Research on Change over Time: Conceptual Overview

Research on change requires the data collected at ***different*** points of time.

There is no hard and fast definition of what constitutes a longitudinal study – but variation of time and repeated observation are always part of longitudinal research.

Examples of the time metric are –

Year of survey (e.g., compare population prevalence in 1998 and 2008)
i.e., Trends Studies

Age (change from age 70 to 80)
Interval after intervention or since beginning of study (e.g., 4 years)
i.e., Panel studies, cohort studies

TODAY: We outline these different types of research designs to evaluate change
- discuss relative advantages /disadvantages
- some analysis issues and strategies
- begin discussion about how to think about time:
  - *how many measurement occasions are needed*?
  - *what time interval is required to observe change*?

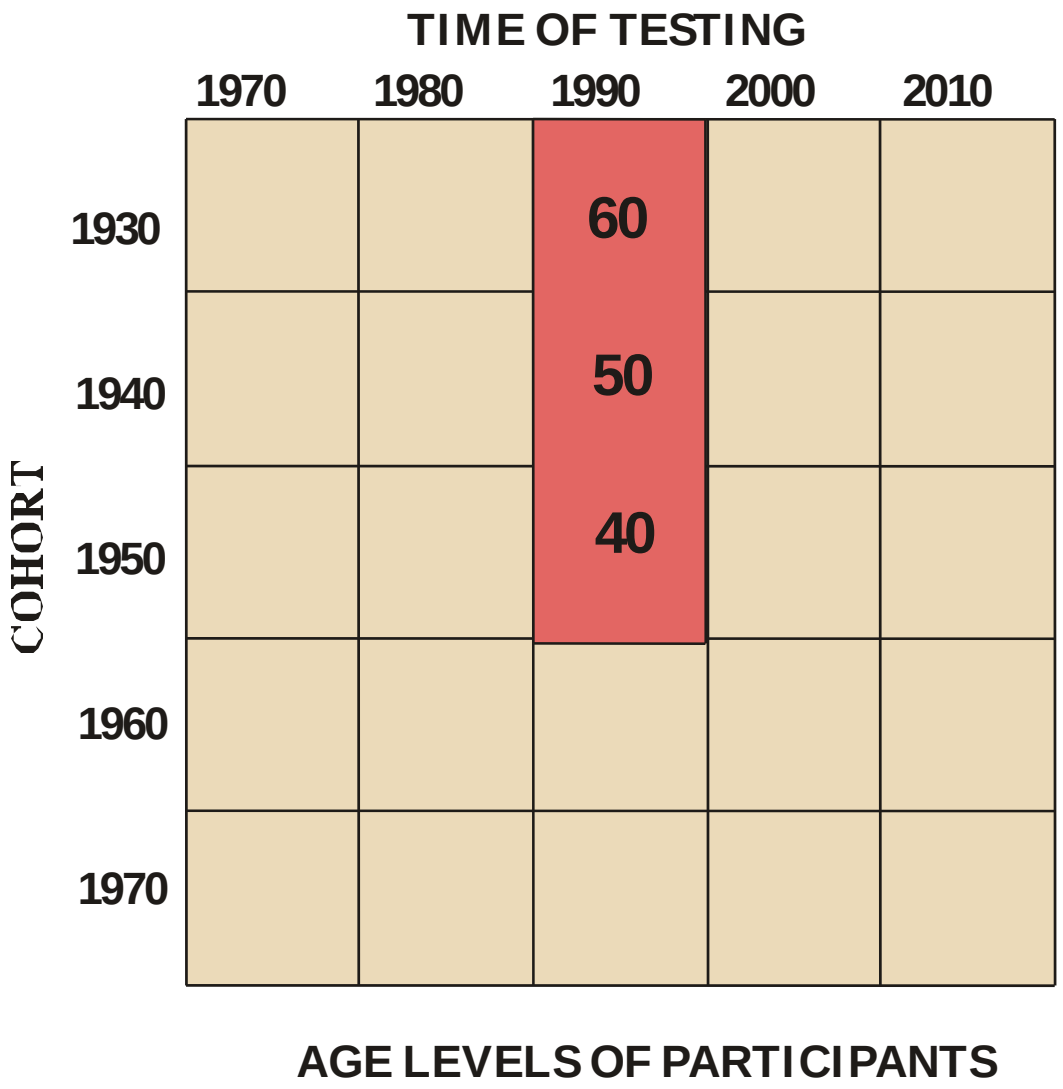
Time and Research on Aging

Age-related effects	**These reflect the effects of time-dependent processes on development and change. Chronological age is a carrier or surrogate variable representing a complex of influences.**
Cohort effects	**Cohort effects are due to a subject's time of birth or generation, but not to actual age. The study of cohort effects emphazises the importance of historical context on development**
Time-of measurement effects	**Some findings reflect effects due to the point in time and/or history when the study was conducted instead of developmental effects.**

Time as a “rubber band”
- Does a “5-year” metric mean the same from age 65 – 70 as from age 85 – 90?
- Which birthcohorts are expected to differ?
- What biases are associated with time-of-measurement? How does this affect a longitudinal study

A CROSS-SECTIONAL DESIGN:

THIS DESIGN MEASURES AGE-RELATED DIFFERENCES BETWEEN COHORTS



Many studies have only one measurement occasion.

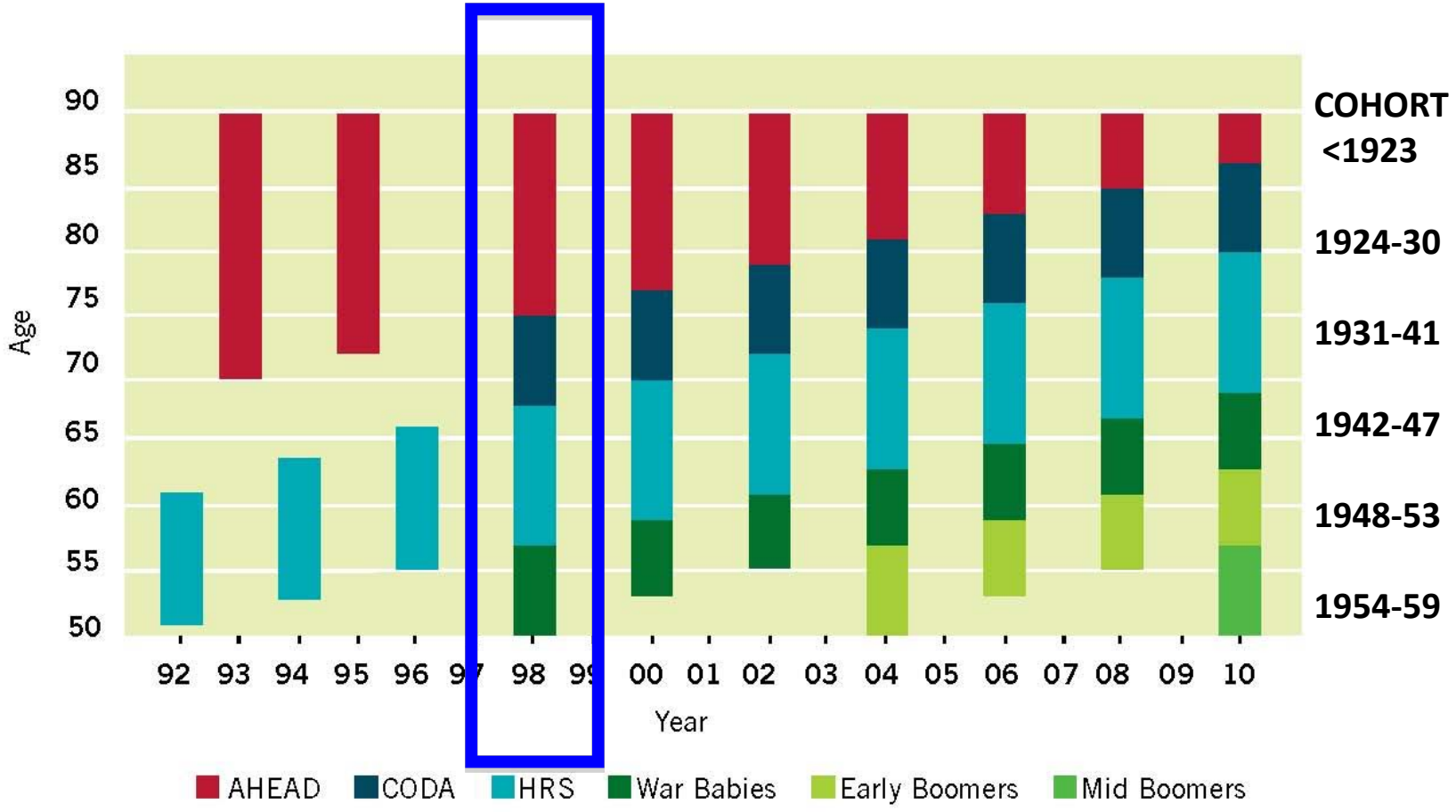
Researchers consider the associations between variables (e.g., regression analyses) and/or subgroup differences (e.g., age, gender, race).

