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Methods for collecting panel data:

What can cultural anthropology learn from other disciplines?

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Abstract

In this article, we argue for the increased use of panel data in cultural anthropology. Panel data, or repeated measures from the same units of observation at different times, have proliferated across the social sciences, with the exception of anthropology. The lack of panel data in anthropology is puzzling, since panel data are among the best for analyzing continuity and change—central concerns of anthropological theory. Panel data also establish temporal order in causal analysis and potentially improve the reliability and accuracy of measurement. We review how researchers in anthropology and neighboring disciplines have dealt with the unique challenges of collecting panel data and draw lessons for minimizing the adverse consequences of measurement error, for reducing attrition, and for ensuring continuity in management, archiving, documentation, financing, and leadership. We argue that increased use of panel data has the potential to advance empirical knowledge and contribute to anthropological theory.

Key words: panel, longitudinal, cross-sectional, research methods, surveys

In the last 50 years, panel studies have grown in number and importance across the social, medical, and public-health sciences. One might expect cultural anthropologists to have seized on the trend, given the discipline's appreciation for long-term field research (Foster et al. 1979, Kemper and Royce 2002). Yet few cultural anthropologists conduct longitudinal research that incorporates panel data, or repeated measures from the same units of observation at different times.

The scarcity of panel studies in anthropology is puzzling, because panel data are particularly apt for the study of continuity and change—central areas of anthropological theory. Panel data would enhance our understanding of many processes that interest cultural anthropologists, including globalization, transnationalism, migration, acculturation, the development of political-economic structures, and the intergenerational transmission of culture. On the other hand, panel data entail unique costs. Here we argue for the increased use of panel data in cultural anthropology, and we review how successful panel studies in cultural anthropology and in neighboring disciplines have dealt with the challenges of collecting panel data in the field.

Our main objective is to draw lessons from disciplines that have come to rely increasingly on panel data. We begin by defining panel data and sketching the history of panel studies in anthropology and in neighboring disciplines. We discuss the advantages and disadvantages of collecting panel data for answering anthropological questions, and we develop specific recommendations for maximizing the benefits and minimizing the costs of panel studies in cultural anthropology. Our focus on panel designs, rather than long-term research, and our comparative perspective on anthropology and neighboring disciplines distinguishes our argument from previous, related contributions (e.g., Kemper and Royce 2002).

Panel studies, like cross-sectional studies, are compatible with the full range of qualitative and quantitative methods in social science, including case studies, experiments, sample surveys, or the collection of narrative text (Menard 2002:34). We focus here on structured, face-to-face surveys to make the discussion manageable, but much of what we say applies to other types of data (James and Sørensen 2000, Mednick, Harway, and Finello 1984, Saldaña 2003, Schulsinger, Mednick, and Knopf 1981). Also, we focus on research design and data collection rather than on methods for analyzing panel data; other sources cover the unique challenges of analyzing panel data (see Diggle et al. 2002, Hsiao 2003, Singer and Willett 2003, Wooldridge 2002).

Definitions

Our goal of learning from the experience of neighboring disciplines is complicated by cross-disciplinary differences in the vocabulary of research design. The methods we describe are known in various fields as panel methods, longitudinal designs, prospective cohort studies, or repeated observations. Cultural anthropologists often equate longitudinal studies with long-term fieldwork. Our first task, then, is to define terms.

Figure 1 illustrates the relation between types of research design. We follow others in regarding longitudinal methods as a broad class of methods, rather than as a specific suite of techniques (Menard 2002; Wall and Williams 1970). Longitudinal methods are easiest to define in contrast to cross-sectional research, in which data are collected for each unit of observation at only one time. Although data collection typically lasts for months or even years, a standard assumption in cross-sectional research is that data can be regarded as contemporaneous (Menard 2002:2). In contrast, longitudinal research requires repeated measures of the same variable from the same unit of observation at least twice. This definition implies that each wave of data

collection uses standardized procedures to ensure the comparability of data from different times (Baltes and Nesselroade 1979, Menard 2002).

Several types of research may be regarded as longitudinal. In Figure 1, we first distinguish between panel and repeated cross-sectional studies. In repeated cross-sectional studies, researchers collect data from independent samples at two or more times. When samples are comparable (e.g., two probability samples from the same population), it is possible to make inferences about aggregate changes over time by comparing cross-sections. Because repeated cross-sectional studies do not follow the same units of observation through time, it is not possible to study individual trajectories of change with such studies. For example, we may think of a national periodic census as a repeated cross-section. Census data may show how the proportion of people living in poverty changes from one decade to the next, but it does not indicate whether any specific person experiences a change in poverty status over time.

Statements about individual-level change require panel data. Figure 1 shows three varieties of panel designs. In *prospective panels*, researchers collect data from the same cohort at least twice. In *retrospective panels*, researchers doing a cross-sectional study collect information about the past and present, and treat information from different times as if it had been collected at those times. In *rotating panels*, researchers drop part of the initial sample after multiple waves of data collection and replace it with a fresh look-alike sample to lower respondent fatigue and to ensure the panel continues to represent the target population (Menard 2002). Panel studies often combine elements of the three designs.

We focus on panel data, rather than on longitudinal methods more generally. One rationale is to distinguish longitudinal research from long-term ethnographic fieldwork. This distinction is often overlooked. For example, in Kemper and Royce's (2002) *Chronicling*

Cultures, the index entry for "longitudinal research" directs readers to "*see also* long-term research." Foster (2002:256) likewise equates long-term and longitudinal research, though he distinguishes both from restudies of a field site. Saldaña (2003:3) suggests that "a qualitative study becomes longitudinal when its fieldwork progresses over a lonnnnnnnng time." Yet, according to our definition, not all long-term fieldwork is longitudinal, nor is all longitudinal research long-term (Johansen and White 2002).

Indeed, the chief criterion of panel studies—repeated measures of the same unit of observation—does not mean studies last a long time. The duration of panel studies and the time elapsed between waves of data collection may be long or short, depending on the research question. For example, Scudder and Colson (2002) collected demographic information on roughly 10,000 Tonga in the Gwembe District of Zambia for nearly 50 years. By contrast, Espy and colleagues (2000) followed a panel of 40 newborn infants for just two weeks to determine the effect of prenatal cocaine exposure on infant's physical and cognitive development. Despite different time scales, both studies demonstrate the key feature of panel designs: repeated measures of the same unit of observation in the same way over time. By this criterion, relatively few long-term studies in cultural anthropology may be regarded as true panel designs.

Panel Studies in Anthropology and Neighboring Disciplines

The history of panel research begins in 1759, when Count Philibert Guéneau du Montbeillard began recording his son's stature every six months from birth to age 18 (Baltes and Nesselroade 1979). Montbeillard's record-keeping bears little in common with contemporary panel studies, aside from his systematic repeated observations. The current concept of panel research was not established until the 1920s and 1930s, when several classic studies of human growth and development began—many involving anthropologists (Bogin 1999).

Since the mid-1900s, panel studies have proliferated across the social sciences. Figure 2 shows the number of studies initiated annually from 1911 to 1980 (three-year moving average) (Young, Savola, and Phelps 1991). The figure demonstrates rapid growth in the use of panel data from the mid-1950s through the late 1970s, and the trend continues: The journal *Demography* published 26 articles based on panel data between 1980 and 1989 and 65 such articles between 1990 and 2000 (Alderman et al. 2001). In the last decade, at least 40 percent of all studies in the *Journal of Gerontology: Social Sciences* have used panel data (Ferraro and Kelley-Moore 2003) and there has been a similar trend in management research (Goodman and Blum 1996).

Several factors have influenced the increased production of panel data in the social sciences. Policy concerns about work and unemployment stimulated funding in 1966 for the National Longitudinal Surveys (NLS) and in 1968 for the Panel Study of Income Dynamics (PSID) (Giele and Elder 1998). Both studies continue today. Advances in computers and telecommunications, in telephone interviewing technology, and in statistical methods for analyzing panel data facilitated collection of large, complex data sets on a national scale (Phelps and Colby 2002, Ferraro and Kelley-Moore 2003).

Of all the social sciences, anthropology participated least in the growth of panel research. Figure 3 shows the number of longitudinal studies published between 1990 and 2003 across five disciplines: anthropology, economics, epidemiology, psychology, and sociology. The Social Science Citation Index, from which the data in Figure 3 were taken, does not cover all panel studies because it excludes monographs and because disciplines vary in their use of keywords for indexing. Still, Figure 3 tells a compelling story.[1] From 1990 to 2003, 430 longitudinal studies were published in epidemiology, 330 in psychology, 213 in economics, 65 in sociology, and 16 in anthropology.

