Topic #10

LONGITUDINAL AND CROSS-SECTIONAL DESIGNS

These designs are of particular interest in developmental and gerontological psychological research where age and long time lags are of interest or are important.

1. **Cross-sectional Designs**

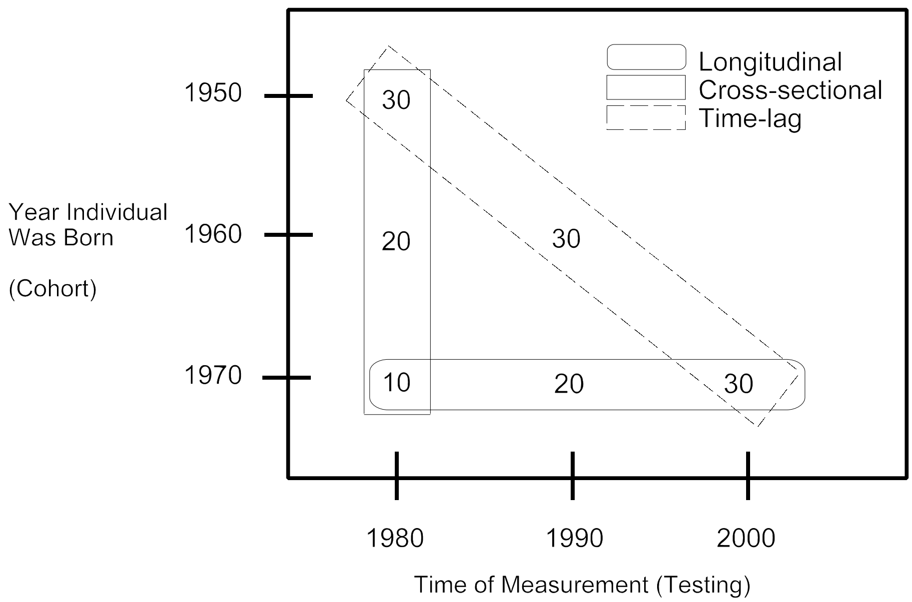
   - These are research designs in which different cohorts or individuals are tested at a given point in time.
   - Cross-sectional designs are between-subjects designs. The primary advantage of cross-sectional designs is that they are very economical.

2. **Longitudinal Designs**

   - These are research designs in which a cohort is selected and studied over a relatively long period of time with repeated measurements. The same sample or group of individuals is studied over time.
   - Longitudinal designs are typically within-subjects or repeated measurement designs.
   - HOWEVER, they can also be between-subjects or independent groups designs. This would be the case if in studying a given cohort at each individual time of measurement, we selected a different sample from that same cohort. This is still a longitudinal design because we are studying the same cohort; and it is a between-subjects design because at each time of measurement we are selecting a *different* sample but from the same cohort.
   - An advantage of longitudinal designs is their strength in allowing us to assess the change in variables or constructs over time. They are also generally stronger than cross-sectional designs because the temporal sequencing of the IV and DV is more clearly established.

3. **Time Lag Designs**

   - These designs permit us to investigate changes across or differences between cohorts.
   - They furnish us with cohort descriptive data because they are intended to map out changes across cohorts holding age constant.
   - They use several cross-sectional designs over time.
   - They still do not totally eliminate confounding.



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Within-Cohort Age-Related Differences in Cognitive Functioning

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Abstract

It is widely accepted that the level of cognitive functioning can be influenced by characteristics of the environment that change over time. Many developmental researchers have referred to these influences as cohort effects, and have used year of birth as the basis for determining cohort membership. Furthermore, age-related differences in cognitive functioning are sometimes assumed to be primarily attributable to cohort differences, which implies that differences between birth cohorts should be much larger than differences within birth cohorts. Comparisons of composite scores for five cognitive abilities in different people tested at different ages in different years revealed that within-cohort differences across ages were often as large as between-cohort differences across ages. These results lead to questions about the practice of relying on birth cohort to represent influences on cognitive functioning associated with temporal shifts in characteristics of the environment.