Subgroup differences are confounded with birthcohort differences.

We should not infer change from cross-sectional data

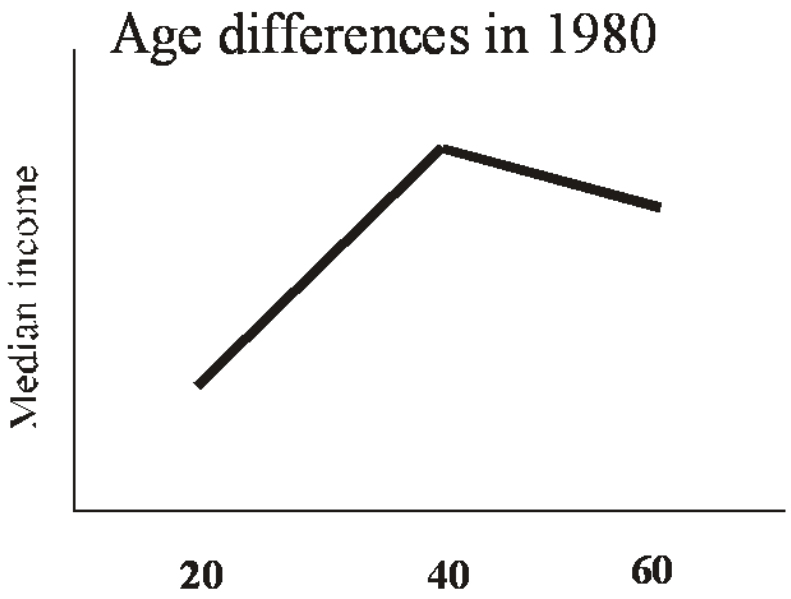
The Health and Retirement Sample Design

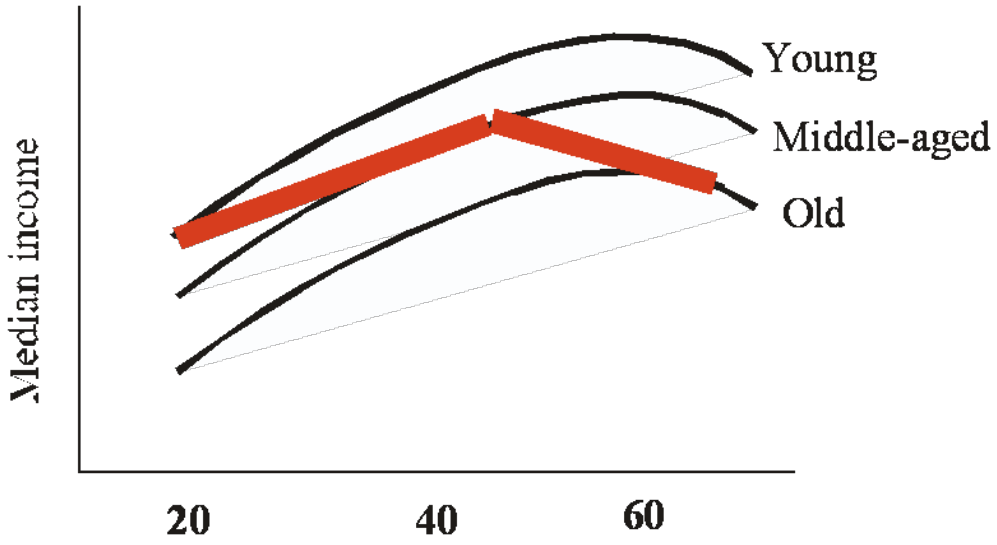
For some questions, researchers use only one wave of HRS



- **Includes spouse / partner of sampled individual**
- **Includes oversamples of African-American and Hispanics**

AGE AND COHORT EFFECTS





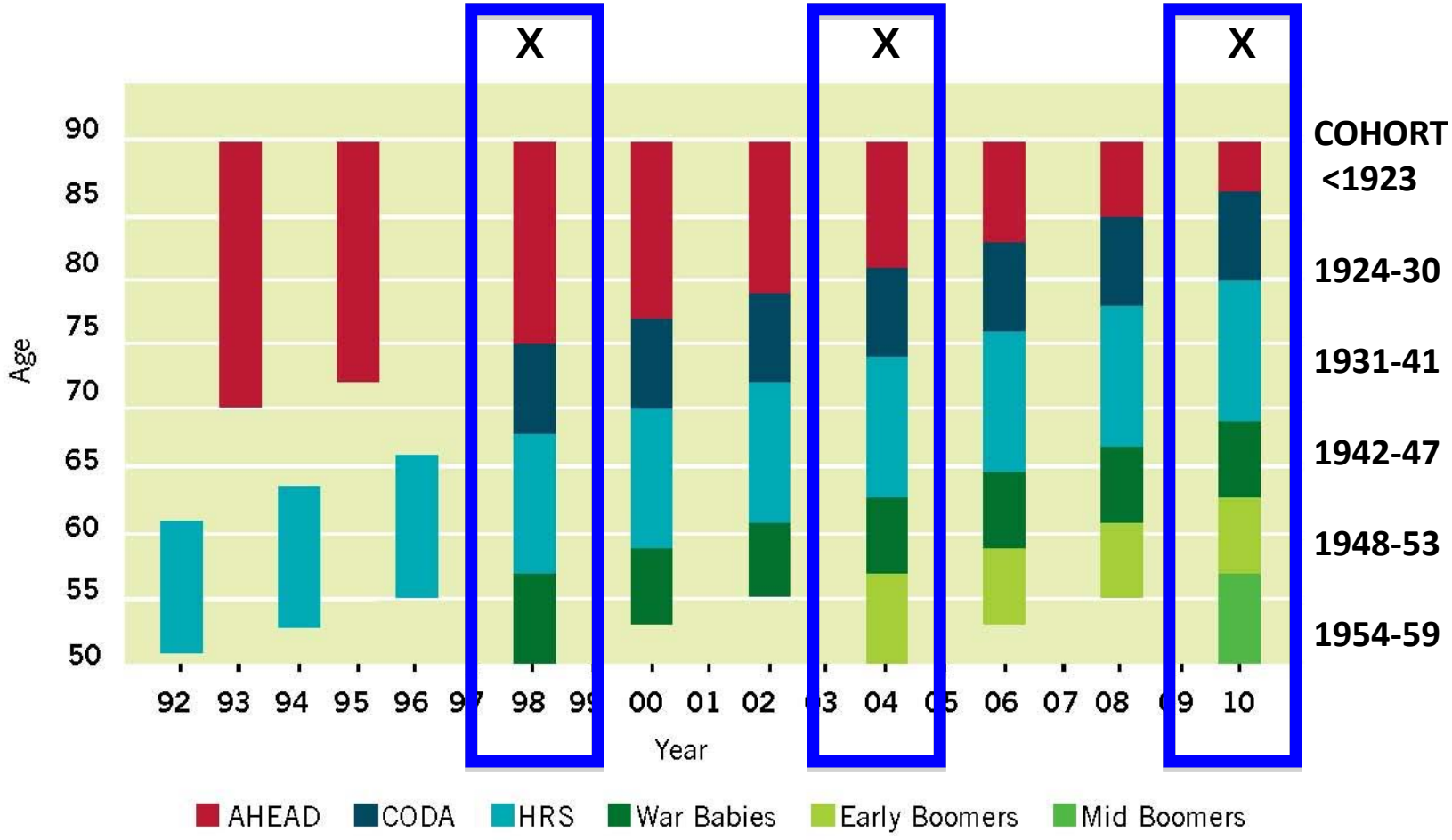
If each cohort earns increasingly more, and also earns more at each life stage, the cross-sectional data is misleading.

Study of Population Trends: e.g., Trends in Disability, Depression, Dementia

- A trend study samples ***different*** **groups of people at different points in time from the *same* population**.
- For example, trend studies are common on public opinion (Gallop Poll) and in public health.
- Trend studies provide information about ***net changes*** at an aggregate level. Trend studies are valuable in describing long-term changes in a population.
- However, we do not know how many people changed their positions, nor do we know how many stayed with their original choice.
- To determine both the gross change and the net change, a panel study is necessary.

The Health and Retirement Sample Design

E.g., Trends in Income Distribution or Prevalence of Disability in Population over 50



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Disadvantages of Trend Analysis

- If data are unreliable false trends will show up in the results.

- If trend analysis is based on inconsistent measures, the results will be biased. That is, changes in the way indexes are constructed or the way questions are asked will produce results that are not comparable over time (*problem of measurement equivalence*).

- In the worst case, the changes in measures alone can produce a pseudo trend which might fool both the researchers and readers.