A closer look at SSCI data reveals that the dearth of panel studies is greater in cultural anthropology than in other subfields. In biological anthropology, there is an established tradition of panel research, beginning with Franz Boas's 1894 study of Worcester school-children—the first longitudinal study of human growth in the United States (Tanner 1981). A search for "longitudinal or panel" from 1990 to 2003 yields 64 articles in the *American Journal of Physical Anthropology* and 121 articles in the *American Journal of Human Biology*.[2] Corresponding searches in *Cultural Anthropology* and the *American Ethnologist* return no publications, while *Cross-Cultural Research* returns just one. The lack of panel data is most striking because of cultural anthropologists' broad theoretical interest in cultural continuity and change over time.[3]

For another view of cross-disciplinary differences in the design of panel studies, we compare exemplary studies in anthropology against the gold standards of neighboring disciplines. Table 1 summarizes key features of two classic longitudinal ethnographic projects and five noteworthy panel studies from public health, epidemiology, sociology, economics, and psychology. Although other ethnographic studies warrant inclusion in this comparison, we focus on the Gwembe Tonga (Zambia) and Tzintzuntzan (Mexico) studies because they are among the longest-running studies, provide ample documentation, and are moving towards electronic dissemination of their data.

Table 1 draws out several important contrasts. First, unlike studies in neighboring disciplines, the Gwembe Tonga and Tzintzuntzan projects were not conceived as panel studies (Foster 2002:255, Scudder and Colson 2002:198). Long-term ethnographic fieldwork accommodated the collection of panel data, but did not require it. One consequence is that the range of variables for which panel data have been collected in Gwembe and Tzintzuntzan is more limited than in the comparison studies. In Gwembe and Tzintzuntzan, panel data consists

primarily of sociodemographic information collected systematically in periodic ethnographic censuses; panel data are not available for the complete range of variables or research questions addressed in either setting. By contrast, the comparison studies emphasized from the beginning the comparability of repeated measures on the same unit of observation for a broad range of variables. In most cases, the sampling strategies, tracking rules, and periodicity of data collection were also specified in advance to address particular research questions. This contrast points to the need for explicit panel designs in anthropology, with appropriate sampling strategies, suitable periodicity, and systematic data collection procedures to ensure comparability over time (Royce and Kemper 2002, see also Moles 1977).

Another striking contrast in Table 1 is the number of publications across studies. Although there are disciplinary differences in the expectations and format of scholarly publications, the wide gap in number of publications between anthropology and other disciplines points to a more fundamental difference. The ethnographic projects in Gwembe and Tzintzuntzan were primarily the work of founding researchers and their students; the panel studies in other disciplines were conceived in part as resources for the entire research community. For that reason, all but the Fels Longitudinal Study have made provisions for public access to the raw data. There are currently efforts underway to make data from Gwembe and Tzintzuntzan more widely available (Cliggett 2002; Kemper 2002; Scudder and Colson 2002), but these exemplary anthropological studies still lag behind other disciplines in the archiving and dissemination of data. As we argue below, data sharing maximizes the contribution of panel studies to the growth of empirical knowledge and to the training of future researchers. For example, in the last five years alone, more than 70 Ph.D. dissertations were based on data from the Panel Study of Income Dynamics.

A related pattern evident in Table 1 is that most panel studies outside of anthropology involve significant interdisciplinary collaboration. The trend may reflect the fact that interest in developmental processes cuts across disciplines. We also speculate that interdisciplinary collaboration may provide a better return on the investment in collecting panel data, since the same study can generate data amenable to complementary research questions in different disciplines. The lesson here for anthropology is that panel studies may help to bridge subdisciplinary boundaries. Indeed, several successful panel studies in anthropology draw on collaboration across subfields, especially between cultural and biological anthropology (Hill and Hurtado 1996, Flinn and England 1995, Godoy et al. 2005a, Scudder and Colson 2002). These studies vary in the extent to which they involve researchers outside of anthropology.

Advantages of Panel Data

We now discuss three advantages of panel data over cross-sectional research: (1) panel data facilitate the analysis of change within units of observation; (2) they help to establish the direction and magnitude of causal relationships; and (3) they potentially improve the reliability and accuracy of measurements.

Change within units of observation

The most important advantage of panel studies is the ability to identify and describe patterns of change *within units of observation*. Singer and Willett (2003) point out that the study of change entails two levels of analysis: (1) describing *within-individual* trajectories of change and (2) examining differences *between individuals* in their trajectories of change (cf. Baltes and Nesselroade 1979). Both levels of analysis inform questions of long-standing theoretical interest to anthropologists, but the relevance of panel data is often overlooked.

Consider the comparative study of folk racial classification in Brazil and other parts of Latin America. A recurrent theme in the ethnographic record is that racial identity is more fluid

and ambiguous in Brazil than it is in the United States (Wade 1997). This view is commonly expressed by the idea that "money whitens"—with greater prestige in social class, racial identity favors lighter categories. Unfortunately, the evidence for whitening comes almost entirely from cross-sectional data, even though it implies a process of individual change. Following Singer and Willett, there are two pertinent questions: (1) How do individuals' ascribed identities *change* over time? and (2) do men and women, children and adults, rich and poor, or light- and dark-skinned Brazilians change in the same or in different ways over time? Panel data are apt to address these questions.

Anthropological concepts like adaptation or enculturation also imply a concern for change within units of observation. For example, Zarger and Stepp (2004) ask how the acquisition of ethnobotanical knowledge among Tzeltal Maya children in Mexico might have changed over the last 30 years, given rapid sociocultural, economic, and environmental change. Zarger and Stepp use a repeated cross-sectional design. They replicate a previous study in the same community (Stross 1970) and conclude that little or no change occurred in children's plant-naming ability over the intervening 30 years. This conclusion about aggregate change at the community level is warranted, given the repeated cross-sectional design. But Zarger and Stepp also indicate that their core theoretical interest is the "process of acquiring environmental knowledge" (p. 414)—an individual-level process that implies a need for panel data, tracking the same sample of children over time.

Using panel data, one might ask (1) how each child's knowledge of ethnobotanical terminology changes with age and (2) what accounts for variation in how quickly children acquire new knowledge. Zarger and Stepp propose (p. 416) that cross-sectional differences among children of different ages reflect developmental regularities in the acquisition of

ethnobotanical knowledge. Cross-sectional data are unable to test this claim. It is also possible that children of varying ages in 1999 would have experienced enculturation differently, because they came of age at different times and potentially under different circumstances.

This example illustrates a general problem: cross-sectional studies alone can never distinguish between age *differences* and age *changes* (Schaie 1967). Figure 4 depicts the problem. Suppose we conducted a cross-sectional study in 1980 and observed a cross-sectional difference in, say, political attitudes among three generations of a community. The difference could be interpreted as part of the aging process: Perhaps people become more conservative with age. But generational differences could also reflect the fact that people born in 1925 grew up in a different socio-cultural environment than did people born in 1945, who, in turn, grew up in a different environment than did people born in 1965. Cross-sectional studies cannot separate alternative explanations because they conflate the effects of cohorts and aging (Palmore 1978, cf. Handwerker 2001:114).

Panel data can better distinguish between age and cohort effects because they track changes within individuals. For example, if we re-interviewed our 1980 sample in 1990 and in 2000, we could determine how each individual's political attitudes changed with age and thereby distinguish maturational changes from cohort differences. Following a single cohort over time would present another problem, however, since differences between waves of data collection could be due to changes in the environment, rather than to consistent maturational changes. Panel studies with multiple cohorts, as shown in Figure 4, improve our ability to disentangle the effects of age, time period, and cohort (Palmore 1978).

A recent study of culture change, body image, and eating disorders in Belize (Anderson-Fye 2004) further illustrates the relevance of this point for anthropology. Anderson-Fye (2004)

reports on ethnographic research from 1995–2002 to address the apparent paradox that, despite rapid cultural change related to globalization, young women in Belize remain relatively satisfied with their bodies, and eating disorders remain rare. Her data come from participant observation and more than 90 ethnographic interviews, including "in-depth clinical longitudinal interviews" with 16 young Belizean women. The use of a panel design for the 16 clinical interviews allowed Anderson-Fye to track the few nascent cases of disordered eating as they unfolded.

The trajectories of change Anderson-Fye identified challenge prevailing assumptions about how globalization shapes the meaning of body size and the emergence of eating disorders in non-Western settings. In particular, she observed that young women who began to display eating disordered behavior did not first internalize a desire for thinness or dissatisfaction with their bodies. Rather, their economic dependence on tourism and their families' upward social mobility precipitated changes in eating behavior. Anderson-Fye suggests that this pattern was unique to young women. Based on participant observation, she claims that older women exhibited more frequent and different types of eating disordered behavior. However, because older women were not part of the panel, it remains unclear whether cross-sectional age differences reflect different trajectories of change across generations. A larger, more systematic panel would yield greater insight into how globalization and culture change affect the meaning of body size and eating behavior over the life course.