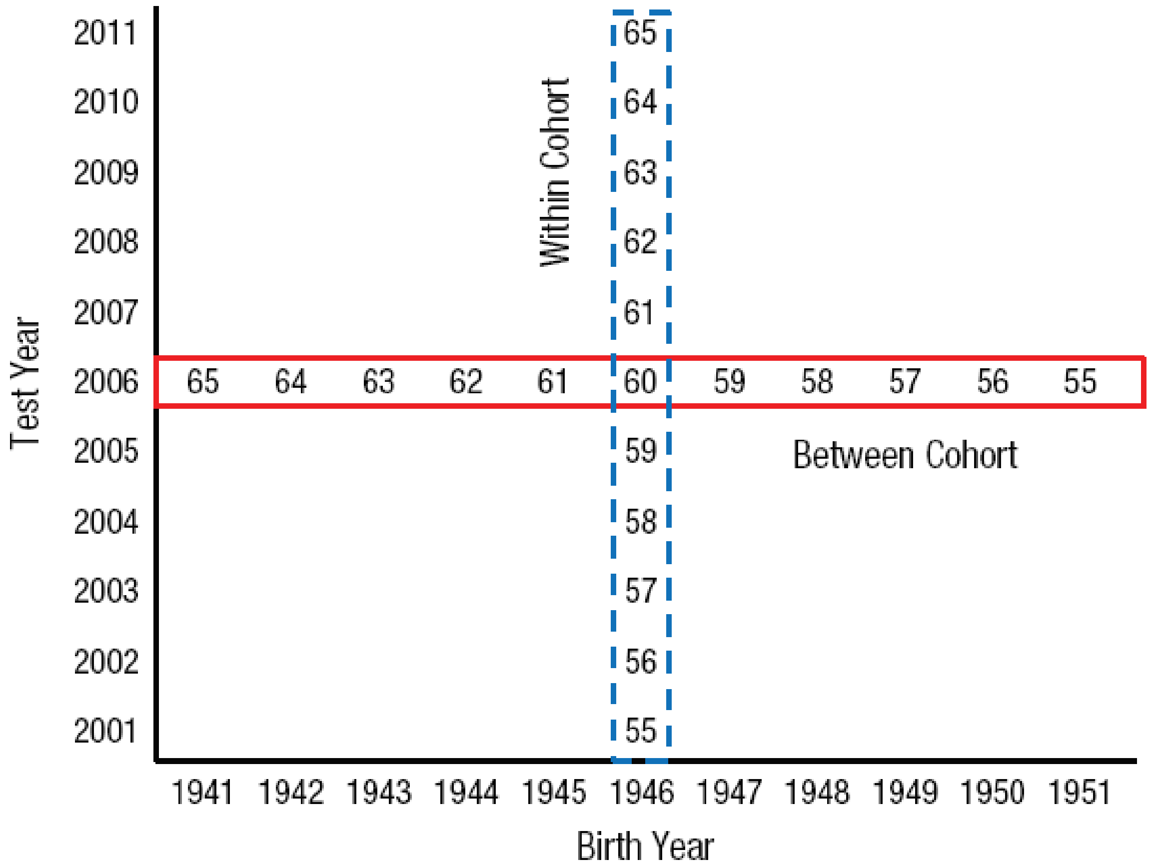

Fig. 1. Illustration of the structure of the data in the current project. Although the birth years ranged from 1907 to 1989, only a limited number of birth years are illustrated for the sake of clarity. Each cell in the matrix consists of data from different people. Thus, comparisons along a row are between cohort, because they involve people who were of different ages (and thus born in different years) but who were tested in the same year; comparisons along a column are within cohort, because they involve people who were of different ages (but born in the same year) and who were tested in different years. The numbers in the cells correspond to the ages of individuals from the indicated birth and test years.

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Who Rises to the Top? Early Indicators

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Abstract

Youth identified before age 13 (N = 320) as having profound mathematical or verbal reasoning abilities (top 1 in 10,000) were tracked for nearly three decades. Their awards and creative accomplishments by age 38, in combination with specific details about their occupational responsibilities, illuminate the magnitude of their contribution and professional stature. Many have been entrusted with obligations and resources for making critical decisions about individual and organizational well-being. Their leadership positions in business, health care, law, the professoriate, and STEM (science, technology, engineering, and mathematics) suggest that many are outstanding creators of modern culture, constituting a precious human-capital resource. Identifying truly profound human potential, and forecasting differential development within such populations, requires assessing multiple cognitive abilities and using atypical measurement procedures. This study illustrates how *ultimate criteria* may be aggregated and longitudinally sequenced to validate such measures.

Why Are There Different Age Relations in Cross-Sectional and Longitudinal Comparisons of Cognitive Functioning?