A Cohort Study

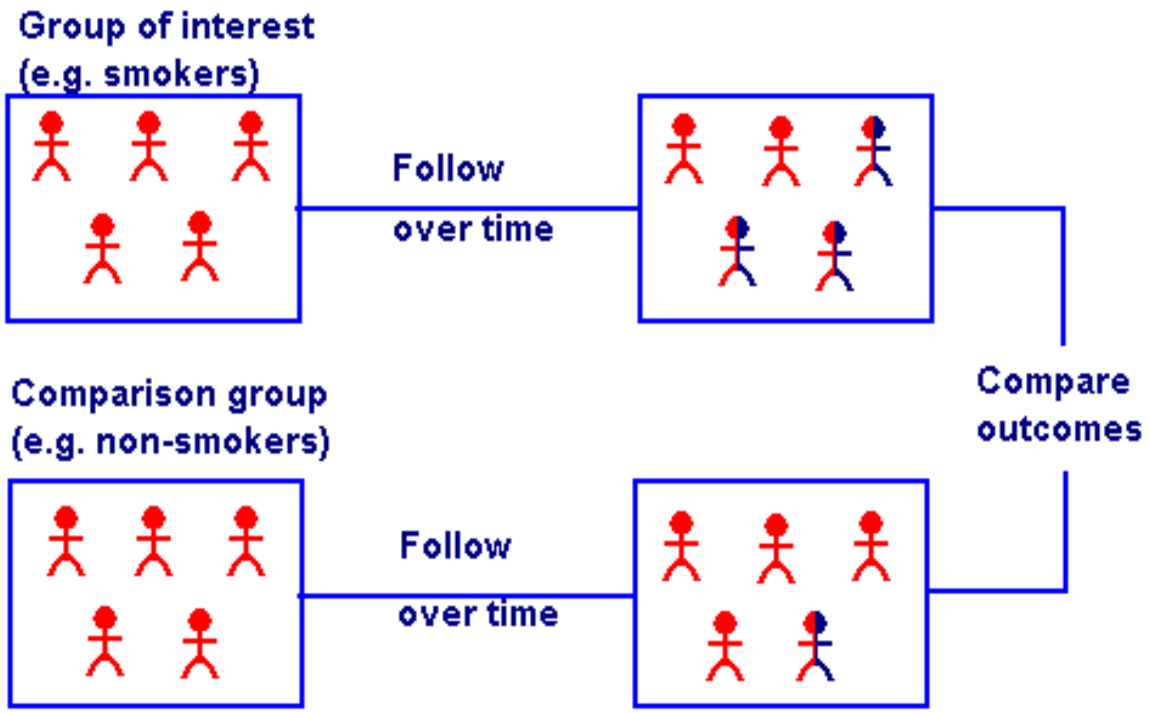
Individuals who have a certain condition and/or receive a particular treatment are followed over time and compared with another group who are not affected by the condition under investigation.

A cohort is any group of individuals who are linked in some way or who have experienced the same significant life event within a given period. There are many kinds of cohorts, including birth (for example, all those who born between 1970 and 1975) disease, education, employment, family formation, etc. Any study in which there are measures of some characteristic of **one or more cohorts at two or more points in time** is cohort analysis.

Cohort analysis attempts to identify cohorts effects: Are changes in the dependent variable (e.g., health problems) due to aging, or are they present because the sample members belong to the same cohort (1920s vs. 1950s).

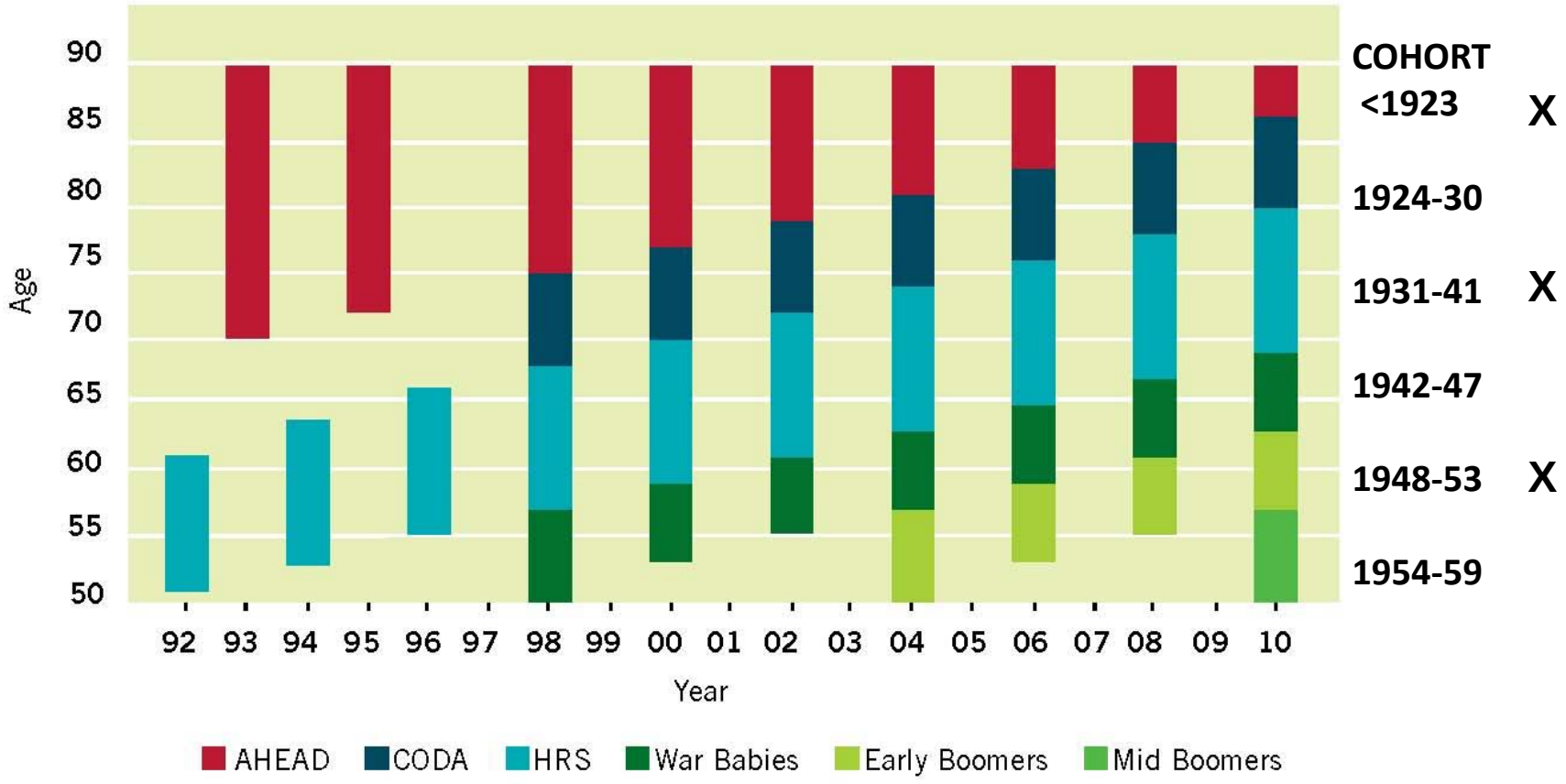
They can tell us what circumstances in early life are associated with the population's characteristics in later life - what encourages the development in particular directions and what appears to impede it. We can study such developmental changes across any stage of life in any life domain: education, employment, housing, family formation, citizenship and health.