Causal analysis

Panel studies also offer benefits for establishing the direction and magnitude of causal relations (Finkel 1995, Menard 2002). There are generally four criteria of causal inference in the social sciences: (1) variables must covary, (2) their relationship must not be spurious, (3) there must be a logical time order between variables, and (4) there must be a theory about causal mechanisms (Bernard 2002, Blalock 1964). Cross-sectional studies demonstrate covariation, but

they generally cannot establish temporal order. Panel data inform causal analysis by determining the temporal sequence of presumed cause and effect (Miller 1999), and they permit better tests of spuriousness (Finkel 1995). These benefits are clearest in panels with at least three waves of data collection, but even two-wave panels have significant advantages over cross-sectional data (Finkel 1995:87). [4]

The Tsimane' Amazonian Panel Study (TAPS) provides an example of how panel data can help to resolve theoretical debates about causality in cultural anthropology. There is long-standing debate about what drives self-sufficient indigenous peoples to participate in the market economy—and what effect is has on their well being. Godoy et al. (2005b, n.d.) use panel data from TAPS to answer both questions. First, they test five hypotheses for push and pull factors that previous researchers had proposed to explain market participation. In general, they find support for pull rather than push factors and for individual and household variables rather than community-level determinants. Next, they use panel data to examine how market integration relates to trends in economic, health, psychological, and social indicators of well-being among the Tsimane' (Godoy et al. n.d.). Results suggest a general improvement in Tsimane' well-being, with higher levels of improvement in villages closer to the nearest market town. Godoy et al. argue that previous debate about the causes and consequences of market integration had been hampered by reliance on cross-sectional data, which are ill-suited for testing causal hypotheses.

Reliability and accuracy of measurement

A less widely recognized advantage of panel data is their potential to improve the reliability and accuracy of estimates. This advantage accrues in two ways. First, panel data make it possible to control for so-called personal fixed effects—attributes that do not change over time, but that may bias observed relationships in cross-sectional studies (e.g., genotype). Second, prospective panels reduce recall bias—a known threat to the reliability of estimates (Bernard et

al. 1984)—by shortening the time elapsed between the event of interest and the date of data collection. For example, a recent analysis from the Framingham Heart Study used prospective panel data on parents and offspring to estimate the importance of parents' history of heart disease for offspring cardiovascular risk (Lloyd-Jones et al. 2004). The study confirmed the importance of parental history but revised previous estimates, which drew on retrospective data. The associated recall bias in previous studies often inflated estimates of the risk associated with parental heart disease.

Dealing with Challenges of Panel Data

The balance of the article deals with the challenges of collecting panel data, including measurement error, attrition, costs, data storage and dissemination, and sustainability. We make suggestions to minimize these threats to the validity of panel data.

Measurement Error

Measurement error refers to difference between the true value of a variable and the measured variable. All studies are vulnerable to measurement error, but collecting panel data introduces a unique threat of error due to respondents' repeated exposure to the same stimuli. We distinguish between two types of measurement error: classical and systematic. Classical measurement errors are random and uncorrelated over time. Systematic measurement errors display a pattern.

Classical measurement errors. Classical measurement errors arise when respondents guess in answering questions, when researchers make mistakes coding or transcribing data, or when they mismatch files of respondents from different survey rounds. Some classical measurement errors are apparent only with panel data. For example, in 2001 Godoy et al. (2006) asked a sample of Tsimane' Amerindians in the Bolivian Amazon (n=4,657) for their age and for that of their children. They returned a year later at about the same time and asked the same

questions, knowing that respondents' age had increased by only one year (±2 months for variation in the re-interview date). Only 20% of respondents reported their age correctly between waves. Likewise, in a panel survey in rural Ghana, Jackson et al. (2003) asked women ages 15–49 whether they had been circumcised. Between 1995 and 2000, 15 percent of women gave inconsistent responses, including 11 percent who reported having been circumcised in 1995 but denied it five years later. It would not be possible to detect these errors with cross-sectional data.

Classical measurement errors in panel studies also arise from changes in how people collect data. In particular, random measurement errors arise from changes in (1) wording or order of questions (Kalton and Schuman 1982, Fowler 2001), (2) data-collection modes (e.g., from telephone to mail survey), even if question wording remains the same (Kalton, Kasprzyk, and McMillen 1994, Shettle and Mooney 1999), (3) number and types of questions (Polivka 1996, Angrist and Krueger 1999), (4) visual layout in self-administered surveys (Christian and Dillman 2003), (5) codes and surveyors (Epstein 2002), (6) proxy respondents (e.g., parents who answer questions for children), and (7) respondents' interpretation of questions, even if the survey mode and wording of questions remain constant (Seldin, Friedman, and Martin 2002).

Measurement error from changes in respondents' interpretation of questions is particularly relevant for cultural anthropologists. Even if researchers pose a question unambiguously, the question's meaning might change as culture changes. For example, Mott (2002) suggests that respondents' changing responses across multiple waves of the National Longitudinal Surveys may yield insight into shifting norms regarding acceptable family structure, fertility behavior, marriage, or other partnership relations. This example highlights the mutual relevance of panel data and ethnography. Ethnographic data on cultural models of family, fertility, and marriage would improve the interpretation of inconsistent responses over time;

inconsistent responses over time may help to identify sociocultural changes that deserve ethnographic study.

Classical measurement error is not unique to panel data, but its adverse consequences are magnified with panel data when making inferences from regression analysis. Classical measurement error in an explanatory variable produces an attenuation bias, or movement of the estimated parameter toward zero. Panel data increases attenuation bias because random measurement errors increase the ratio of noise to signal. As a consequence, classical measurement errors in explanatory variables with panel data increase the likelihood of accepting the null hypothesis of no association between variables, even if a real association exists (Angrist and Krueger 1999, Ashenfelter, Deaton, and Solon 1986, Griliches and Hausman 1986).

Systematic time-in-sample errors. Systematic measurement errors are persistent and patterned, and arise when participants under- or over-report answers. Time-in-sample systematic errors are unique to panel studies and refer to changes in participants' response due to repeated exposure to the same questions (Bailar 1994, Duncan 2000, Kalton and Citro 2000, Rose 2000). Time-in-sample errors are also known as panel conditioning, contamination, or re-interviewer effect.

Time-in-sample errors can either increase or decrease accuracy. Improvements in accuracy occur for several reasons. First, respondents may become motivated to provide more accurate information as they get to know the interviewer and the purpose of the study. Sudman and Bradburn (1982:82) note that "confidence and perceived threat both level off fairly rapidly after two or three … interviews." Similarly, anthropologists recognize that long-term engagement with a community helps to build rapport and improves data quality (Vogt 2002:145, Foster 2002:275, Royce 2002:10).

Second, participants may provide more accurate answers in later phases because they learn how to do the survey tasks—provided that elapsed time does not impair cognitive functioning (Levin et al. 2000). Godoy et al. (2004) and Reyes-García et al. (2005) draw on data from TAPS to show that the reliability of measures of time preference and folk knowledge increased during later waves of the panel.

But repeated exposure to the survey can also erode the accuracy of data because of fatigue or learning. Some errors depend on the behavior of interviewers. Due to fatigue, surveyors may not provide as much stimulus to respondents in later interviews as in earlier interviews. Experienced interviewers may start to amplify or provide leads when asking questions. Other errors may occur if participants alter their responses as they learn the survey instrument. With repeated surveys, respondents learn that some questions lead to further questions, and they may give rote, terse responses or refuse to answer to minimize the time spent with surveyors (Bailar 1994, Kalton and Citro 2000, Scudder and Colson 2002). Repeated exposure to questions on certain topics, such as political participation and health, can affect responses by making people more politically active or conscious of their health (Campbell and Stanley 1966). Consequently, time-in-sample errors are more pronounced in certain categories of behavior, such as political attitudes, health, or sexual behavior, than in others, such as job search or employment (Veroff, Hatchett, and Douvan 1992, Ashenfelter, Deaton, and Solon 1986). They are also more pronounced with shorter intervals between surveys, due to more frequent exposure to surveyors.

There is some debate about the magnitude of bias from systematic time-in-sample measurement error (Duncan 2000, Rose 2000). Some researchers suggest that time-in-sample bias tends to decrease after early waves (Sudman and Ferber 1979). Waterton and Lievesley

(1994) draw on three annual waves (1983-1986) of the Social Attitudes Survey from Great Britain and compare changes in the panel with data from a national cross-sectional survey of political attitudes. They find that participants "become politicized by the interview, that they report more honestly, and that they become less likely to answer 'don't know.'" But they also find that the magnitude of conditioning was small and that conditioning was "not a major hazard" (pp. 335-336). Halpern et al. (1994) show that repeated questioning of adolescent males about sex had no significant effect on their sexual behavior.

