CHAPTER 15

The Life Event Calendar Method in Criminological Research

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The life events calendar (LEC), used in a number of fields for collecting retrospective data on one or more aspects of individuals' lives, has been variously referred to as the "life history calendar," "event history calendar," "life chart interview," "calendar method," "calendar interviewing," and "timeline followback" method. Regardless of the name, the method capitalizes on what is known about the storage of autobiographical memory and involves entering key time markers on a calendar in order to facilitate the recall of events and life circumstances.

With increased use of the LEC across a variety of disciplines, more attention has been focused on this method and on the quality of data resulting from its use. Early reviews of the method and its utility were provided by Freedman et al. (1988) and by Caspi et al. (1996). More recently, Belli and colleagues have written extensively about the method's theoretical foundations and have conducted important research comparing the LEC to more traditional methodological approaches (Belli 1998; Belli et al. 2001, 2007, 2009).

In this chapter, we update information on the LEC methodology and its utility while focusing on applications in criminology. We start by describing the theoretical underpinnings of the LEC methodology, and then we elaborate on the varied ways calendars are employed by providing detailed criminological examples. We then move to a discussion of practical design and implementation issues, following with a review of studies on the quality of calendar data. Finally, we discuss future directions for LEC research.

THEORETICAL UNDERPINNINGS OF THE LEC

In all of its various forms, the LEC facilitates recall through processes that capitalize on the sequential and hierarchical storage of memory (Caspi et al. 1996; Belli 1998). Sequential storage was emphasized by Bradburn et al. (1987), who used the term "autobiographical sequences" to refer to linked sets of events that are remembered together. They gave the example of a person remembering a visit to the dentist "as part of an extended temporal-causal unit beginning with a toothache, continuing with an initial appointment, and finishing with the last of a series of dental visits (p. 158)."

Other theorists (Barsalou 1988; Brewer 1986; Conway 1996; Linton 1986) have emphasized the hierarchical structure of stored memories. Belli (1998) summarized this literature, describing three types of hierarchically organized memories. At the top of the hierarchy are extended events – those that last for relatively long periods of time, have distinctive starting and stopping points, and are relatively easily remembered. Extended events typically represent some phase of a person's life, such as a first marriage, working in a particular factory, or serving a prison sentence. These events tend to be the basic building blocks for organizing memory, and they serve as useful cues for events lower in the hierarchy. In the middle of the hierarchy are summarized events, which have common themes and last for time periods generally shorter than those occupied by extended events. These might include periods of hanging out regularly in bars or using drugs heavily. At the bottom of the hierarchy are specific events, such as burglaries, domestic violence victimizations, or arrests, that can be pinpointed to short, distinctive time periods.

In facilitating recall, the LEC method capitalizes on the structure of memory storage in three distinct ways (Barsalou 1988; Belli 1998; Caspi et al. 1996; Conway 1996). First, in order to tap into memories stored in autobiographical sequences, interviewers use sequential cuing, generally by tracking a particular domain for the entire calendar period before moving to another domain. For example, by entering all residences for the calendar period, an interviewer takes advantage of a respondent's memory of a sequence of moves (such as moving from the apartment on Main Street where the respondent lived with friends to the house on Fifth Avenue, where he moved in with a romantic partner). The interviewer might then proceed to the domain of employment, where the respondent might rely on linked memories to report that he moved from the assembly line job to a supervisor's position, and so on.

Second, parallel cuing encourages respondents to tap into cross-domain associations. A respondent who is struggling to remember precisely when he started a particular job can be prompted by asking whether the job coincided with residence X or Y, or relationship X or Y. Finally, top-down cuing capitalizes on the hierarchical structure of memory by using the extended events at the top of the hierarchy to cue the recall for summarized events and specific events that are nested within those broader life periods. Thinking about a period when living with friends, for example, can help a respondent remember periods in which he was going out to bars several nights a week. These memories, in turn, can facilitate the memory of specific events, such as bar fights, that occurred during that time.

Through all these cuing processes the LEC "contextualizes events by connecting them to other events; less-easily remembered events may then be more reliably recalled when connected to other more memorable life events" (Caspi et al. 1996, p. 104). These more memorable events have been referred to as time markers or cognitive "landmarks" (Loftus and Marburger 1983; Belli 1998) in the storage of memories. A blank calendar can provide dates that frame a reference period, but research has shown the importance of salient events and life circumstances in improving recall. A classic study by Loftus and Marburger (1983) found that survey respondents given time markers as cues (e.g., "Since the first major eruption of Mt. St. Helens, has anyone beaten you up?") were less likely to telescope forward their recall of victimizations compared to survey respondents in the traditional condition (e.g., "In the past 6 months, did anyone beat you up?").