Cohort Study of Two Groups with Different Health Behaviors



The Health and Retirement Sample Design

E.g., Compare Health Changes over time in Different Cohorts



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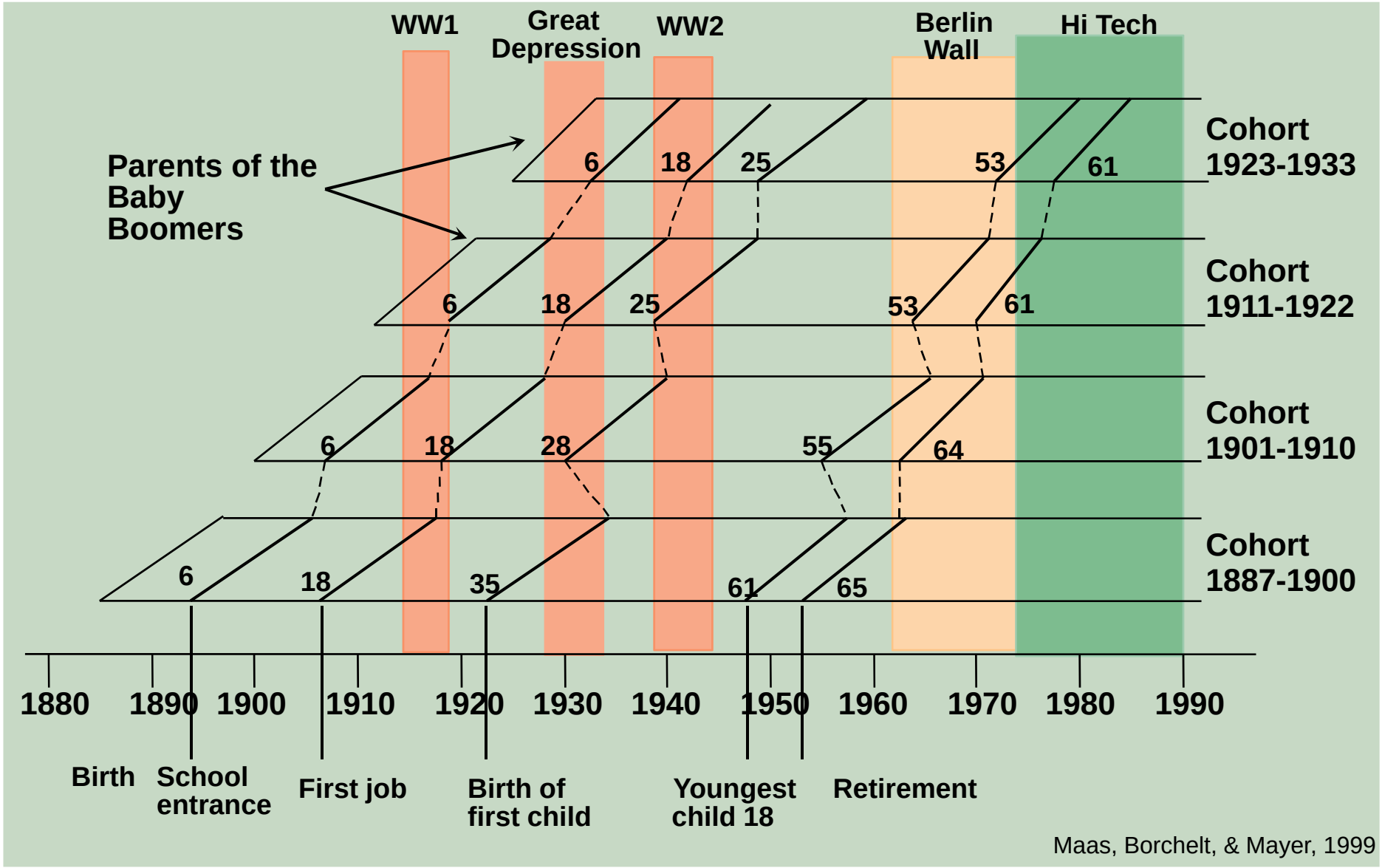
LIFE HISTORIES OF YOUNG-OLD AND OLDEST-OLD INDIVIDUALS IN THE 1990s:

EXAMPLES FROM THE BERLIN AGING STUDY (BASE)



Maas, Borchelt, & Mayer, 1999

Some Issues with Cohort Studies

Because of the lack of randomization in the cohort design, the two groups may differ in ways other than in the variable under study. For example, if the subjects who smoke tend to have less money than the non-smokers, and thus have less access to health care, that would exaggerate the difference between the two groups.

Cohort studies often require a very long time, since the researchers have to wait for the conditions of interest to develop.

Another disadvantage with longitudinal studies is that the sample composition tends to change over the course of the study. People die, move away, or develop other conditions, new and promising treatments arise, and so on. If the remaining cohort members differ in regard to the variable under study, the variation in the cohort study may simply reflect this change.

It is therefore important that findings from cohort studies are critically scrutinized before any judgment of causality is made.

Panel Studies

Panel studies measure the ***same*** sample of respondents at different points in time.

Depending on the purpose, some panel studies use a continuous panel (all measures repeated at every wave), or an interval panel, whose members agree to complete a certain number of measurement instruments only when the information is needed.

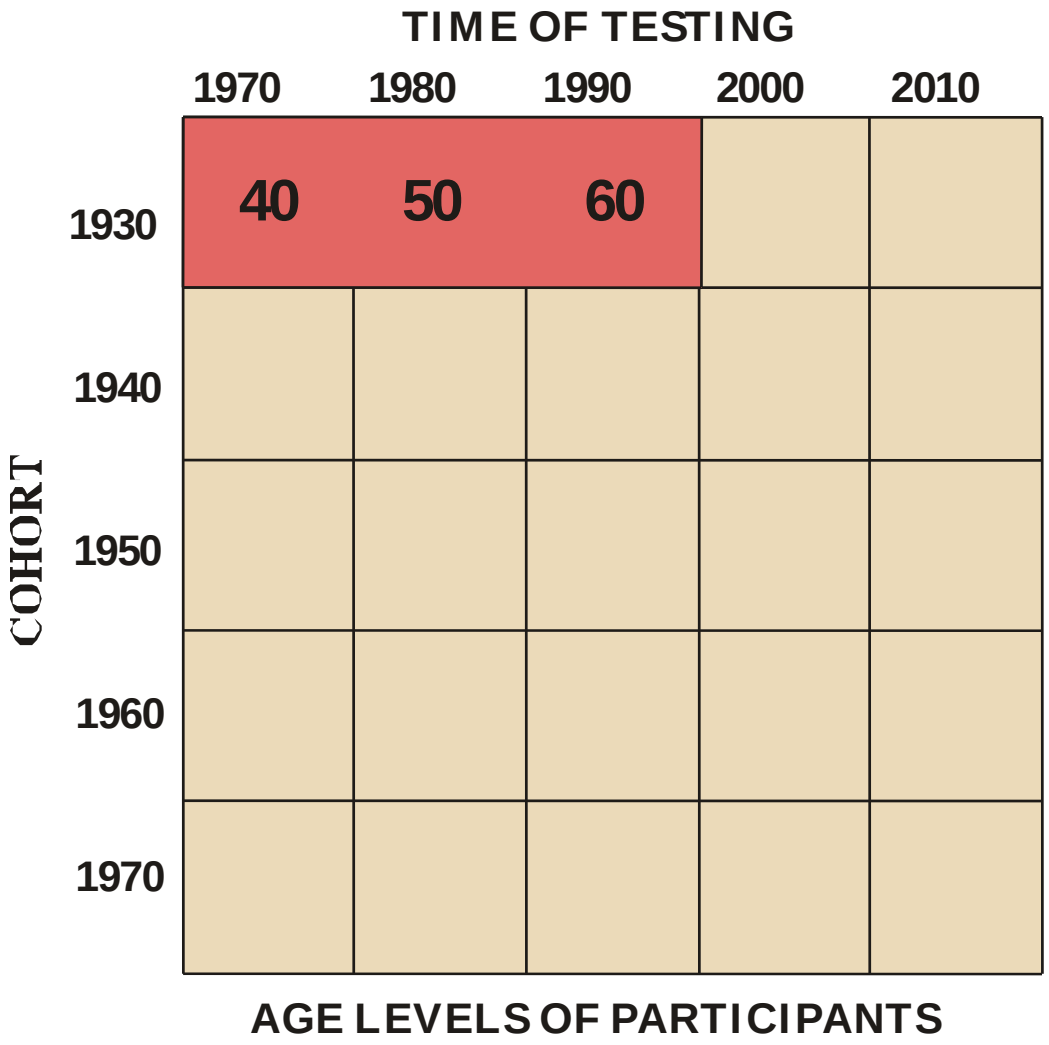
In general, panel studies provide data suitable for sophisticated statistical analysis and might enable researcher to predict cause-effect relationships.

Panel data are particularly useful in predicting long-term or cumulative effects.

Some panel studies follow different cohorts. HRS, for example, also adds new cohorts over time.