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Abstract

A major challenge for researchers interested in investigating relations between aging and cognitive functioning is distinguishing influences of aging from other determinants of cognitive performance. For example, cross-sectional comparisons may be distorted because people of different ages were born and grew up in different time periods, and longitudinal comparisons may be distorted because performance on a second occasion is influenced by the experience of performing the tests on the first occasion. One way in which these different types of influences might be investigated is with research designs involving comparisons of people of different ages from the same birth cohorts who are all tested for the first time in different years. Results from several recent studies using these types of designs suggest that the age trends in some cognitive abilities more closely resemble those from cross-sectional comparisons than those from longitudinal comparisons. These findings imply that a major reason for different age trends in longitudinal and cross-sectional comparisons of cognitive functioning is that the experience with the tests on the first occasion inflates scores on the second occasion in longitudinal studies.

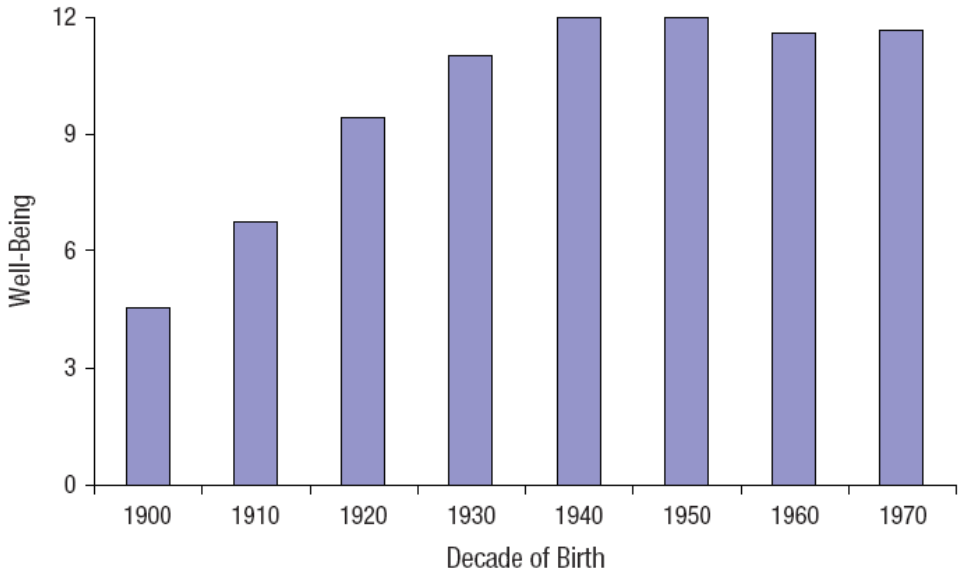
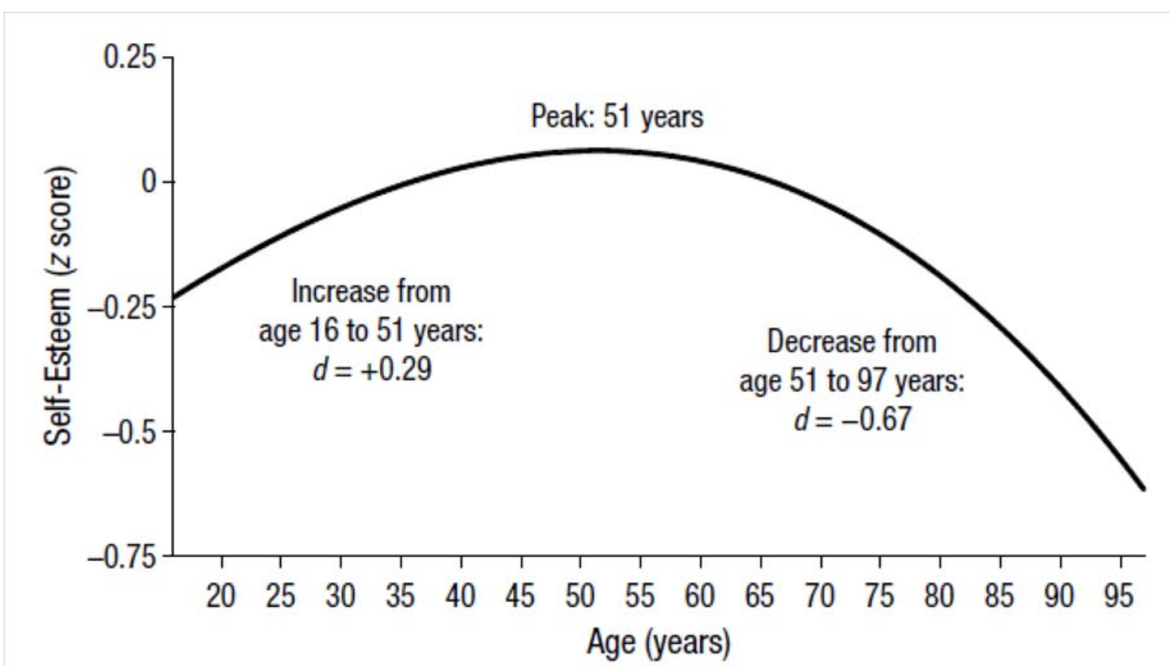


Fig. 2. Estimated marginal mean well-being in the Baltimore Longitudinal Study of Aging sample as a function of participants' decade of birth, controlling for age, age-squared, sex, ethnicity, and education.