One strategy to detect time-in-sample errors is to combine a panel with an independent cross-section that mirrors the panel sample, and to interview both samples in parallel (O'Muircheartaigh 1994). This strategy permits two comparisons: (1) mean values of a variable at the beginning and at the end of the panel and (2) mean values of the same variable for the last wave of the panel and for the cross-sectional sample. The first comparison estimates systematic errors from exposure to the survey, and the second determines whether information from the panel diverges in significant ways from information in the cross-sectional control group at the end of the study.

The Social Indicators Study of Alaskan Coastal Villages provides an anthropological example of this strategy. Jorgensen et al. conducted a four-year study in 31 villages to examine the consequences of economic development for the quality of life in rural Alaskan Native communities (Jorgensen 1993; Jorgensen et al. 1985). The study incorporated a range of complementary data collection techniques—forced-choice questionnaires, open-ended key informant interviews, semistructured observations, genealogies, and secondary analysis of archival data. The researchers used a variant of the Solomon (1949) four-group design, which entailed nesting panels in three waves of data collection from 1987–1990.

The first wave consisted of key informant interviews with a panel of 172 people and survey interviews with a separate panel of 548 people. In the second wave, a year later, all survey respondents and about 40 percent of the key informants were reinterviewed; the rest of the key informants were reinterviewed in the third wave (two years after the initial interviews). In the third wave, researchers also reinterviewed all survey respondents and added a new sample of respondents who had not been interviewed before. In addition, they added new villages to the study to assess the impact of the *Exxon Valdez* spill in 1989. The addition of new respondents in the last wave of data collection enabled the researchers to test for time-in-sample errors, while the continuing panel design reduced errors from recall bias, established the reliability of measures over time, and abated threats to internal validity from historical confounds such as the *Exxon Valdez* spill (Jorgensen 1993).[5]

Correcting measurement errors. Three strategies help to abate classical measurement error when collecting panel data. The first is to delete poorly measured rounds of data collection. Early rounds may contain greater random measurement error due to distrust of researchers or because researchers have not yet learned the local language and culture. Consequently, some researchers spend early rounds of a panel study refining methods before starting formal data collection. Even after finalizing data-collection procedures, researchers often drop one or more rounds of data due to measurement error. The Consumer Expenditure Survey of the United States uses the first of five rounds of surveys to anchor questions in time for subsequent rounds because researchers assume consumers must learn how to report purchases (Silberstein and Jacobs 1994). We have found several examples in anthropology of researchers dropping from the analysis early waves of data collection owing to measurement errors (Hill and Hurtado 1996, Byron 2003, Demmer and Overman 2001, Reyes-García 2001).

A second strategy to minimize measurement error is to improve consistency in data collection procedures to ensure that responses do not differ because of changes in the way researchers collected data. Keeping constant the day of the week, month, or season of the year matters if seasonality affects the parameters of interest (Byron 2003). To avoid burdening subjects, surveyors sometimes bring past data to the interview and simply confirm it with the subject, or use it as a benchmark to assess changes since the last interview. Computer-assisted data collection with laptop or handheld computers allows for consistency checks across different surveys rounds (Gravlee 2002, Couper and Nicholls 1998). Researchers who collect data manually can have two people enter the same data (or a sample) into the computer to check for errors in transcribing.

Despite the benefits of using the same survey mode for reducing measurement error, changes in data collection are almost always necessary. Panel studies allow researchers to learn from their mistakes in early rounds of data collection. Researchers often want to add or modify questions because unanticipated questions and new goals surface, because participants find it hard to understand or interpret questions, or because more efficient technologies or more accurate methods of data collection become available. Also, to lower the burden of respondent participation, some questions asked in early rounds need not be asked as frequently or at all in later rounds when the answers are unlikely to change across survey rounds. Changes to instruments for collecting panel data might be inevitable, but researchers must consider the possible effects of changes and decide if the costs outweigh the benefits (Dillman and Christian 2005).

A third strategy to reduce the adverse consequence of measurement errors in explanatory variables is to collect data on so-called instrumental variables.[6] A convincing instrumental

variable is one that correlates highly with the poorly measured explanatory variable for reasons the researcher can verify and explain (Angrist and Krueger 2001), but that does not correlate with the error term or with the outcome, except through the poorly measured variable. There are several recent reviews of instrumental-variable estimation for poorly measured variables (Angrist and Krueger 2001, Rosenzweig and Wolpin 2000, Meyer 1995).

Attrition

Attrition refers to respondents' ceasing participation in a study for one or more survey waves. Attrition has been called the "Achilles heel" of panel studies (Thomas, Frankenberg, and Smith 2000). Our discussion focuses on how to monitor and redress attrition; statistical tests to assess whether attrition biases conclusions are covered elsewhere (Ahern and Le Brocque 2005).

Types of attrition. Attrition can be temporary or permanent. Temporary or intermittent attriters leave the sample but return, or they decline to participate in some rounds of a study but not in others (Burkam and Lee 2000, Rendtel 2002). Unit non-response occurs when respondents turn down requests for an interview or drop out of the sample; item non-response occurs when respondents do not answer only some questions. Permanent attriters migrate out of the study site after early rounds and never return, or they remain in the site but refuse to participate or are hard to find (Thomas, Frankenberg, and Smith 2000).

If attrition is random and uncorrelated with observed variables, then sample size and the efficiency of parameter estimates will suffer, but estimated coefficients will remain unbiased (Sherman 2000). In this case, observations are said to be missing completely at random (MCAR), and one can ignore and not model the causes of attrition (Little and Rubin 1987). Besides loss of efficiency, the only cost associated with this type of attrition is the investment in initial waves of data collection and perhaps in replacing attriters with a new sample. To correct

for random attrition, researchers can over-sample at baseline to ensure enough statistical power for a sample after attrition.

Non-random or informative attrition refers to units leaving the sample for systematic reasons, due to observed or unobserved attributes. This type of attrition can (1) produce inconsistent parameter estimates (Heckman 1979, Hausman and Wise 1979, Nijman and Verbeek 1992, Little and Rubin 1987, Schafer 1997), (2) make the sample unrepresentative, (3) affect the univariate distribution of variables (Hauser 2005), and (4) give the false impression of stability, since those who divorce, find new jobs, die, get sick, or change lifestyles are more likely to leave the sample (Rendtel 2002, Goldberg et al. 2003, Ridder 1990). Non-random attrition cannot be ignored and must be modeled along with the outcome of substantive interest. The extent to which non-random attrition biases parameter estimates is an empirical issue.

Causes and magnitude of attrition. We know of no panel study explicitly designed to study the causes of attrition. Studies on attrition are an afterthought, done after or while researchers collect panel data. As a result, our understanding of the causes of attrition comes from indirect, fragmentary evidence (Alderman et al. 2000). One approach to determine whether attriters differ systematically from those who do not leave the sample is to compare the mean and variance of measured variables for the two groups at baseline, before attrition.

Recent reviews suggest that the magnitude of attrition varies widely across studies and cultures (Glewwe and Jacoby 2000, Thomas, Frankenberg, and Smith 2000). Alderman et al. (2000) review attrition rates from 10 studies in developing countries and find that rates varied from as low as 1.5%/year in Indonesia (1993 to 1997) to 19.4%/ year in Bolivia (1995/6 to 1998). The Wisconsin Longitudinal Study lost only 2.8% of the sample from 1957 to 1975, but the Panel Study of Income Dynamics lost 40% of its sample from 1968 to 1981 and half of its

sample by 1989 (Becketti et al. 1988, Fitzgerald, Gottschalk, and Moffitt 1998). Ridder (1990) reviews case studies from Europe showing attrition rates of over 50%. Attrition rates among school-age populations may be even higher; a study with high-school students in Adelaide lost 80% of the sample by the end of the seventh year (Simkin et al. 2000).

Despite the potential magnitude of attrition, empirical studies suggest that attrition does not significantly bias parameter estimates in either developed or developing nations (Rendtel 2002). However, studies of attrition bias tend to be based on large, nationally representative samples, which are unlike most anthropological studies. Attrition could bias estimates if samples are small, if attrition is not random, and if attriters account for a large share of the sample (Angrist and Krueger 1999). For example, Quandt and colleagues (2002) document patterns of attrition in an anthropological intervention study among migrant farmworkers (n = 457) in rural North Carolina. They found that approximately 30 percent of farmworkers migrated during a single summer season—despite the continual availability of work in North Carolina. This level of non-random attrition was larger than expected and undermined the validity of the study design. Quandt et al. (2002:27) argue that combining ethnography and panel designs can help to elucidate the causes and consequences of attrition in future studies.

Minimizing attrition. Given the potential for bias, anthropologists should take steps to reduce attrition before it occurs. Hauser (2005) describes aspects of project management that facilitated a low attrition rate in the Wisconsin Longitudinal Study (2.8%/year, 1957-1975). First, the primary researchers, who had a vested interest in data quality, did the work themselves rather than subcontract data collection. Second, before each wave of data collection, they sent letters, made telephone calls, and, in more recent years, advertised in regional media and on the Internet to remind people about the upcoming survey. Third, they followed attriters through telephone

interviews and tracked them by asking neighbors, parents, and siblings. If all leads failed, they started over; they sent letters, made telephone calls, and visited neighbors, as though they had never done it before. Other panel studies have used similar techniques (Badawi et al. 1999, Thomas, Frankenberg, and Smith 2000). The success of these techniques in survey research implies that level of rapport that anthropologists typically develop with participants during long-term fieldwork may help to reduce attrition.