VARIETIES OF LEC APPLICATION

In some studies, the LEC has been used primarily as a visual cue to frame a reference period and enhance the recall of events or behavior elicited through traditional survey questions. In the RAND Second Inmate Survey (Peterson et al. 1982), for example, a calendar was used to frame the 24-month period for which researchers wanted to measure the rates of criminal offending. In group administered surveys, prison inmates were instructed to mark pre-printed calendars to show the months during which they were "on the street" before their most recent incarceration. They were then asked a series of questions about their life circumstances during the reference period, including where and with whom they were living. Although these circumstances were not entered on the calendar, their recall was intended to help respondents answer questions about the number of crimes committed during the reference period.

In most criminological applications, the LEC has been used as a tool for collecting time-based data as well as a tool for stimulating memory. As Schubert et al. (2004) observed regarding juvenile offenders, collecting time-based data is challenging because their "lives often are chaotic and unstable, with frequent changes in residence, education, employment, and interpersonal relationships" (p. 7). These problems apply widely to the subjects of criminological research, and they make the use of the LEC appealing.

LEC designs for collecting time-based data have ranged from the simplest paper calendars with check lists of a few basic life circumstances to complex computerized calendars designed to chart numerous domains in great detail. The calendars have been designed to address recall periods that are relatively short (e.g., 6 months) while others span entire lifetimes. They have been used to collect data on specific incidents, key life transitions, and spells of continuing activities. Here, we describe several versions of the LEC that have been used to collect time-based data of interest to criminologists.

Simple Checklist Calendar

In one of the simplest applications of the LEC, Horney and Marshall (1991, 1992), in a methodological elaboration of the RAND study with Nebraska inmates, used two paper calendars with basic checklists to collect monthly data on life circumstances and on offending (see crime calendar in Fig. 15.1). Interviewers questioned respondents about their lives and their criminal involvement for a period preceding their most recent arrest and placed checks on the calendar to capture the timing of these circumstances. The data were analyzed to study the correspondence between local life circumstances and criminal involvement (e.g., offending during periods of living with a wife) over a period between 25 and 36 months (Horney et al. 1995). Versions of these simple calendars were later used to study male and female probationers (MacKenzie and Li 2002; Li and MacKenzie 2003) and female jail inmates (Griffin and Armstrong 2003; Armstrong and Griffin 2007).

Grid Calendar with Multiple Domains

Whereas the LEC applications described earlier involved one-time surveys, the LEC has also been used in conjunction with prospective longitudinal studies in order to provide a more complete account of the time between the waves of data collection. In their New Zealand birth

Survey Number: _____

Year: _____

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Burglary	0	0	0							0	0	0
Rob-Bus.												
Rob-Per.												
Theft												
Car theft												
Forgery												
Fraud												
Drugs	1	1	1							3	3	3

Year: _____

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Burglary	1	1	1	1	1	1	1	1	2	2	2	2
Rob-Bus.												
Rob-Per.												
Theft												
Car theft												
Forgery												
Fraud												
Drugs	1	1	1	1	2	2	2	2	2	0		0

Year Arrested: _____

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Burglary	2	2	3	3	3							
Rob-Bus.												
Rob-Per.												
Theft												
Car theft												
Forgery												
Fraud												
Drugs	1	1	1	1	1							

Arrested

FIGURE 15.1. "Checklist Crime Calendar," originally published in Horney and Marshall (1991: Fig. 3).

cohort study, Caspi, et al. (1996) used a more elaborate paper LEC to provide continuous, monthly data about residential patterns, spouses and partners, children, education, work, arrests, incarceration, victimization, disability, and deaths for the period that had elapsed since their 21-year-old respondents had last been interviewed. They noted that the LEC allows for the collection of "continuous rather than static information about life events" in contrast with longitudinal studies that typically "yield only sequential snapshots of individual lives" because they fail to ask about conditions during the times between assessment periods (p. 102).

