the cognitive deficits in Alzheimer’s disease; and the Mechanisms of Age-Associated Memory Impairment Study focused on the study of cognitive mediators and mechanisms underlying memory differences between young and elderly adults. Longitudinal studies in this program have demonstrated that cognitive changes associated with normal aging are significantly influenced by contamination of normative samples by individuals with unidentified preclinical dementia (Sliwinski, Lipton, Buschke, & Stewart, 1996). Others findings demonstrate that although processing speed mediates longitudinal changes in memory and cognition to some degree (6% to 29%), longitudinal mediation accounts for much less variance compared to cross-sectional age mediation models (70–100%; Sliwinski & Buschke, 1999).


A major aim of this study is to understand the sex differences in health and health-related variables. The sampling frame is based on all living pairs of opposite-sex twins in Sweden born between 1906 and 1925 and includes 249 complete pairs of unlike-sex dizygotic (DZ) twins.

I. Groningen Longitudinal Aging Study (1993)

This study focuses on functional status and the need for supportive and institutional care. Assessment includes a variety of person characteristics, and environmental factors are combined with multiple measures of outcomes (i.e., disease-related impairments, symptoms, functional limitations, disability, and quality of life) to achieve greater insight into the complex adaptation process resulting
from impairment in late life. Findings from this study include changes in cognitive functioning (Jelincic & Kempen, 1997), personality and health-related quality of life (Kempen, Jelincic, & Ormel, 1997), and depressive symptoms and chronic health problems (Ormel, et al., 1998).


The aims of this study include description of "normal" aging, prevalence and incidence of disease, and the evaluation of the potential for preventing functional decline in late life (Rinder, Roupe, Steen, & Svanborg, 1975). The initial representative sample of 70-year-olds was obtained in the city of Gothenburg in 1971–1972. The study is multidisciplinary and includes extensive physiological exams as well as demographic, social, and cognitive variables. The examination of aging-related changes in cognitive functioning related to education, disease, and survival (terminal drop) has been a central focus of psychologically oriented analyses (Berg, 1987; Maxson, Berg, & McClearn, 1996).


This study focuses on predictors and determinants of successful physiological and mental aging (Rudinger & Minnemann, 1997). The sample includes 1390 participants from two age cohorts (1930–1932 and 1950–1952 born before and after WWII) and 4 years between measurement occasions. Reports include adjustment to retirement (Lehr, et al., in press), changes in cognitive ability across participants from former East and West Germany (Oswald, Rupprecht, & Hagen, 1997), and age differences in stress, social resources, and well-being (Martin, Grunendahl, & Martin, in press).

L. The Kungsholmen Project (1987)

This longitudinal population-based study of individuals aged 75 and over focuses on aging and the incidence of dementia (Frattigioni, et al., 1991). The initial sample includes residents of the Kungsholmen district of Stockholm, with later expansion to include individuals from two other areas in Sweden. Recent findings include differential change in memory performance over 3 years across groups defined by apoE-epsilon 4 allele (Small, Basun, & Bäckman, 1998), predictors of cognitive changes in memory, visuospatial, and verbal performance (Small & Bäckman, 1998), and negative and positive affect associations with health and life satisfaction in late life (Hillerås, Jorm, Herlitz, & Winblad, 1998).

M. Long Beach Longitudinal Study (1978)

This study, which focuses on mechanisms and models of change in cognitive functioning, was initiated in 1978. Recent results include comparison of both cross-sectional and longitudinal age trends on memory performance (Zelinski, Gilewski, & Schaeie, 1993), Zelinski and Burnnight (1997) report age declines in list and text recall with no evidence for differential decline across cohorts over a 16-year longitudinal period. However, no reliable decline was observed for recognition memory (Zelinski & Stewart, 1998).

N. Longitudinal Aging Study Amsterdam (1992)

This study is guided by questions concerning changes in physical, cognitive, emotional, and social components of aging, predictors of changes with age, association between aging-related changes, and consequences of such changes in terms of quality of life, adjustment, and need for care (Deeg, Beekman, Kriegsman, & Westendorp-de Serière,
1998). Findings from this study demonstrate a link between depression and incidence of physical disability, providing evidence that risk for physical disability may be related to less physical activity and having fewer social contacts among depressed individuals (Penninx, Leveille, Ferruci, van Eijk, & Guralnik, 1999). Smits, Deeg, Kriegman, and Schmand (1999) found that measures of cognitive functioning (i.e., processing speed, fluid intelligence) independently predicted mortality after controlling for health, age, depressive symptoms, and other covariates.