Other methods to reduce attrition include: (1) obtaining at baseline a list of close contacts likely to know the participant's future address should the participant move, (2) keeping continuity in the relationship between interviewers and participants, (3) changing survey modes to fit the participants' needs, (4) sending more skilled interviewers after people who decline interviews (Falaris and Peters 1998), (5) sending surveyors to track households that move out of the study site (Maluccio, Thomas, and Haddad 1999), (6) sending "personalized persuasion letters" to reluctant participants (Hill 1992), (7) matching participants with interviewers of the same ethnic identity, (8) scheduling interviews so they do not conflict with participants' other activities (Frank et al. 2003), (9) paying participants for the interview and for returning postcards with change of address information, (10) intensive training of staff, and (11) instilling *esprit de corps* among surveyors and pride among respondents for taking part in the study (Giele 2002).

To emphasize the value of respondents' contribution, many panel studies use personal hand-written reminders (Robles, Flaherty, and Day 1994), birthday cards (with address correction requested), frequent telephone calls (Hartsough, Babinski, and Lambert 1996), gifts (e.g., coffee mugs), and reports summarizing research results. The Framingham Heart Study gives participants the results of their medical exams. Gifts and material incentives are typically small, symbolic, and have often come late in the study. The strongest impetus—at least in

developed nations—comes from participants' feeling part of a larger research project, contributing to the public good, and feeling at ease with researchers. We know of no explicit discussion about how to reduce attrition in anthropological studies; it remains for future researchers to determine how well some of the strategies just discussed work in other settings.

Costs

We know of only one study that compares the costs of collecting panel and cross-sectional data (Duncan, Juster, and Morgan 1984). Duncan et al. found that panel studies have lower costs per unit of observation than do cross-sectional studies. But Heckman and Robb (1985) note that Duncan and colleagues do not provide details of how they estimated costs and ignore the extra costs of correcting for non-random attrition, particularly for the costs of finding hard attriters.

Panel studies probably enjoy lower fixed costs for training and recruitment than do cross-sectional studies. Scudder and Colson (2002) argue that long-term fieldwork is inexpensive because equipment can be stored in the field and data collection becomes more efficient with each field trip. Panel studies do incur unique costs in retaining participants and in data documentation and archiving across waves (discussed below). To lower costs of panel studies, researchers in developed nations often collect initial waves of information through personal interviews and then switch to a mix of cheaper survey modes, such as telephone, web, or mail (Dillman 2002, Hauser 2005). Following participants who split from original households, rather than selecting new samples, also lowers the costs of panel studies (Ashenfelter, Deaton, and Solon 1986). On the other hand, the natural growth of the initial cohort and its descendants can increase the costs of collecting panel data if one follows all descendants. Because the Panel Study of Income Dynamics tracked descendants of the initial cohort, its sample size increased from about 5,000 to 8, 700 families, and its costs grew as well. To offset rising costs, the study

does not interview every participant in every round. Rather, subgroups of the sample participate with varying frequency.

Data storage, documentation, and dissemination

Effective documentation, archiving, and dissemination of data are essential to the progress of empirical research (National Research Council 1985, Rockwell and Abeles 1998, Fienberg 1994). The special strengths and challenges of panel data make documentation and dissemination of data particularly important.

First, panel studies are almost always team efforts, often including researchers from different disciplines. Effective collaboration requires clear documentation of design decisions and methods for data collection and analysis. It also increases the need for early development of procedures for data sharing among team members (Fienberg 1994). In anthropology, Vogt (2002:145) notes that fieldworkers in the Chiapas Project agreed to deposit their data in a central archive accessible only to other researchers on the project. Scudder and Colson (2002:206) decided from the beginning to share data from their Gwembe Tonga research with one another. They have now extended the policy to a new generation of team members and are working to provide wider access to their data electronically (Cliggett 2002:247, Scudder and Colson 2002:227).

Second, detailed documentation serves to track consistency and change in surveys or variables and to reconstruct the meaning of data collected in earlier phases of a study. Detailed documentation helps researchers unfamiliar with the original data collection to be able to use the data. Taylor (2000:162) identifies the necessary elements of data documentation for panel studies and warns that "without it, the data are, at best, meaningless, and, at worst, subject to serious misinterpretation." This warning is prescient when reading Lamphere's (2002) account of long-term ethnographic study among the Navajo. She reports difficulties in making sense of "masses

of accumulated data" in the files of Clyde Kluckhohn's Ramah Project: "It was as if the 'key' to the Ramah Files had died with Kluckhohn" (Lamphere 2002:119). Systematic documentation of the background, research design, data structure, and field protocols would have provided an enduring "key" to Kluckhohn's materials for later generations.

Third, panel studies typically generate far more data than project researchers can analyze, making panel data sets potentially valuable to researchers outside of the project. This point is evident in the thousands of publications based on publicly available panel data, such as the Panel Study of Income Dynamics or Add Health (Table 1). The potential for secondary analysis of anthropological material is also clear. Foster (2002:263) reflects on the amount of data he has amassed in Tzintzuntzan and notes that much analysis remains to be done, "almost certainly by someone else." Scudder and Colson (2002:224) comment on the challenges of maintaining—much less analyzing—the enormous database they have created over 50 years of research. Their collaboration with colleagues with expertise in database management and quantitative data analysis demonstrates the value of analysis by third parties (Clark et al. 1995, see also White and Johansen 2005). Other anthropologists have recognized the value of making data available for secondary analysis by others (Silverman and Parezo 1995). For example, data from the 2002-2006 panel of the Tsimane' Amazonian Panel Study are now available from the TAPS website.[7]

There are also obstacles to data documentation and sharing. Although networked computing and the Internet have made it easier for researchers to store and share data electronically, there remain significant costs associated with cleaning, coding, and documenting data for distribution (Rockwell and Abeles 1998). The costs are higher in panel studies because of the need to document changes across waves of data collection and to produce usable summary files with multiple waves of data. It is important to anticipate data documentation and

dissemination in initial budget proposals; costs are higher when no plans are made in advance (Fienberg 1994:3). Funding agencies may regard such expenses as justifiable if it is likely that a community of researchers will benefit from having access to panel data (Rockwell and Abeles 1998). Indeed, many funding agencies explicitly encourage researchers to develop plans to place data in the public domain (U.S. Department of Health and Human Services 2003, National Science Foundation 2003).

Other generic obstacles to data documentation and data sharing, not specific to panel studies, are discussed elsewhere (National Research Council 1985, Corti 2000, Rockwell and Abeles 1998, Fienberg 1994). In most instances, the benefits are likely to outweigh the costs. The benefits of data sharing are so widely recognized in neighboring disciplines that researchers now have many well documented panel data sets to choose from. If anthropologists are to remain competitive for public funding and support, they may want to make their data available so the public can use them. We suggest that anthropologists learn more about data documentation and dissemination practices in neighboring disciplines by seeking out key resources such as the Inter-University Consortium for Political and Social Research and the UK Economic and Social Data Service.

Sustaining a panel study

Because successful panel studies can outlast their founding investigators, they must recruit new leaders. Young, potential leaders may feel that the benefits of collecting panel data accrue only in the long term, while the costs appear early. As a result, young potential leaders face weak incentives to lead a panel study, and might even view such a role as an obstacle to their careers (Entwisle, Alexander, and Olson 2002). Many panel studies have been fortunate to have potential successors in the right place at the right time, but the procedure for recruiting new leaders remains unresolved (Giele 2002).

Anthropologists (Kemper and Royce 2002) and other social scientists (Phelps, Furstenberg, and Colby 2002) attest to the benefits of having taken part in panel studies early in their careers. Cliggett (2005) remarks on how joining an ethnographic project that had been running for 50 years gave her a head start as a graduate student:

> To have all this information—specific villages, a total village census and extensive genealogies, locations of migrants, basic socioeconomic history, and potential research assistants—before arriving in country, let alone in the village, is extremely valuable for a PhD student as she sets about beginning her research (Cliggett 2005:29).

A common theme for new members of long-term panel studies is the need to balance the demands of long-term research with the demands of producing results in the short run. To reap tangible short-run benefits from a panel study, young researchers can treat the early rounds of data as a stand-alone, cross-sectional study (Duncan 2000). For the strategy to work, researchers must be able to admit that their preliminary conclusions may be wrong (Furstenberg 2002, Cahn 20023:26, Cliggett 2002:247).