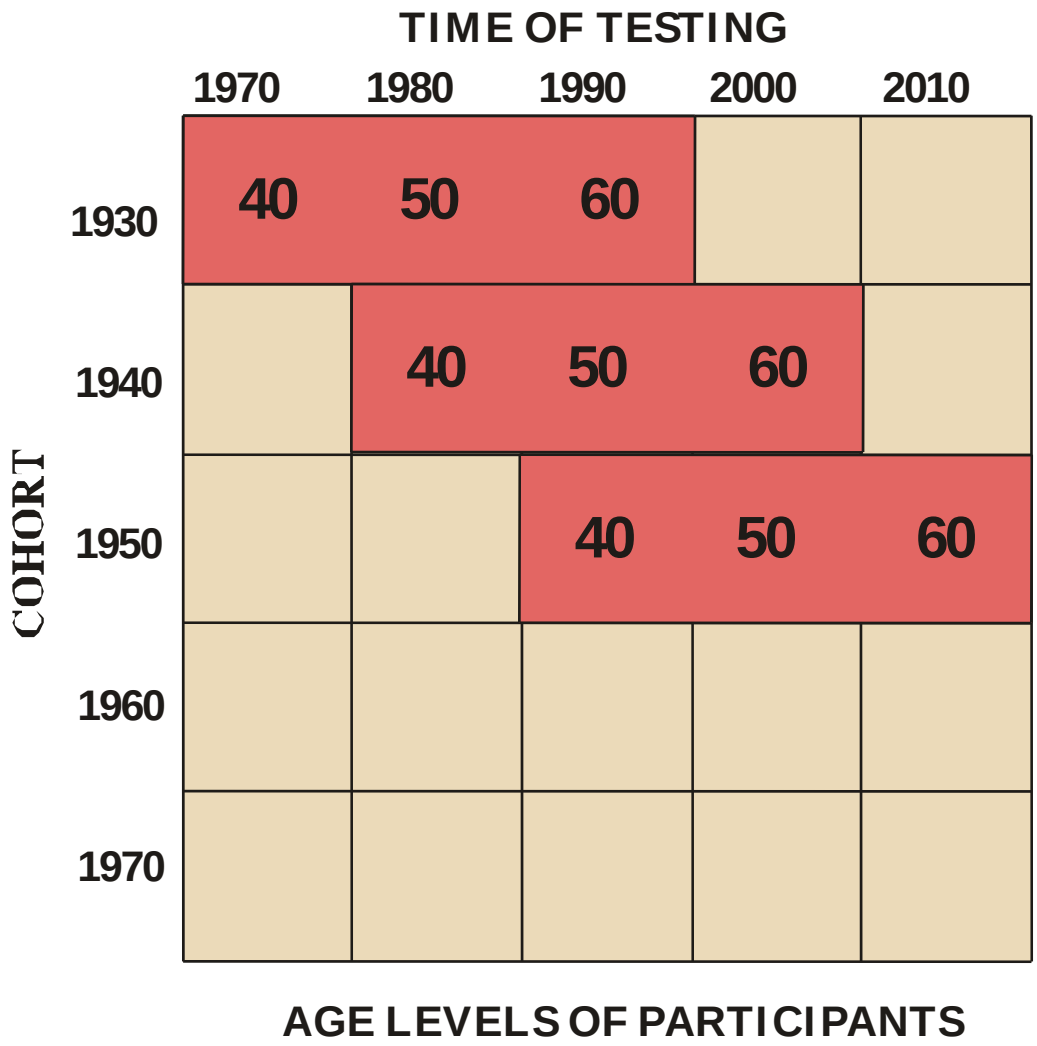
A LONGITUDINAL DESIGN:

THIS DESIGN MEASURES AGE-RELATED CHANGES WITHIN A COHORT



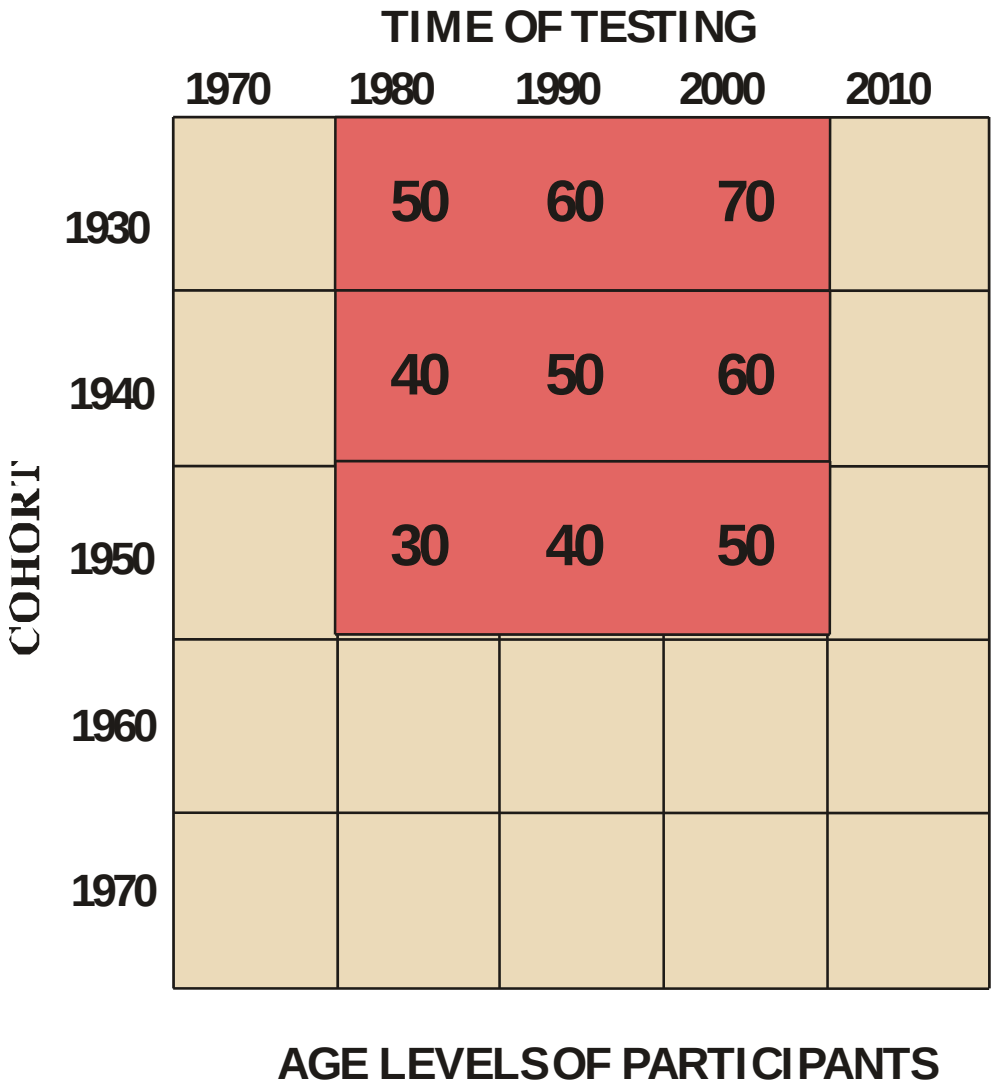
A COHORT-SEQUENTIAL DESIGN:

THIS DESIGN INVOLVES TWO OR MORE LONGITUDINAL STUDIES COVERING THE SAME AGE RANGES OVER DIFFERENT TIME ERAS

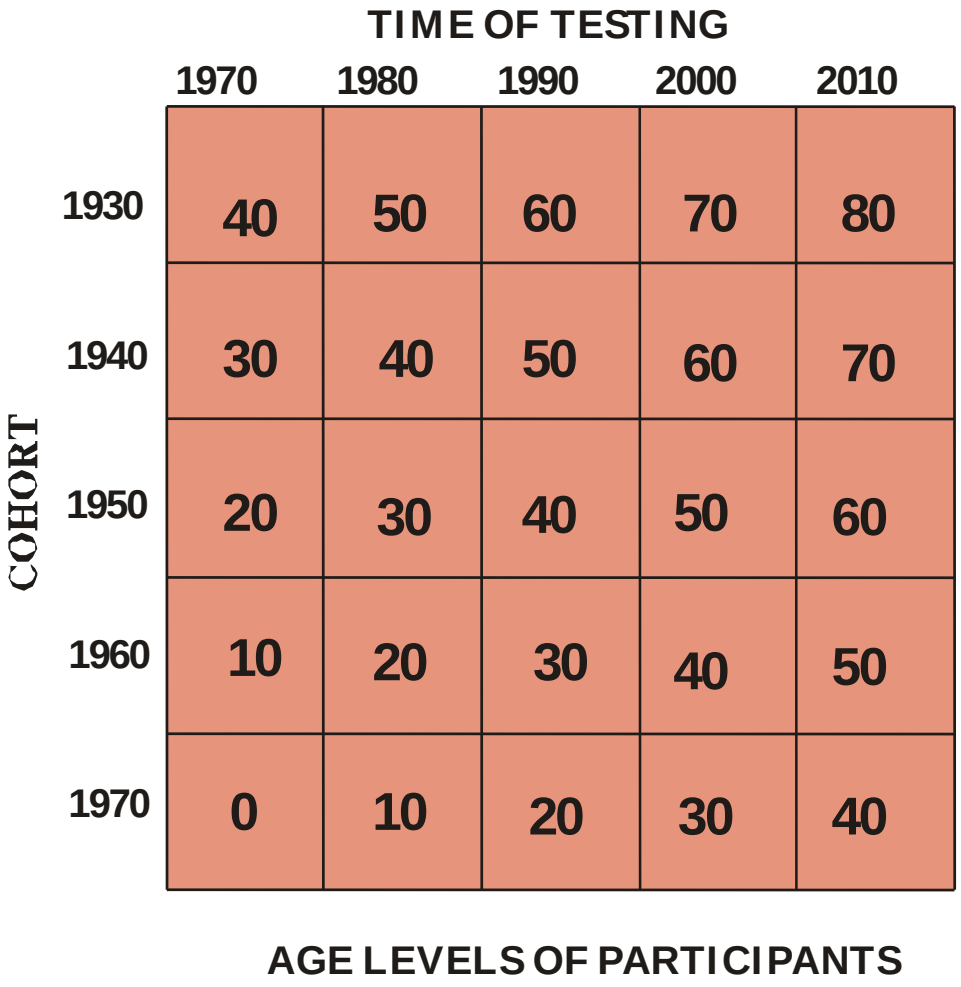


A CROSS-SEQUENTIAL DESIGN:

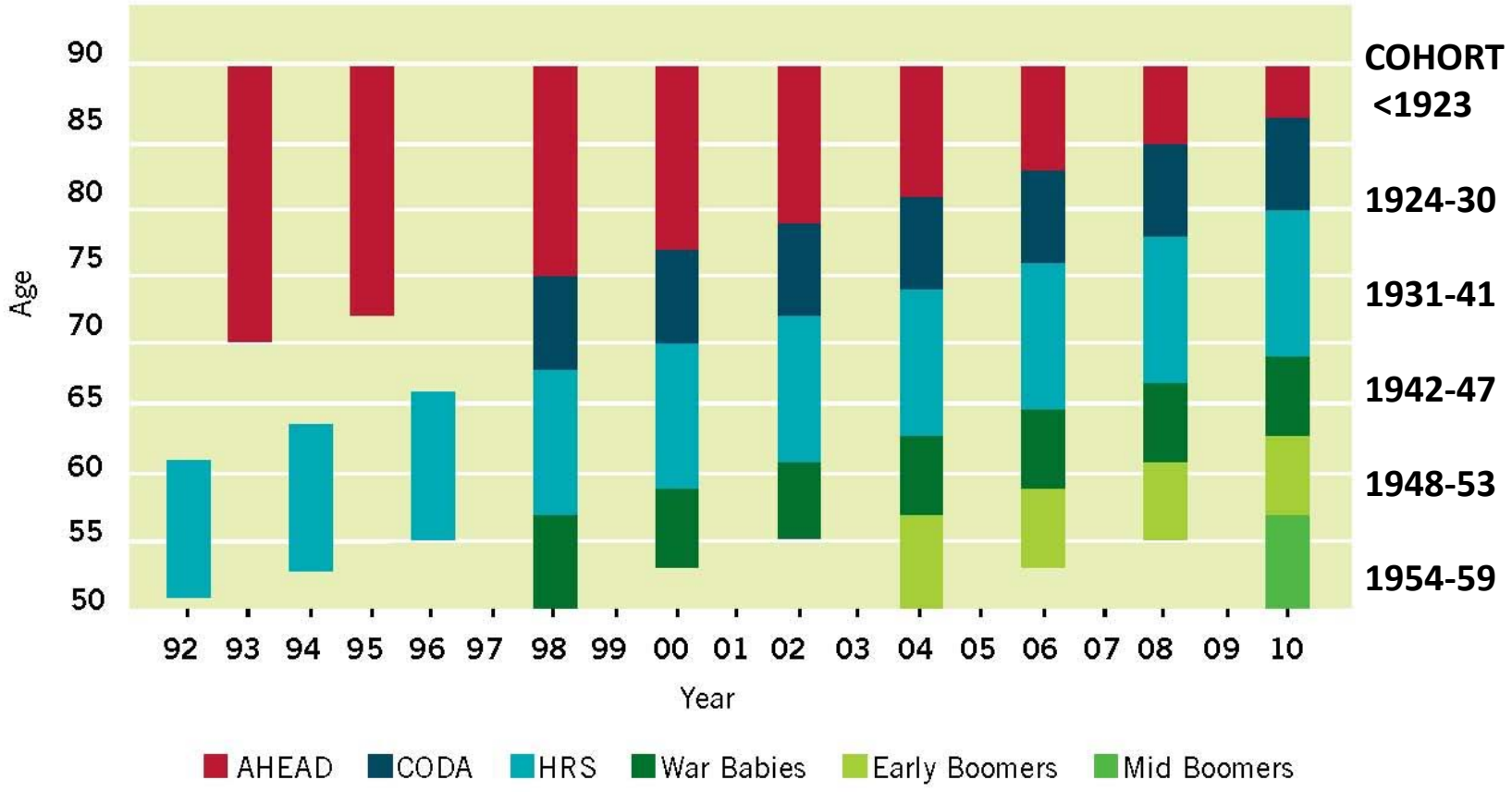
THIS DESIGN COMBINES THE CROSS-SECTIONAL AND LONGITUDINAL DESIGN



Schaie's "Ideal" Cross-Sequential Design



Evolution of the HRS Longitudinal Sample Design



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Panel Studies

Advantages

Panel data are particularly useful in answering questions about the dynamics of change.

Additionally, as mentioned above, panel study is useful in predicting long-term or cumulative effects.

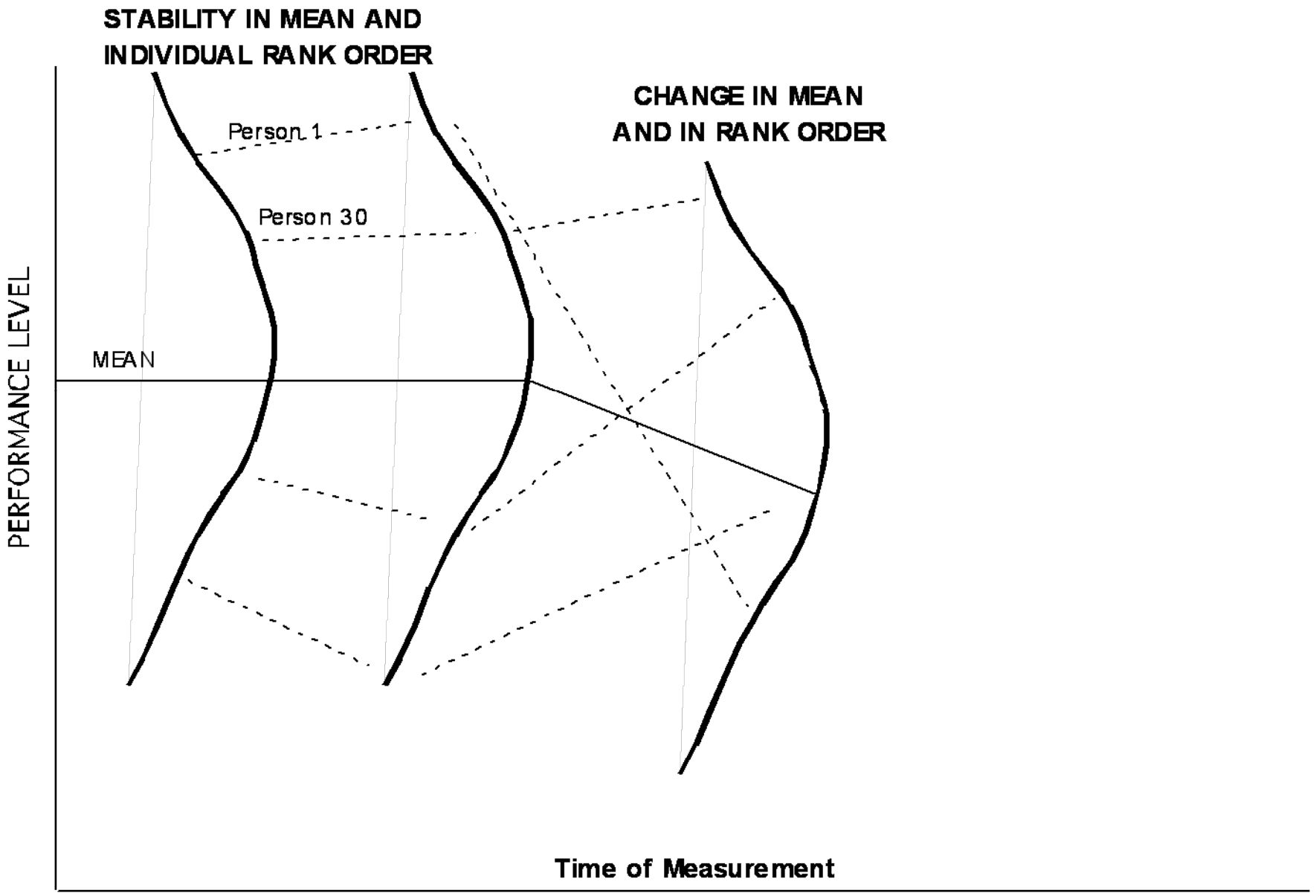
Disadvantages

Panel members are often difficult to recruit because of an unwillingness to commit to interviews several times.

Once the sample has been secured, the problem of attrition/dropout emerges. Some panel members will drop out for one reason or another. Because the strength of panel studies lies in interviewing the sample size at different times, this advantage diminishes as the sample size decreases.

Another problem related to this mortality issue is that it can hurt internal validity of the study design.