O. The (Lund) 80+ Studies (1988)

The initial 80+ study was based in Lund, Sweden, (Svensson, Dehlin, Hagberg, & Samuelsson, 1993) and has since expanded to include other 80+ studies in Reykjavik, Iceland (1993) and Fredericton, New Brunswick, Canada (1998), which permit cross-cultural cohort comparisons. Each study is based on a cohort-sequential design and includes yearly assessments of medical, social, and psychological variables (similar forms across studies). Recent research has focused on predictors of life satisfaction (McCamish-Svensson, Samuelsson, Hagberg, Svensson, & Dehlin, 1999b) and formal and informal support (McCamish-Svensson, Samuelsson, Hagberg, Svensson, & Dehlin, 1999a).

P. Manchester and Newcastle Longitudinal Studies of Aging (1982)

The Manchester and Newcastle Longitudinal Studies of Cognitive Performance include data on approximately 6400 self-selected volunteers aged between 49 and 96 years and approximately 75% female (Rabbitt, 1990, 1993; Rabbitt, Donlan, Bent, McInnes, & Abson, 1993). Age, distance and cause of death, self-reports of health status and recent medical care, and activities of daily living were found to be predictive of cognitive ability (Rabbitt, Bent, & McInnes, 1997). An analysis of four trials of a letter-letter coding test, similar to the WAIS Digit-Symbol Substitution Subtest, given in succession within a single test occasion suggests that memory plays an important role in substitution coding tests (Piccinin & Rabbitt, 1999).

Q. MacArthur Studies of Successful Aging (1988)

This study emphasizes the prediction of cognitive function in a healthy sample of individuals. Education was found to be the strongest predictor of cognitive change assessed over a 2.0–2.5-year period in participants aged 70–79 years (Albert, et al., 1995). A previous cross-sectional study reported that level of cognitive performance was predicted by educational attainment, with income and race having smaller influences (Inouye, Albert, Mohs, Sun, & Berkman, 1993).

R. Normative Aging Study (1963)

This study was established as an intramural research program within the Department of Veterans Affairs and focused on describing the biomedical, psychosocial, and disease-related changes associated with aging. The initial sample was composed of 2,280 men with an average age of 72 years, most of whom were veterans from WWII and the Korean War. Clinical health data were collected at 3-year intervals and supplemented with mailed surveys.

S. Nordic Research on Ageing (1989)

This study (Heikkinen, Berg, Schroll, Steen, & Viidik, 1997) is a comparative study of functional capacity and health in 75-year-old men and women. This international collaborative study is com-
posed of systematic random samples of 75-year-old residents of Glostrup in Denmark (n = 481), Gothenburg in Sweden (n = 368), and residents of Jyväskyla in Finland (n = 355). Results focus on functional ability status [Heikkinen et al., 1997] and memory and cognitive functioning [Steen, Fromholt, Äystö, & Berg, 1997].

T. The Nun Study (1986)

Participants in the Nun Study include 678 members of the School Sisters of Notre Dame who were 75–103 years of age in 1986. The focus is on aging and Alzheimer's disease, with annual medical and psychological assessments and full access to archival and medical records. Results from this study indicate that those without the apoE epsilon 4 allele had half the risk of decline in cognitive functioning compared to those with the allele [Riley, et al., 2000]. Low linguistic ability early in life was found to be predictive of lower cognitive functioning and Alzheimer's disease in old age [Snowden, et al., 1996] and of mortality [Snowdon, Greiner, Kemper, Nanayakkara, & Mortimer, 1999].

U. Origins of Variance in the Old-Old (1991)

Participants in this study included 351 twin pairs, 149 monozygotic (MZ) and 202 same-sex DZ twin pairs, aged 80 and older. The gender ratio, education, socioeconomic status, marital status, and housing for this unique sample corresponds to population statistics for this age segment of the Swedish population [Simmons, et al., 1997]. A broad spectrum of biobehavioral measures of health and functional capacity, personality, well-being, interpersonal functioning, as well as memory and cognition were obtained. Findings from this study include evidence for substantial genetic influence on cognitive capabilities late in life [McClearn, et al., 1997] and somewhat less genetic influence on measures of memory [Johansson et al., 1999].