Figure 15.2 shows the Caspi et al. calendar covering a 5-year period, along with their techniques for marking events and the duration of life circumstances. In recording with whom the respondent was living, for example, the interviewer marked an X in the month in which the respondent began living with a partner, drew a line through succeeding months in which the cohabitation continued, and then entered another X for the final month in which the respondent lived with that partner. This method provides a strong visual image for the respondent that establishes contextual cues for the questions that follow.

Computerized Calendars

The paper calendars described earlier rely on a grid format that allows recording events in a number of domains. With either larger numbers of domains or more detail within domains, a paper calendar quickly becomes cumbersome. In a second Nebraska inmate study, Horney (2001) used a computerized LEC programmed with Microsoft Access that facilitated the retrospective collection of highly detailed monthly data on numerous domains including: incarceration and correctional supervision, residence, employment, income, school, military service, living relationships, intimate partnerships, gang membership, routine leisure activities, stress, gun possession and carrying, alcohol and substance use, and criminal involvement. The calendar was also used to record violent and avoided violent events in which the respondent was involved. A version of this calendar has also been used with prison inmates in Ohio (Bellair and Sutton 2006).[1]

As seen in Figs. 15.3 and 15.4, the computerized calendar forms described by Horney (2001) were limited to specific life domains (employment forms shown here). The interviewer began the time-based data collection for each domain by eliciting information about the last month on the calendar (Fig. 15.3). If the respondent reported any changes during the preceding months of the reference period, the second screen (Fig. 15.4) appeared and, working backwards, the interviewer entered all employment sequences. In Fig. 15.4, the first 16 of the 36 calendar months are shown. It can be seen that the respondent worked 40 h a week as a welder (a job to which he was committed) for the first 5 months, at which point he was

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[1] In the interest of facilitating the collection of data on the situational aspects of violence, the National Consortium on Violence Research (NCOVR) funded three projects to adapt the Nebraska computerized calendar for use in new data collection efforts. One project focused on validation of the calendar method with a group of mental patients with a history of violence (Roberts et al. 2005). In a second project the calendar developed for male inmates was adapted for use in the Women's Experience of Violence (WEV) study (Principal investigators Julie Horney, Rosemary Gartner, Candace Krutschnitt, and Sally Simpson), in which jailed women in three cities were interviewed. In the third NCOVR-funded project, an adaptation of the calendar was used by Richard Trembley and his colleagues in The Quebec Longitudinal Study of Kindergarten Children (QLAKC) when their respondents were age 20 in order to capture details about respondents' lives for the 5-year period since the previous wave of data collection.

FIGURE 15.2. "Grid Calendar with Multiple Domains," originally published in Caspi, et al. (1996: Fig. 1).

FIGURE 15.3. "'Last Month' Employment Questions, Computerized Calendar".

dismissed from his job (code 3 for "why left"). In the sixth month, he started working 40 h a week on a road construction job to which he had little commitment. He continued working on roads through month 14, when he was laid off (code 2 for "why left"). In month 15, the respondent again obtained work as a welder (along with another unspecified job) but for fewer hours, and was again committed to the job. The computerized calendar format allowed a similar level of detail to be recorded for each of the domains of life circumstances, but it did not provide a visual calendar display with multiple domains. In order to provide visual cues, interviewers entered particularly salient information on a paper calendar that was placed before the respondents throughout the interview. Respondents were also encouraged to use it to make any notes they thought would be helpful.

A different design was used in creating a computerized calendar for the *Pathways to Desistance* study of juvenile offenders in Philadelphia and Phoenix (Schubert et al. 2004). In this study, interviews were conducted every 6 months during the first 3 years of the study and then yearly for the fourth through seventh year of the study. As can be seen in Fig. 15.5, which shows the screen for recording data on schooling, this LEC format differs considerably from the calendar used by Horney (2001). Across the top of the screen are a series of tabs corresponding to the different life domains included in their study, arrayed so that the interviewer can easily move from one to the other. Above the spaces for entering school data, information already gathered on major life events and respondent's residence is displayed to facilitate recall for the questions about schooling. The format allows for visual calendar cues to be present throughout the collection of extensive details of the respondents' lives.