ONE EXAMPLE OF POSSIBLE CHANGES IN PERFORMANCE DISTRIBUTION AND LEVEL OVER TIME: INTELLIGENCE



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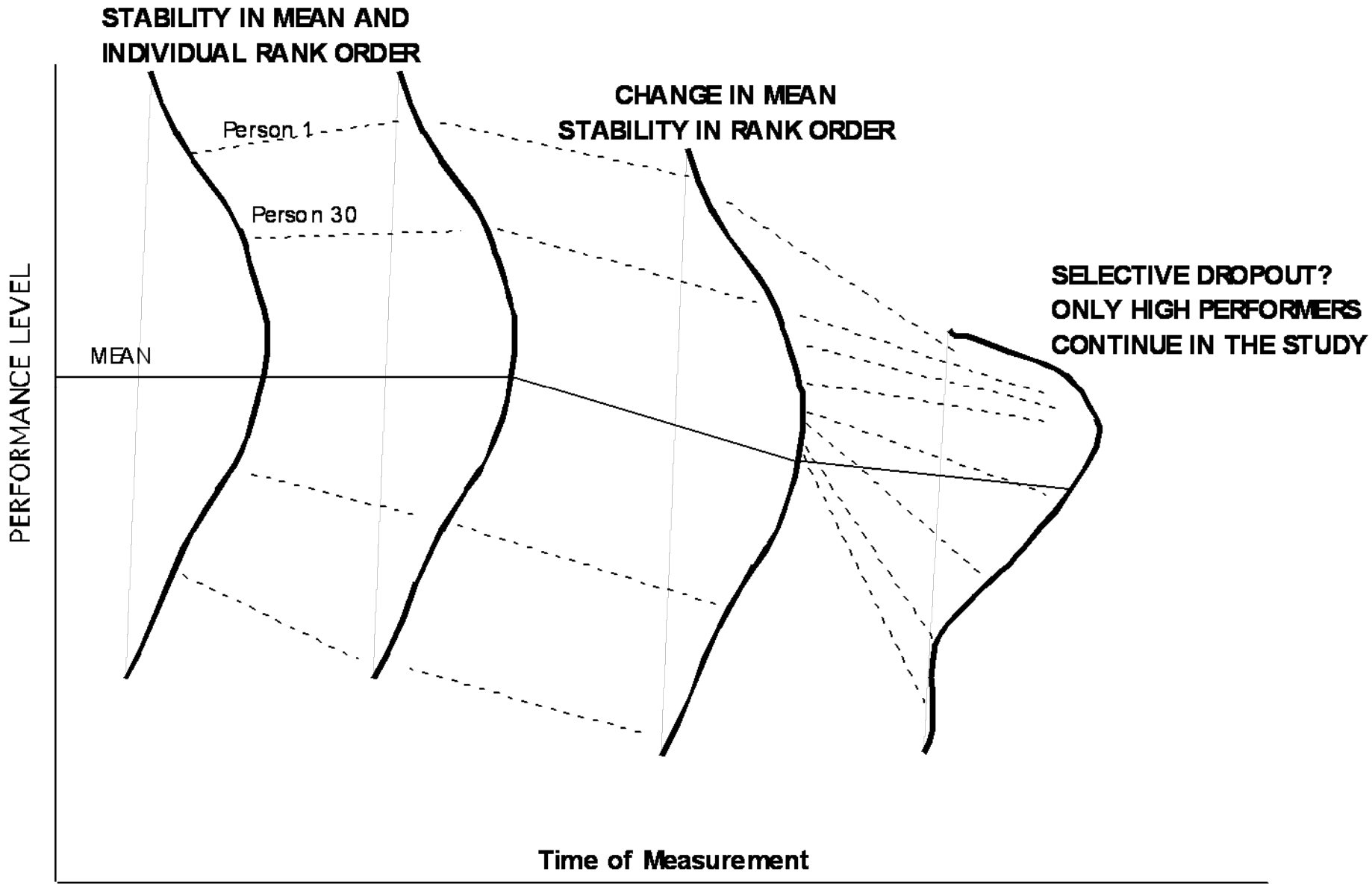
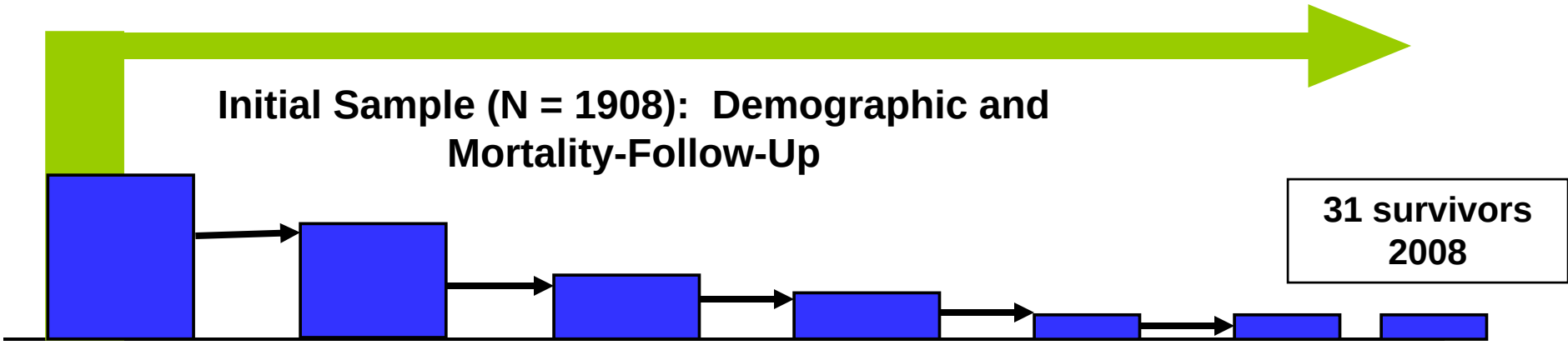
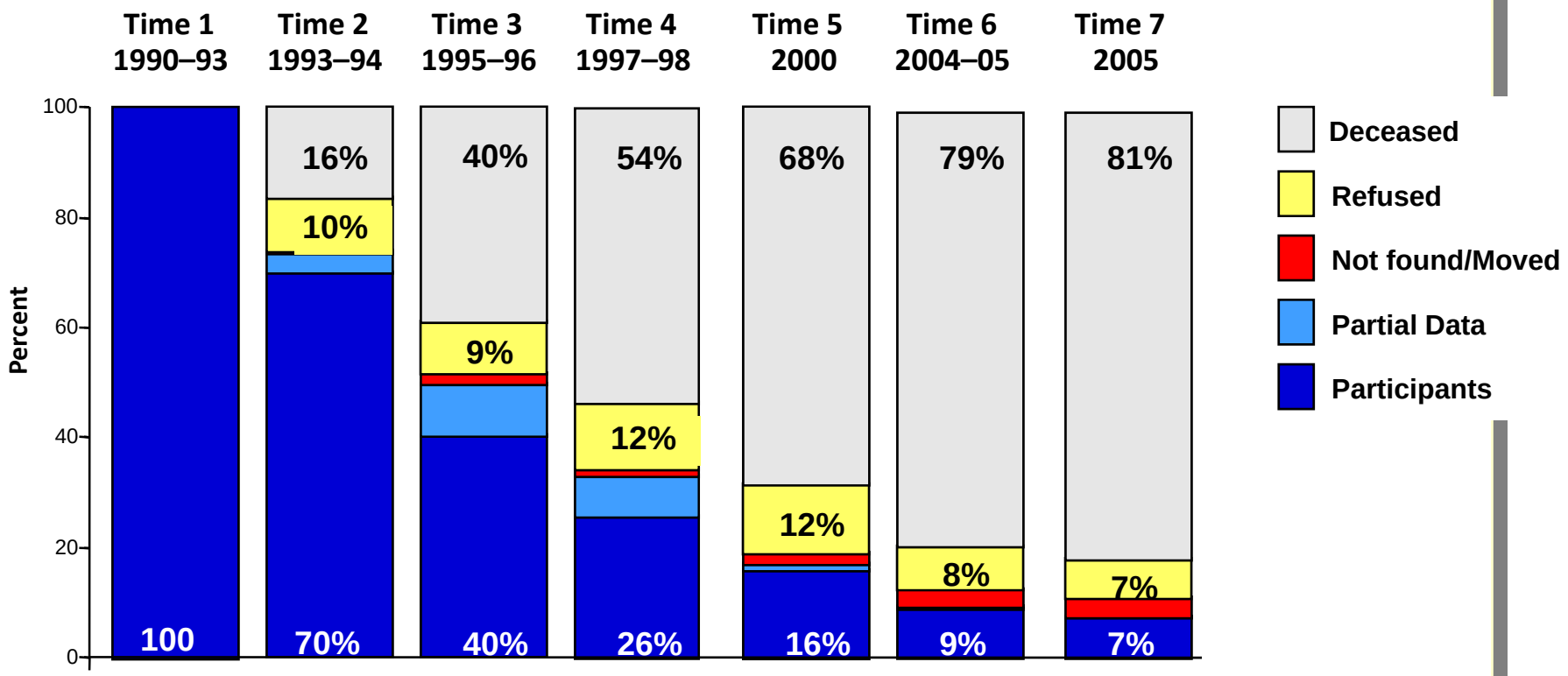