APS Award Address

Intelligence Over Time

Never before or since the Scottish Mental Surveys (SMS) of 1932 and 1947 has the cognitive capacity of almost an entire birth-year segment of a country's population been measured. The results of those surveys have led to extensive and fruitful lines of research, including how intelligence test scores relate to longevity and how cognitive ability changes from childhood to old age. APS James McKeen Cattell Fellow Ian J. Deary (University of Edinburgh, Scotland), one of the founders of the field of cognitive epidemiology and a contributor of seminal work in that area, has followed up with many of the original study participants to explore lifetime changes in brain structure and behavior.

Deary has based much of his research on a 45-minute exam, the Moray House Test No. 12 (MHT), which was used in both the 1932 and the 1947 SMS and scored on a scale of 1–76. The sheer amount of data generated by these two cohorts is staggering: 87,498 children (about 95% of the population of 10- and 11-year-old Scottish children) took the MHT No. 12 in 1932, and 70,805 children took the same test in 1947.

"The … important thing is not just the cognitive stability, though that is interesting, because these studies are the longest follow-up studies of intelligence; the thing that we're after is the determinants of *instability*," Deary explained during his award address at the 2015 APS Annual Convention. "What we're interested in is how much people change from childhood to older age. So we've made that the foundation of our cognitive aging studies."

One major area of interest for the researchers was the effect of differences in the SMS participants' IQs at age 11 on their social and academic progression in life. Deary and colleagues searched the database of the Scottish Midspan Collaborative Studies (MCSs), pioneered by Victor Hawthorne in the 1960s to track large-scale public health research, and found 243 men who took part in both the 1932 SMS and one of the MCSs conducted from 1970–1973. By comparing the IQ of these men at age 11 with their positions in middle age, the psychological scientists found an increasing correlation across the lifespan. Thus, the men's mental ability as children had a lower association with the class of their first jobs (.12) than with their social position in midlife (.43).

"This is sometimes called the 'gravitational effect' — that people who are bright tend eventually to get to their cognitive level," Deary explained.

However, IQ at age 11 was not the only contributor to later life success, he continued: "If you look at the contributors to midlife social position, mental ability contributes; so does education; so does the class of the first job; and so does the father's social class. So the story here is not just meritocracy or social inertia; it's a bit of both … social background as well as ability as well as education all contribute."

Ian J. Deary has tracked many participants in the massive Scottish Mental Surveys of 1932 and 1947 to explore lifetime changes in brain structure and behavior.

Deary and his colleagues also went to great lengths to trace the vital status of some of the original SMS participants in old age. They broke down the data from the original 1932 and 1947 SMS into more manageable geographical cohorts (e.g., the 1932 Aberdeen Cohort, composed of 2,792 children) and spent 3 years tracing as many of the original participants (both alive and dead) as they could. After locating 79.9% of them by 1997 (the participants were then approximately 76 years old), the researchers linked the data with death certificates. One of the starkest contrasts between those with low versus high MHT No. 12 scores, Deary found, was that a 15-point disadvantage in children's mental ability at age 11 resulted in those children being only 79% as likely to be alive 65 years later as their counterparts with higher IQs.

"I'm going to put it even more simply," he said. "On average, a girl with a 30-point disadvantage in IQ on this 45-minute test at age 11 was half as likely to be alive all those years later."

Further research into health outcomes correlated with MHT No. 12 scores has uncovered specific diseases that may be linked with IQ at age 11. After searching dementia databases in Scotland, for example, Deary and colleagues found that vascular dementia, but not Alzheimer's disease, was associated with a lower mental ability at age 11.

To watch video of Ian J. Deary's award address, visit www.psychologicalscience.org/r/Deary.

The psychological scientists also examined whether specific factors, both physical and mental, were instrumental for good cognitive aging in the SMS participants, and whether those factors were related to participants' childhood IQs. The factors they studied included bilingualism, education, occupational complexity, social support, loneliness (or lack thereof), intellect, and sociointellectual activity.