Another challenge in sustaining panel studies is acquiring adequate funding. Most federal agencies and private foundations finance research projects for no more than five years, after which researchers must apply for new money. The funding cycle requires researchers to seek funding continuously, either from the original funding agency or from new agencies. Researchers doing panel studies try to develop a long-term relation with a primary funding source to provide core, long-term funding support (Mott 2002). Outside of anthropology, many successful panel studies rely on one or a few agencies for core funding (Table 1). Anthropologists more commonly rely on multiple sources. Shifting from funding agency to funding agency, each with its own priority, makes it hard to maintain the focus of a panel study (Hauser 2005). To supplement core funding, panel studies charge third parties for including new questions on some

rounds, use panel data and research sites to offer training, and search for new funding opportunities even if there is only a tenuous link with the goals of the original panel.

Conclusions

Methods for collecting panel data deserve a more central place in the toolkit of cultural anthropology. In the last 50 years, panel data have multiplied across the social, medical, and public-health sciences, yet empirical research in cultural anthropology remains overwhelmingly cross-sectional. The neglect of panel data represents a mismatch between theory and method in cultural anthropology. Long-standing theoretical interest in dynamic cultural processes implies a focus on change within units of observation. Panel data is well suited to advance the empirical foundation of such theoretical concerns.

Panel data have other benefits beyond the study of continuity and change, including increased reliability and accuracy of measurement and the ability to establish temporal order in causal analysis. But panel studies are not a panacea, and in some circumstances, cross-sectional data are just as informative or better. Panel studies are not appropriate when researchers are interested only in describing variables or associations at one point in time, or when they have convincing instrumental variables to infer causality from a cross-sectional sample. Panel data are also unnecessary for estimating aggregate changes over time; repeated cross-sectional data are more appropriate for this aim, as in Zarger and Stepp's (2004) study of community-level change. Last, panel studies are of limited use when the variables of interest do not change much over time. For example, repeated observations from a highly autarkic society with relatively little socioeconomic change will yield little new information beyond what one could obtain in a standard cross-sectional study. Repeated measures of relatively stable variables among adults (e.g., vocabulary, language competence, physical stature) provide another example of the limited use of panel data.

Panel data are appropriate when theory implies a concern for within-individual change. Anthropologists who collect panel data can benefit from the experience of neighboring disciplines in managing the unique challenges of panel data, including how to deal with measurement errors, attrition, continuity, and data archiving and documentation. Since the suggestions we offer for dealing with these challenges are based primarily on panel studies in Europe and the United States, anthropologists should use them as a starting point in assessing what might work in other ethnographic settings.

Increased use of panel data will require a more basic change in the way most cultural anthropologists do research, since a prerequisite for making comparisons over time is that data be collected in the same way at each point in time. Our call for more panel studies thus echoes other calls for formal methods in cultural anthropology (Romney 1989, Aunger 2004, Moles 1977, Moran 1994). Our argument does not threaten the iterative or unstructured nature of conventional ethnography; anthropologists and others have used panel designs in studies that collect rich, qualitative data (Anderson-Fye 2004; Hsu et al. 2002; Mattingly 2008; Wallhagen and Yamamoto-Mitani 2006). However, greater use of panel data in anthropology does entail a need for more systematic and explicit methods to supplement standard practices. What distinguishes longitudinal from long-term research is the ability to make systematic comparisons on the attributes of individuals, households, or villages over time, and such comparisons require greater use of formal methods.

The magnitude and pace of culture change is only likely to accelerate with increasing global interdependence. Anthropologists' ability to track such changes depends on the validity of methods for collecting and analyzing panel data. Moreover, to compete for scarce resources, anthropologists must convince funding agencies and colleagues in other disciplines of our ability

to describe and analyze change. When combined with conventional ethnographic methods, panel data could produce new insights that advance anthropological knowledge and confirm the unique value of an anthropological perspective.

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Notes

1. For each discipline, we searched the SSCI for "(longitudinal or panel) and" the name of that discipline (e.g., anthropology, economics, etc.). The approximate shape of the distribution across disciplines holds after adjusting for the number of total publications in that discipline (data not shown). Our results are also confirmed by searches of other databases, including WorldCat, ArticleFirst, and the WilsonWeb Social Sciences Full Text Index.
2. Searching within these journals identifies many more studies than the 16 journals identified for anthropology, because not all studies are tagged with the keyword "anthropology."
3. Some cultural anthropologists address change and continuity over time by incorporating methods from historical demography into their work (e.g., Brettell 1986; Douglass 1984; Kertzer and Fricke 1997). This important work is complementary to panel studies but beyond the scope of our argument here.
4. For an anthropological example of a two-wave panel study that addressed the causal relations between culture, stress, and health, see Dressler et al. (2007)
5. Steven McNabb and colleagues also used a variant of the Solomon four-group design in the Social Transitions in the North project, which aimed to document the causes and consequences of demographic, epidemiologic, and domestic changes in Alaska and the Russian Far East (Mason 20046).
6. Instrumental variables are also used to reduce biases from omitted variables or reverse causality, but in the discussion here we focus only on the use of instrumental variables to lower biases from measurement errors.
7. For more information, visit the TAPS website (http://people.brandeis.edu/~rgodoy/)

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Table 1. Design features of selected large-scale, longitudinal studies across academic disciplines.

	Gwembe Tonga Research Project	Tzintzuntzan, Mexico	Fels Longitudinal Study	Framingham Heart Study	National Longitudinal Study of Adolescent Health (Add Health)	Panel Study of Income Dynamics (PSID)	Wisconsin Longitudinal Study
Discipline	Anthropology	Anthropology	Public Health, Human Biology	Epidemiology	Sociology, Psychology, Public Health	Economics	Sociology
Principal investigators	Thayer Scudder, Elizabeth Colson	George M. Foster, Robert V. Kemper, Stanley Brandes, Peter Cahn	Roger M. Siervogel	Daniel Levy, Philip A. Wolf	J. Richard Udry	Frank P. Stafford, Robert F. Schoeni	Robert M. Hauser
Institutional affiliation	Cal Tech, UC-Berkeley	UC-Berkeley, Southern Methodist U	Wright State U	National Heart, Lung, and Blood Institute, Boston U	U North Carolina-Chapel Hill	U Michigan	U Wisconsin-Madison
Years covered	1956-present	1945-present	1929-present	1948-present	1994-present	1968-present	1957-present
Original target population	Gwembe Tonga, Zambia	mestizo-*Purépecha*, Lake Pátzcuaro region	SW Ohio children	Framingham, MA adults age 30-62	U.S. adolesents grades 7-12 in 1994	U.S. adult population	Wisconsin high school graduates in 1957

Table 1. Continued.

Sample design	Census	Census	Purposive; track offspring; continue to recruit	Purposive; track offspring	Probability; track sample's parents, administrators, peers, friends, and romantic partners	Probability; track all members of sampled family units over time	Probability; track parents, siblings, spouses, widows
Sample size	10,000[a]	5,213[b]; original population =1,231; current population = 3,610 plus >2,000 emigrants and their descendants	4,970[c]	Original cohort: 5,209; Offspring cohort: 5,124 Generation III being recruited: goal of 3,500	Wave I: 20,745 adolescents, 17,700 parents; Wave II: 14,738 adolescents; Wave II: 15,197 young adults	Original design: 3,000; data for > 65,000 individuals by 2003	10,317
Units of analysis	Village, family, individual	Village, household, family, individual	Individual	Individual, family	Individual, family, school, neighborhood	Individual, family	Individual

Table 1. Continued.

Periodicity and mode of data collection	Major fieldwork in 1956-57, 1962-63, 1972-73, 1981-82 1987-88, 1992, 1994-96, 1997, 1998; ethnographic census updated continuously in some villages; subprojects at irregular intervals	Ethnographic censuses in 1945, 1960, 1970, 1980, 1990, 2000; biennial household surveys 1974-present; subprojects at irregular intervals	5 exams from birth to 1 year; semiannual exams from age 5 through puberty; annual to age 20; biennally after 21	Regular exams every 2 years	Waves I and II surveys, 1994-96 Wave III, 2001-02	Annual survey interviews 1968-97; biennial interviews 1997-present	Surveys with original cohort or parents in 1957, 1964, 1975, 1992; selected siblings in 1997, 1994; original cohort, siblings, spouses, widows 2003-04
Core content of panel data	Demographic data; for some years: education, residence, labor migration, economic indicators	Demographic data, socioeconomic data, parish church archival data (late 1700s-present); civil registry data, (1930-1990s)	Demographic data, health history, physical activity, smoking, alcohol, maturity, mentruation, anthropometry, body composition, blood pressure	Demographic data, health history, extensive physical exam, laboratory tests	Demographic data; health-related behaviors; social relationships; family, school, community contexts; anthropometry; biomarkers	Demographic data, economic indicators, family structure, housing, labor market work, housework time, geographic mobility, health	Demographic data, youthful aspirations, schooling, family formation, work history, social participation, residence, mental ability, health

Table 1. Continued.