☐ job end	**1**	☐ job end	**2**
# Jobs 1	**Job Type** welder	**# Jobs** 1	**Job Type** welder
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**3**	☐ job end	**4**
# Jobs 1	**Job Type** welder	**# Jobs** 1	**Job Type** welder
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☑ job end	**5**	☐ job end	**6**
# Jobs 1	**Job Type** welder	**# Jobs** 1	**Job Type** roads
Hours/wk 40	**Why left** 3	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**7**	☐ job end	**8**
# Jobs 1	**Job Type** roads	**# Jobs** 1	**Job Type** roads
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**9**	☐ job end	**10**
# Jobs 1	**Job Type** roads	**# Jobs** 1	**Job Type** roads
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**11**	☐ job end	**12**
# Jobs 1	**Job Type** roads	**# Jobs** 1	**Job Type** roads
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**13**	☐ job end	**14**
# Jobs 1	**Job Type** roads	**# Jobs** 1	**Job Type** roads
Hours/wk 40	**Why left** 0	**Hours/wk** 40	**Why left** 2
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

☐ job end	**15**	☐ job end	**16**
# Jobs 2	**Job Type** welder	**# Jobs** 2	**Job Type** welder
Hours/wk 20	**Why left** 0	**Hours/wk** 20	**Why left** 0
Just a job 1 2 3 4 5	**A job I was very committed to**	**Just a job** 1 2 3 4 5	**A job I was very committed to**

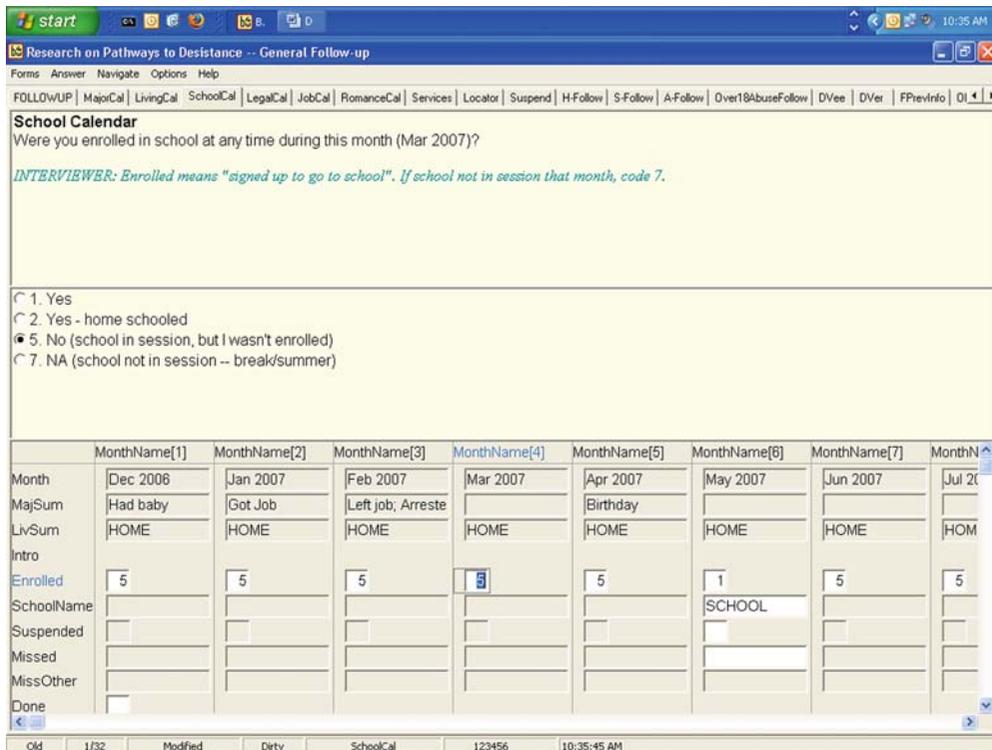FIGURE 15.4. "Computerized Employment Calendar".

FIGURE 15.5. "Computerized School Calendar".

Lifetime Calendars

Although most of the criminological applications of the LEC have used the technique to collect time-based data for a relatively short recall period, others have employed the LEC in order to obtain lifetime accounts of the life events of interest. For example, Yoshihama and her colleagues (see Yoshihama et al. 2002, 2006; Yoshihama 2009) have used the LEC methodology to facilitate women's recall of lifetime experience of intimate partner violence (IPV). Yoshihama (2009) explained how the study of IPV is especially challenging methodologically:

> Because an intimate partner has ongoing access to the woman, IPV is often recurrent and can last for a considerable portion of the woman's life. Recurrence can be episodic (with varying interval lengths) or ongoing (e.g., every day or week). It is also possible (and quite common) that a woman is abused by more than one partner at different periods over her life course. (p. 136)

The LEC is well suited to facilitating the recall and structuring the recording of such complex data. In addition, as Yoshihama et al. (2002) observed, the very events that are expected to serve as effective memory cues are also likely to be correlated with IPV and women's health. Thus the "method by design obtains information on the occurrence and timing of not only domestic violence but also events that affect the relationship between domestic violence and women's well-being" (p. 301).