"This [is] why it's special having these age 11 scores, [because with that information] we can also ask this: For all of these factors that we gather in older age, are any of them related to having a good MHT score at age 11?" The answer, according to Deary, is "some are" — notably, bilingualism, education, occupational complexity, intellect, and sociointellectual activity.

Furthermore, some factors that spur healthy cognition in older age are not simply *related* to having a good MHT No. 12 score at age 11; in fact, the IQ score at age 11 sometimes nullifies the factor–cognition association in older age. This is an example of confounding or reverse causation, something these studies are well placed to test and discover.

"It's smart children who grow up to be older people who engage in a lot of sociointellectual activity" who age healthily, Deary explained. "It's not the sociointellectual activity that's making the brain smarter in older age."

Physical biomarkers such as high levels of vitamin B12, high folic acid, lower homocysteine (a nonprotein amino acid), high levels of "good cholesterol," lower inflammation, not having contracted the cytomegalovirus, longer telomere length, and good retinal vessel topography (a measure of the brain's blood cells) also are related to SMS participants' MHT No. 12 scores at age 11. For some of these factors, the IQ score at age 11 acts as a confounder of the factor–older age cognition association.

The cytomegalovirus infection, or lack thereof, particularly interested Deary. Two-thirds of the birth cohort from Lothian had this virus, which is associated with slightly lower mental ability in children and also with poverty and overcrowding. After reexamining the Lothian birth cohort in older age, the researchers found that the correlation of low mental ability with the cytomegalovirus did not continue through life — but there was a catch.

"Those people who were infected, we measured their antibody titration, and those people who were devoting more of their immune system to dealing with the cytomegalovirus as they got older had lower cognition," Deary added. "So there's a rather detailed story going on there."

Throughout his address, the cognitive epidemiologist (who is trained in both psychology and medicine-psychiatry) stressed the importance of his team's diverse scientific backgrounds and modern technology for his studies — for example, he and his team can make 3-D prints of SMS participants' brains, and they can measure cortical thickness. They also are running full genome sequences on and are making stem cells from some of the participants in the 1921 and 1936 Lothian birth cohorts. Deary hopes these studies will add to the ever-growing databank of information about the SMS and provide additional fodder for future psychological scientists.

-Mariko Hewer

Specific Threats to Internal Validity Faced by Longitudinal and Cross-Sectional Designs

1. **Selective survival**

   - This is intrinsic to both cross-sectional and longitudinal designs.
   - This threat is more critical with older adult samples.
   - This threat is associated with changes in the population composition across time because the weaker, less competent, and less adjusted individuals have typically died off.
   - This makes it difficult to make any retrospective or prospective inferences because the population is NOT the same (at different times).

2. **Selective dropout**

   - This applies to longitudinal research only. This is the situation in which participants drop out of the study sample. They might, for instance, move away, lose interest in the study, die, etc. So individuals who continue to participate may be inherently "different".

3. **Practice effects or retest effects**

   - This applies to repeated measures longitudinal designs where the same individual is tested and retested on the same psychological behavior and tested over a long period of time.
   - The problem is one of participants becoming task- or testwise. Also, if the particular task or test requires the use of particular skills, then with practice gained from repeated testing over a long period of time, participants become very skilled.
   - A vivid example of this is the Berkeley Growth Study. This was a longitudinal study on intelligence in the 1930's. Over less than 20 years participants were tested on the same or different versions of the same test more than 40 times. It seems highly likely that performance on these IQ tests may have been inflated by practice.

4. **History, cohort, or generation effects**

   - This is a threat associated with cross-sectional designs.
   - Cohort—is some group that has some characteristic(s) in common; usually thought of in terms of different age groups.
   - Cohort effect—the variable by which the cohort is grouped confounds the IV.
     - e.g., look at the effects of age on the ability to program a cell phone; age is confounded by one's generation or cohort such that the group that grew up in the (late?) 1990's to 2000's has grown up programming cell phones but our grandparents did not.

Internet Use and Psychological Well-Being: Effects of Activity and Audience

Abstract

Two lines of research fifteen years apart demonstrate that talking with close friends online is associated with improvements in social support, depression, and other measures of well-being. Talking with strangers and reading about acquaintances are not. Readers should be skeptical of cross-sectional and survey-based studies linking well-being to Internet use; instead, experiments or longitudinal designs pairing surveys with log data provide more reliable insights. Human agency is key: The effect of technology on our lives depends on how we use it, what we talk about, and whom we talk to.