V. Seattle Longitudinal Study (1956)

The Seattle Longitudinal Study (SLS) has been a major resource for monitoring age and cohort trends in adult cognitive development, providing normative data for assessment instruments used with older adults, exploring the causes of individual differences in aging, and assessing the effects of targeted cognitive interventions within the context of a longitudinal study [Schaie, 1996]. The SLS began in 1956 and has operated continuously with new participant recruitment at each wave of measurement at 7-year intervals. Extensions of the study include longitudinal data on second-generation family members and assessment of grandchildren of the original participants. Recent findings include evidence for longitudinal factorial invariance of the cognitive structure [Schaie, et al., 1998] and evidence for cognitive and other risk factors for mortality [Bosworth, Schaie, & Willis, 1999].


Central to the aims of the Swedish Adoption/Twin Study of Aging (SATSA) study is understanding the relative importance of genetic and environmental influences that account for individual differences in aging-related outcomes. SATSA includes longitudinal data from both comprehensive questionnaires [measured every 3 years] and in-person interviews on a subset of the total Swedish Twin Registry sample, which included twins who were reared apart. Findings from the SATSA suggest individual differences in cognition are under substantial genetic involvement in middle to late adulthood and that stability in cognitive functioning
in late life is largely genetic (Plomin, Pederson, Lichtenstein, & McClearn, 1994). Finkel, Pederson, Plomin, and McClearn (1998) examined cross-sectional and longitudinal age changes in cognition and found that genetic variance decreased for a cognitive factor when studied longitudinally. Emery, Pedersen, Svartengren, and McClearn (1998) found that forced expiratory volume shared genetic effects with fluid abilities, but not crystallized knowledge, in late life.

X. The Victoria Longitudinal Study (1986)

The objective of the Victoria Longitudinal Study (VLS) is to examine profiles and predictors of cognitive changes in healthy, community-dwelling older adults ranging in age from 55 to 85 years (Hultsch, Hertzog, Dixon, & Small, 1998). Findings from the VLS include the association between intellectually demanding lifestyle activities and maintenance of cognitive functioning (Hultsch, Hertzog, Small, & Dixon, 1999). Declines in quantitative word and text recall were observed, whereas overall qualitative (number of categories and intrusions) levels were relatively maintained over a 6-year period (Small, Dixon, Hultsch, & Hertzog, 1999).

X. Summary and Conclusions

This chapter began by reminding the reader why longitudinal studies are such important contributors to the aging literature, examined problems of longitudinal studies as quasi-experiments, and discussed some of the methodological issues in cross-sectional and longitudinal inquiries. Recent methodological advances that can address some of these issues were indicated. We then provided a brief review of major long-term as well as recently begun longitudinal studies that should be of interest to serious aging researchers.

Several themes have served as motivations for longitudinal studies of psychological aging. What are the normative (nonpathological) changes in cognitive functioning with increasing age? What are the predictors or concomitants of change in cognitive functioning? Does speed account for most of the age-related variability in intellectual functioning? What are the consequences of changes in cognitive functioning in terms of older persons' contributions to society, their adjustment, and their need for care? As we have indicated above, the study of aging is the study of change, and the appropriate unit of analysis is the individual followed over time. These longitudinal studies are producing valuable answers to many of these questions.

We do not feel a need to lobby for more emphasis on longitudinal studies; that message has apparently been well heard and accepted by the aging community. However, we must now call attention to the need of attending to issues of comparability of data that will make possible adequate comparison of data collected with widely differing instruments, in different samples of people, and over differing temporal intervals. It is unlikely that any single investigator can cover the broad field of the psychology of aging, nor is it likely that many investigators will have the resources to both collect data from representative populations and oversample subgroups of special interest. Hence, the role of collaborative longitudinal research, meta-analysis, and pooling of data archives will become increasingly important. In this context, efforts are needed to identify a small number of standard reference measures that should be included in all studies to facilitate cross-battery analysis. Many of the major ongoing studies represent important scientific resources that merit careful documentation and archiving for even-
tual release to the broader scientific community. For this purpose, it would be important to develop standard protocols for the archiving of longitudinal data.

Previous reviews of the status of the psychology of aging have often bemoaned the lack of adequate longitudinal studies covering the period from young adulthood to advanced old age. As this chapter shows, that call has been heeded in many substantive areas. It is our hope that this chapter will provide greater accessibility to the longitudinal literature, particularly for other reviewers and textbook authors. We look particularly to the latter to now provide appropriate corrections for popular misconceptions based largely on cross-sectional data. However, we would also urge them to call attention to the continuing importance of cross-sectional studies for the identification of age-related phenomena and development of age-appropriate measurement instruments as well as to provide data that can form a basis for time-specific policy formulation with regard to problems and needs of the present aging population.

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