Funding agencies	Institute for African Studies at U Zambia, SSRC/ACLS, NSF, John Simon Guggehnheim Mem, MacArthur, Fulbright, Cal Tech, UC-Berkeley	Institute of Social Anthropology, Smithsonian Institution, NSF, NIGMS, Wenner-Gren Foundation; Fulbright, UC-Berkeley, SMU	Fels Fund of Philadelphia, NIH, NSF	NHLBI	NICHD plus 17 other federal agencies	OEO, NSF, NICHD, NIA, HHS, HUD.	NIMH, NIA, Soc Security Admin, UW-Madison, Russell Sage, NSF, MacArthur, Spencer, and other foundations
Number of publications	>200	>100	>1,500	> 1,200	> 1,000	> 2,000	> 160
Data publicly available?	No	In process	No	Yes, with approved proposal	Yes	Yes	Yes

[a]Approximate total population as of 1992 (Clark et al. 1995:95). [b]Master database as of 2000 (see Tzintzuntzan documentation site: http://eclectic.ss.uci.edu/~drwhite/tzintzun/TziDocumentation.htm). [c]Total database, including 4,099 living participants as of 2003 (Remsberg and Siervogel 2003:250) NHBLI = National Heart, Lung, and Blood Institute, NIA = National Institute on Aging, NICHD = National Institute of Child Health and Development, NIH = National Institutes of Health; NIMH = National Institute of Mental Health, NSF = National Science Foundation; OEO = Office of Economic Opportunity in U.S. Dept. of Commerce, SSRC/ACLS = Social Science Research Council/American Council of Learned Societies, HHS = U.S. Dept. of Health and Human Services, HUD = U.S. Dept. of Housing and Urban Development.

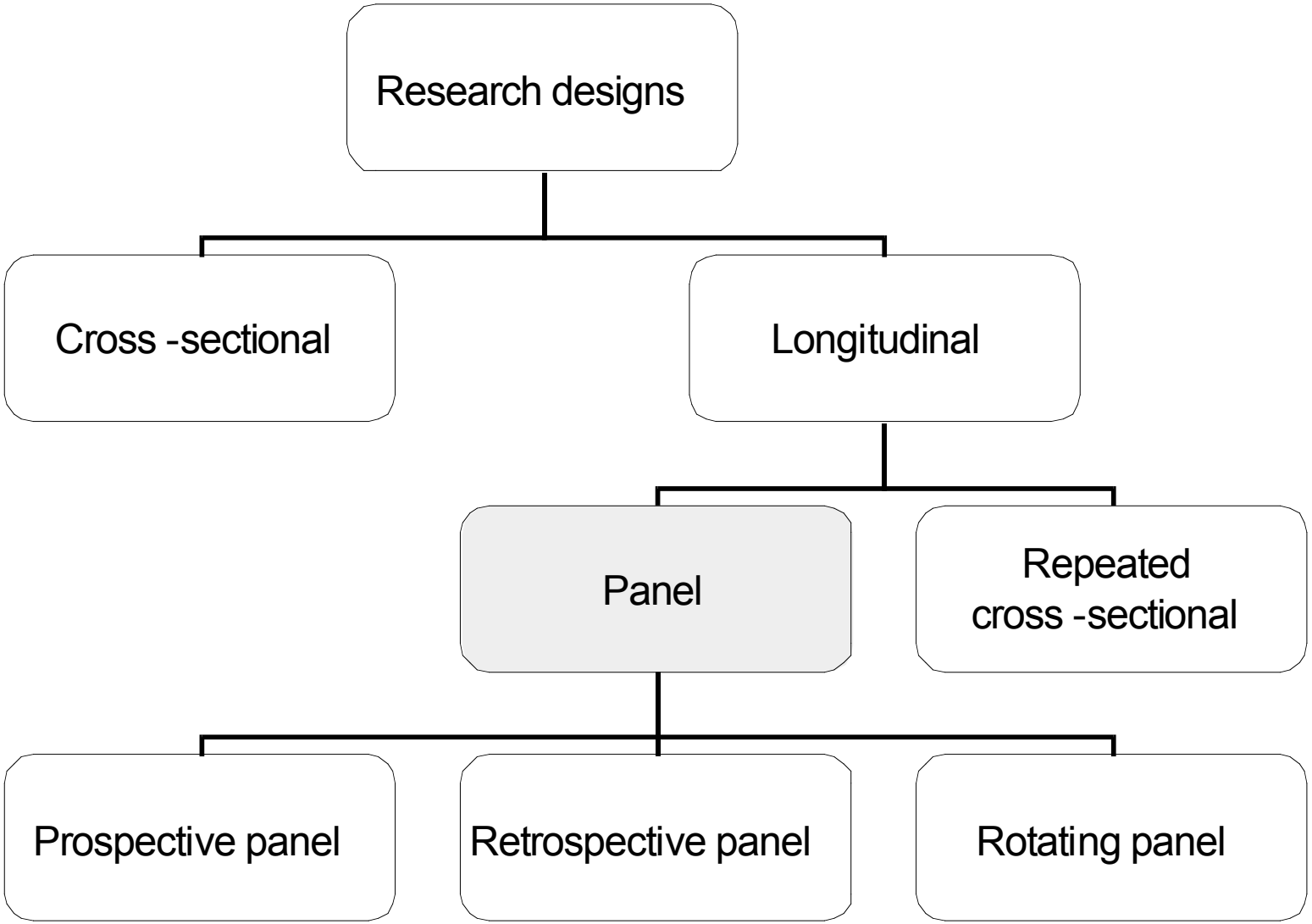

Figure 1. Cross-sectional and longitudinal research designs.

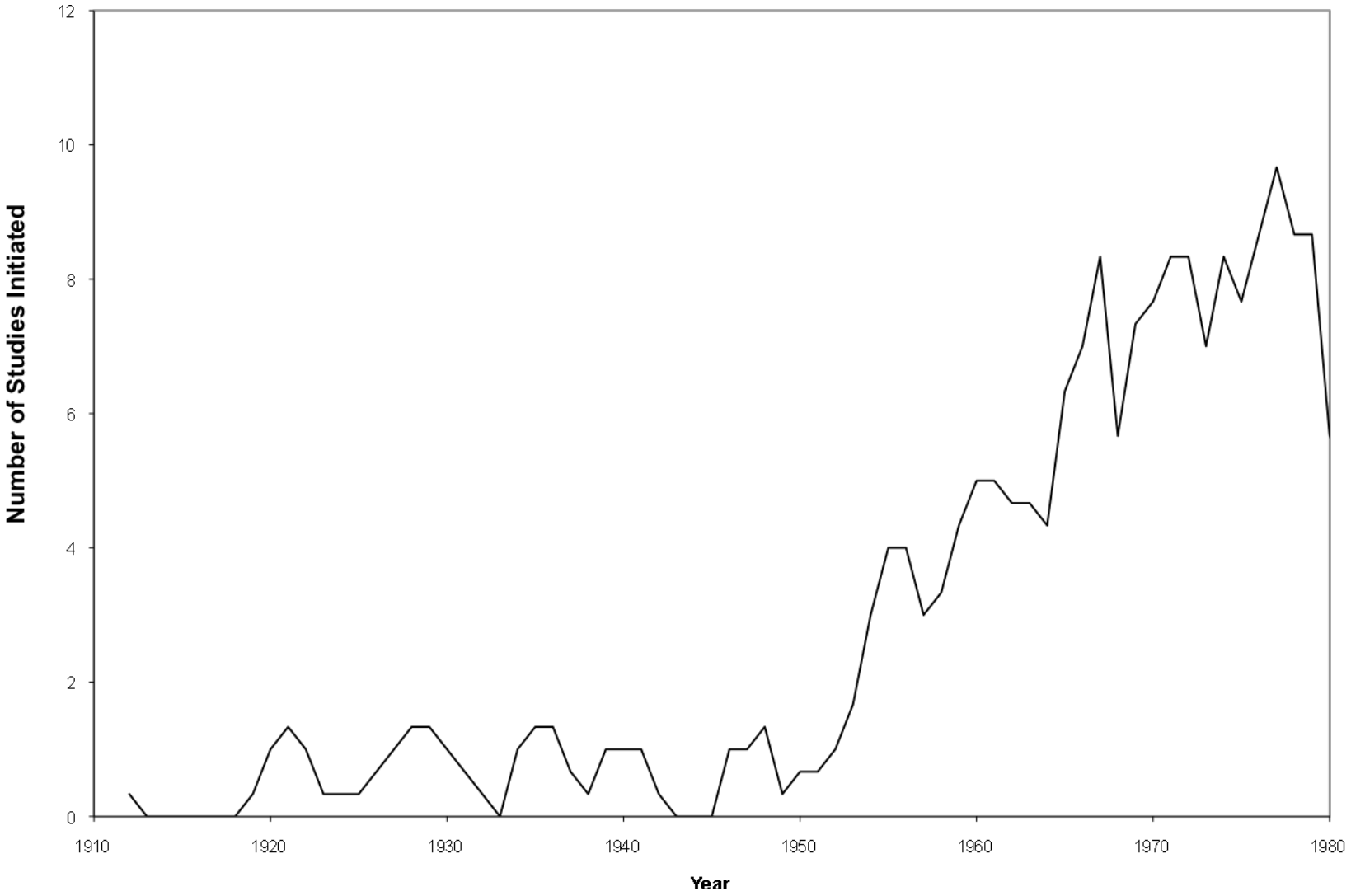

Figure 2. Number of studies in the *Inventory of Longitudinal Studies in the Social Sciences*, 1911-1980 (three-year moving average). Data from Young et al. (1991).