Whereas Yoshihama and colleagues focused on domestic violence, Wittebrood and Nieuwbeerta (2000) studied lifetime occurrences of a number of categories of victimization.

They analyzed data collected with the LEC method in face-to-face interviews with a nationally representative sample of 1,939 Dutch respondents in order to determine the impact of prior victimization on later victimization risk, controlling for patterns in other life circumstances. They suggested that the use of the life history approach could "provide powerful insights into the causal process behind criminal victimization" (p. 117).

Timeline Followback Methods

In contrast to calendars used to measure events over a lifetime, a version of LEC methodology developed to measure alcohol use focuses on daily changes in behavior. This method has been referred to as the timeline followback (TLFB) method (see Sobell and Sobell 1992, for an overview of the approach). The TLFB method uses days as the time units for measuring a specific behavior of interest over relatively brief reference periods. In addition to its use to measure drinking behavior, the method has also been used to collect self-reports on drug use (Agrawal et al. 2008; Fals-Stewart et al. 2000), gambling (Weinstock et al. 2004), smoking (Brown et al. 1998), and domestic violence (Fals-Stewart et al. 2003). Although space limitations preclude our thoroughly reviewing the TLFB, researchers who are interested in measuring behavior at this more micro level should be aware of the extensive literature on the topic.

DESIGN AND IMPLEMENTATION ISSUES

In describing the varied approaches to the LEC in criminological studies, we touched on differences in calendar design and differences in how interviewers use the LEC. Here, we discuss in more detail a number of practical design and implementation issues that researchers need to address when planning an LEC study.

Time Units and Reference Periods

In order to use the LEC to collect time-based data, researchers must determine the length of both the time unit of measurement and the overall reference period for the study. We have described studies with reference periods as brief as 2 months to studies of entire lifetimes, with time units ranging from 1 day to 1 year. The choice of both reference period and time unit obviously depend on the purpose of the research. As Caspi et al. (1996) observed, one important consideration is "whether the designated time unit is fine-grained enough to measure with precision the sequence and interrelation of different events" (p. 107). A common problem in prospective longitudinal studies has been the inability to sort out the sequences of events, such as onset of alcohol consumption and delinquent activity, when surveys at fairly widely spaced intervals have simply asked whether each occurred during the period since the last interview. Because a major goal of using the LEC is to establish accurate sequencing of events, the choice must consider how quickly the events and transitions of interest are believed to occur.

The length of reference periods and time units will generally be inversely related. With time units as long as a year, data might be collected for periods as long as a lifetime, whereas

with daily or monthly accounts there will be serious limits on the period of time for which such detailed memory will be reliable. Little research has addressed the question of how data quality is affected by choice of either the time unit of measurement or the entire reference period in calendar research. We see a need for much more research on both topics in order to determine the limits of human memory when using the LEC to collect retrospective data.

Split Time Units

Regardless of the particular time unit chosen for a study, researchers must make decisions about how to classify a time unit that is "split." For example, presume the calendar month is the time unit. If a respondent reports living in jail *and* living out on the street in a particular month, how is this coded? Researchers could mark the month as being split or they could mark the month according to where the subject spent the majority of the month. These kinds of decisions will likely be driven by the research question at hand but should be thought through during the planning stage.

Time Markers

Most researchers using the LEC start by entering extended events such as where the respondent was living and with whom, and whether and where the respondent was working, as well as easily remembered specific events, such as marriages and births of children. For criminologists, periods of incarceration are often among the first entries on the LEC. All of these time markers can then serve as anchoring points to stimulate memory and to help pinpoint dates of less salient events (Belli 1998).

Some researchers have used "respondent-generated landmarks" (Yoshihama 2009) to facilitate recall. With this technique, in addition to the structured questions about standard life circumstances that are asked, respondents are asked to report significant events that have occurred in their lives during the reference period (Yoshihama 2009). Events such as hospitalizations, special awards, or deaths of loved ones might be entered on the calendar. In our pre-tests with groups of male prison inmates, one respondent suggested that we should ask for information on what cars respondents were driving at different times throughout the reference period because this would help the men to recall other events.