Longitudinal Design of the Berlin Aging Study (BASE)



Longitudinal Evolution of the BASE 516 Sample over Seven Measurements

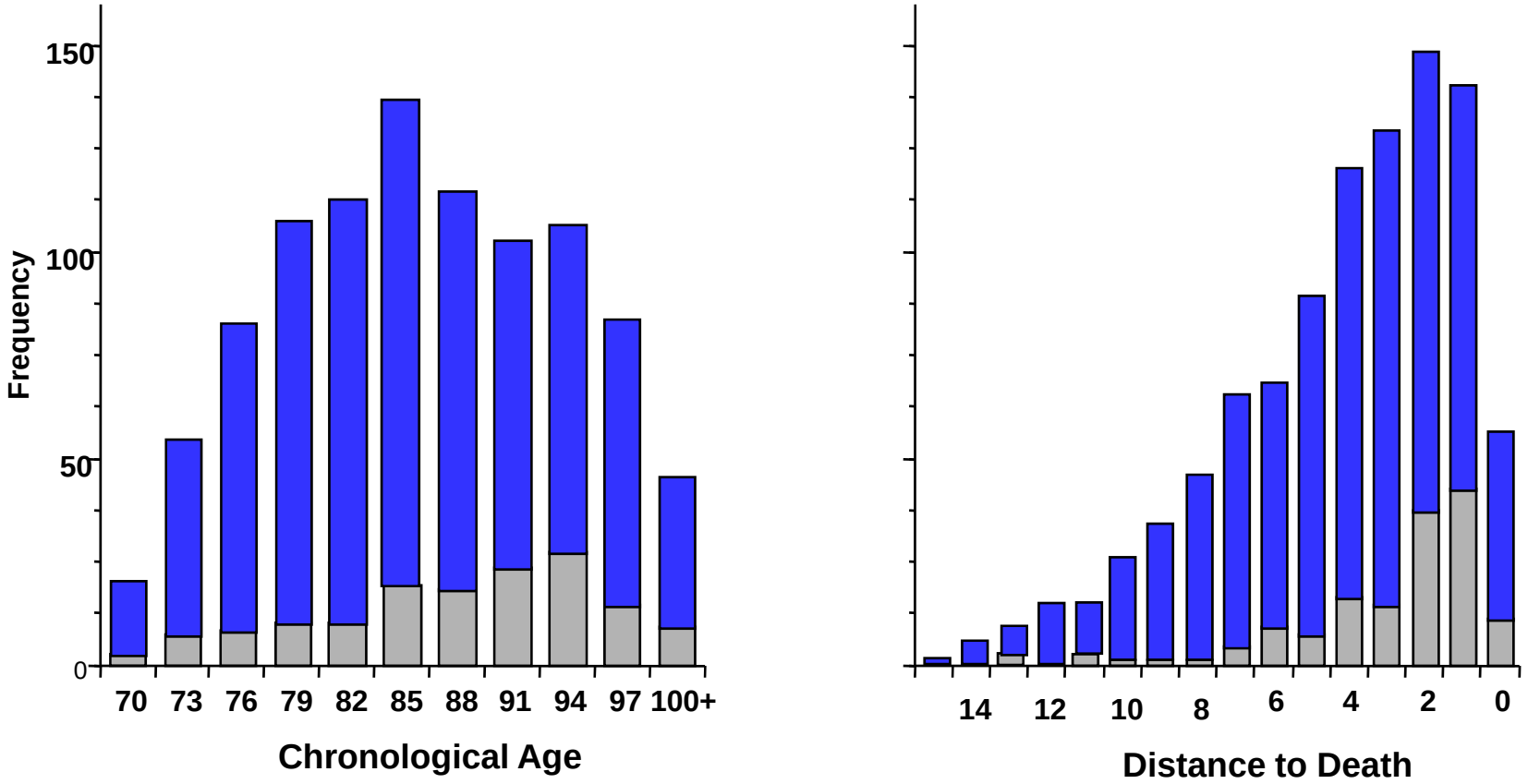
2-years on average between assessments



Berlin Aging Study (BASE): adapted from Smith & Delius, 2002

Longitudinal BASE Samples: Cumulative Observations

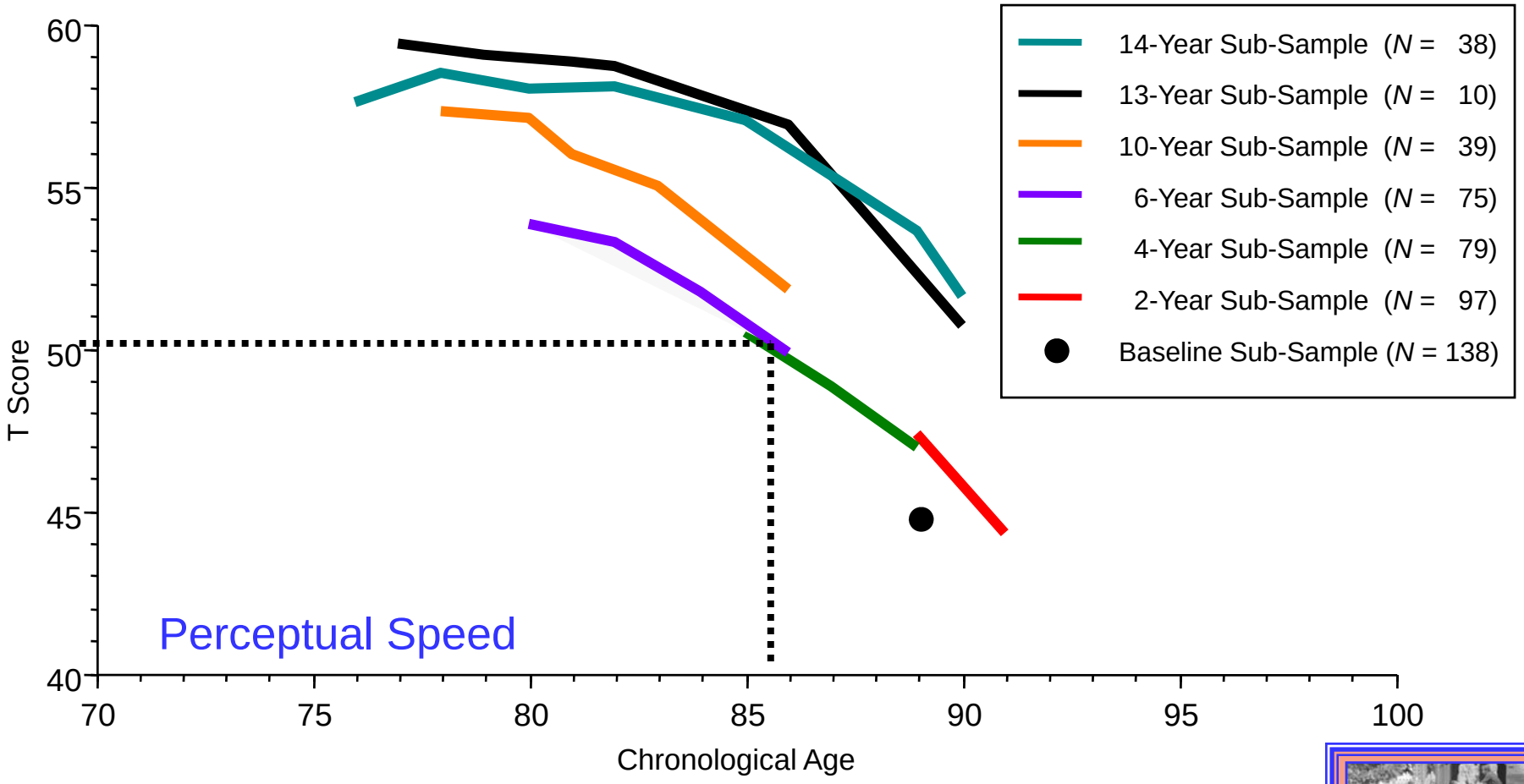
Complete and Incomplete Data for Latent Models of Age Trajectories



Status 2006

Average Long-Term Change for BASE Survivor Samples
Cognitive decline may be delayed for the long-lived

They reach the sample mean (centred at age 85) at or after age 90



Gerstorf, Lindenberger & Smith, in prep;
Singer, Lindenberger et al., 2002, 2003

Some Analysis Strategies with Longitudinal Data That Fail to Address Questions about Change

- ***Repeated measures ANOVA***
  (no parametric method for change)
- ***Wave-to-wave regression***
  (e.g., regression of T_2 on T_1 , T_3 on T_2)
- ***Separate but parallel analyses***
  (ignoring replicate measures over time)
- ***"Simplifying" analyses by….***
  - *Setting aside waves*
  - *Combining waves*
- ***Ignoring age-heterogeneity in sample*** *(even when measurement wave is surely not the best metric for time)*

Adapted from Singer et al.

What kinds of research questions require longitudinal methods?

Adapted from Singer et al.