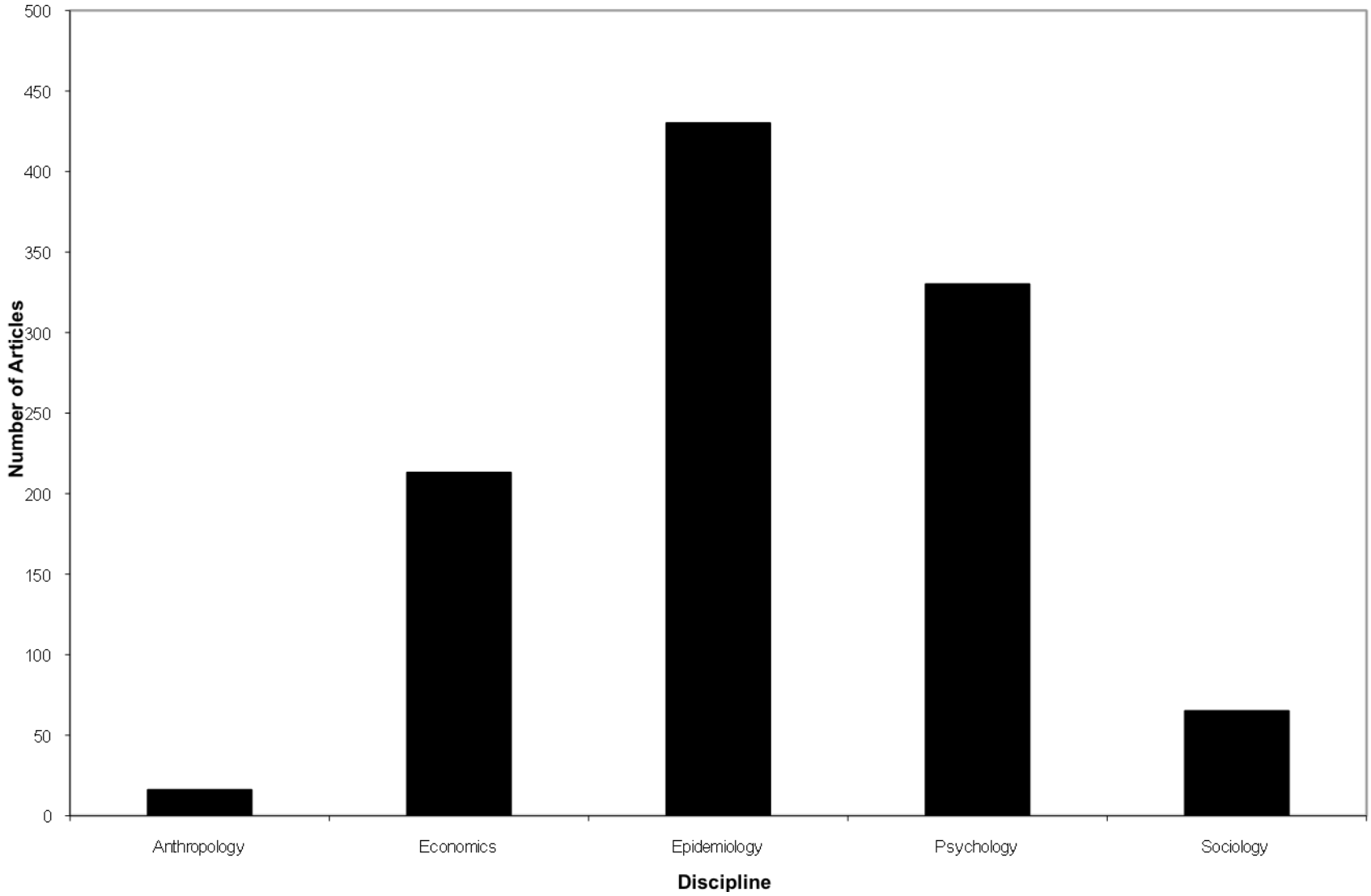

Figure 3. Frequency of longitudinal studies in the Social Science Citation Index by discipline, 1990-2003

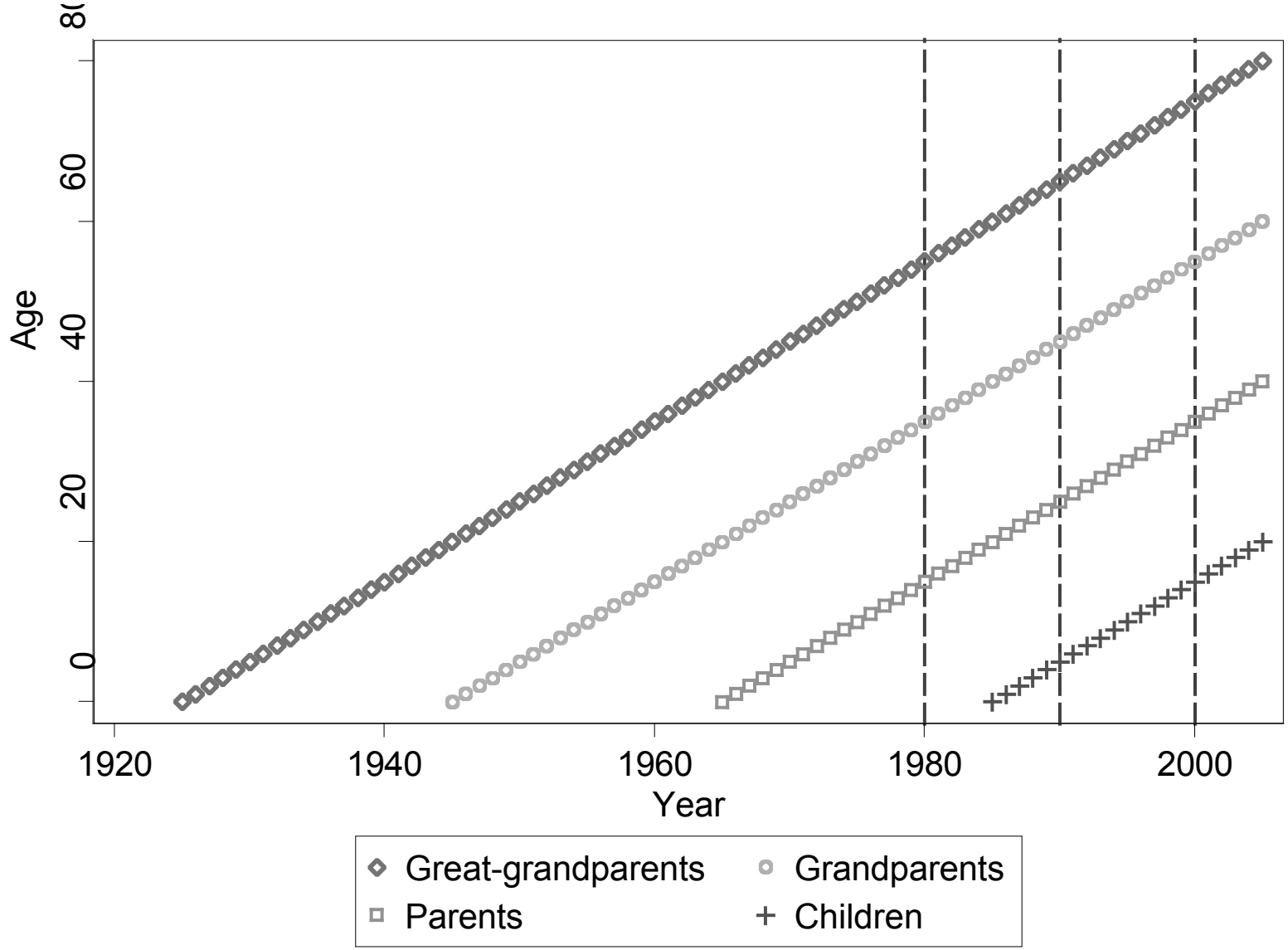

Figure 4. Lexis diagram of age, period (year) and cohort effects. Dashed lines represent hypothetical times of data collection.