Some studies have shown such personal events to be more effective in cuing recall than public events (e.g., presidential elections), because memory for public events is poorer in terms of occurrence, detail, and timing (see for example, Rubin and Kozin 1984; Shum 1998). However, contrary results were found by Axinn et al. (1999), who used preliminary interviews with members of their study population to identify public events of particular salience. In their study of families in south-central Nepal, the first democratic election held in Nepal and a major earthquake that had occurred in the area served as notable cognitive landmarks for most respondents, stimulating recall of the personal events of interest. Public events that are effective as time markers may be generated by individual respondents when using an approach like that reported by Yoshihama (2009), but then these markers could not be pre-printed on calendars. The approach used by Axinn et al. (1999) would probably be most useful when researchers want to establish the same historical reference period for all respondents.

Yoshihama (2009) has provided interesting data on the relative utility of different time markers for enhancing recall. She asked respondents to rate how helpful events in other domains were to them in recalling their experiences with intimate partner violence. Respondents gave higher ratings to residence, partner names or initials, and respondent-generated landmarks. We believe it would be fruitful to expand this line of research by explicitly examining the relative effectiveness of different kinds of time markers in improving the validity of retrospective data gathered with the LEC. Such research may need to be specific to particular populations of interest.

Moving Through the Calendar

As noted earlier, in collecting time-based data, interviewers typically inquire about one calendar domain at a time in order to focus on the streams of events and tap into the sequential storage of memories. However, different approaches have been taken to move through time within a particular domain. Caspi, et al. (1996, p. 109) report moving forward from the beginning of the calendar period to the end. Thus, they started collecting residential data by saying to the respondent "To start with, please tell me each of the places you have lived since your 15th birthday and how long you lived there. Where were you living when you turned 15?" After recording the initial information, the interviewer would ask "Until what date did you live at that same address?" followed by "Then where did you live?"

In the Horney (2001) study of incarcerated offenders, the interviewer always started with the last month on the calendar (the month of the arrest that led to the respondent's incarceration). As shown in Fig. 15.3, a number of questions were asked about employment in the last month. As responses were keyed in for each variable, the program automatically entered the values in a data table for the last calendar month and all preceding months. Next, the interviewer asked if any features of employment had changed during the calendar period. If the respondent answered "yes," the program went to the calendar screen (Fig. 15.4), and the interviewer asked him to indicate the most recent preceding month in which there had been a change. The change was then entered and that value was back-filled for all preceding months. This process of entering changes continued until data were entered for every month on the calendar.

We are unaware of any research directly comparing the different approaches to moving through the LEC, but Bradburn et al. (1987) report that "experiments on autobiographical memory show that people achieve better levels of recall if they are required to begin with the most recent item in a series and work backward than if they must begin at the beginning" (p. 210). Belli et al. (2001) have proposed that interviewers should consider respondents' preferences for moving through time, perhaps using different approaches for different domains. They consider such flexibility an important feature of the LEC.

Paper versus Computerized Calendar

The choice of whether to employ a paper or a computerized calendar depends on the purpose of the calendar and on its complexity. If the LEC is intended primarily as an aid to recall, the paper calendar with checklists or with blank space for entry of salient life circumstances is easy to construct and use. The key concern is to have the entire calendar period laid out in a format that makes it a strong visual cue for the respondent. If the calendar is to be used

for the collection of time-based data, the choice of paper or computer calendar will depend on both the breadth and detail of the questions to be asked as well as on the length of the reference period. A paper calendar can quickly become unwieldy when many time units are involved or when the domains of life circumstances of interest include many categories and sub-categories.

With complex data collection, the computerized calendar has a number of advantages:

1. Electronic entry of data. When data are entered on a paper calendar, an extra step is needed for entering the data into an electronic database in order to make them available for analysis. This step can be costly and also introduces another stage at which errors can be made. With a computerized calendar, the extra step and additional errors are avoided as the program can be directly linked to a database. Data can be immediately transferred from the laptops of interviewers to centralized databases, and in some multi-site studies, this has facilitated the sharing of data across sites, allowing for "ongoing monitoring of the psychometric properties of the measures, identification of inconsistencies or problems with the data, and detection of study-wide and site-specific trends in the data as they emerge" (Schubert et al. 2004, p. 7).

2. Automatic cross-referencing. Computerized calendars can be programmed to check for consistency in answers and raise flags for the interviewer. As Schubert et al. (2004) noted, cross-referencing can allow for "identification of significant status changes (e.g., whether the person who is identified as having raised the adolescent in the current interview is the same person named in prior sections or interviews)" and "(E)rror messages can be built in to alert the interviewer to these inconsistencies" (p. 7).

3. Facilitation of skip patterns and accurate interviewing. Computerized calendars can be programmed to make it easy for an interviewer to follow complex skip patterns in questioning. In an inmate survey, for example, once a respondent has identified months of incarceration in the reference period, the program can automatically enter a "not applicable" code for those months for irrelevant questions (e.g., whether the respondent was living with wife or children). Certain computer forms can be skipped altogether when answers to screen questions make them irrelevant. For example, if a respondent reports that he did not possess any guns in a particular month, the screen asking about the types of guns and how they were obtained would not appear.

4. Visual interest. Although both paper and computerized calendars are intended to provide visual cues that aid in recall, a computerized calendar can be programmed to make it visually interesting and even entertaining. In very long interviews, screens that change in appearance and different visual formats keyed to different kinds of questions can help in motivating respondents to remain attentive.

Schubert et al. (2004) point out that one potential disadvantage of computerized calendars is that "a major investment must be made in programming and software testing before data collection can begin" (p. 7). However, they report reducing development time by using commercially available software for constructing interviews. In their *Pathways to Desistance* study, Mulvey and colleagues tried several software packages before settling on Blaise software (Mulvey, personal communication, October 15, 2008). Some of the software they initially tried would not support their calendar instrument because of its size. The Microsoft Access program developed by Horney (2001) has been used by a number of other researchers who have adapted it to their own needs, but at least some minimal programming costs have been involved. As more computerized calendars come into use, the initial programming costs are likely to be substantially reduced.

A second disadvantage of computerized calendars is that it is more difficult to display the entire calendar so that the respondent has constant visual cues for time markers that have been entered. As shown earlier in Fig. 15.5, however, the calendar developed for the *Pathways to Desistance* project (Schubert et al. 2004) provides a display of some basic time markers on every screen. Horney (2001) dealt with this problem by entering key information on a paper calendar that was placed before the respondent throughout the interview.

Working Together on a Complex Task

The completion of the LEC can seem a daunting task. In our experience, respondents are at first skeptical that they will be able to remember the details and timing of their life circumstances but are usually surprised at how well the technique helps them to construct the past. We found by accident, during pre-testing our instrument, that having the interviewer and respondent sit side-by-side viewing the computer screen is a very good arrangement (Horney 2001). Schubert et al. (2004) and Caspi et al. (1996) also report using the side-by-side approach. We believe this arrangement, whether used in conjunction with a paper or a computerized calendar, accomplishes several things:

1. It creates a sense of two people working together to solve a complex puzzle, which provides additional motivation to the respondent. We found that respondents frequently asked the interviewer to go back and make changes when they realized that they had made mistakes, such as having been wrong about the month in which an event occurred.
2. It fosters a sense of trust in the interviewer. Instead of sitting across the table from an interviewer and wondering what he or she is actually writing down, the respondent sees all the information that is entered into the computer or onto the paper calendar.
3. It reinforces the assurances of confidentiality. The respondent sees that his/her name is not recorded anywhere and that most data entries are simply checks or numbers or letter codes and not anything that reveals of the respondent's identity.

Training Interviewers

Even experienced survey interviewers may be largely unfamiliar with calendar interviewing. Thus, they should be trained not only in the "how to's" of the method but also in the theoretical underpinnings. Understanding the principles of sequential and parallel cuing can help interviewers get the maximum benefit from the LEC. In our use of the LEC with prison inmates (Horney 2001), we found practice interviews with all other interviewers observing, were particularly helpful. We started with interviewers practicing with other students who simulated answers that might be given by an inmate, and then we conducted test interviews with inmates in a prison setting similar to the one to be used in the actual interviews. In initial practice sessions, one interviewer asked all the questions, but all of the interviewers observed and individually recorded the information. Interviewers were encouraged to ask questions to clarify specific issues that arose.

The initial interviews were followed by one-on-one practice interviews. These steps allowed the interviewer to gain comfort with the instrument and work on interviewing technique as well (e.g., probing for more information, using the calendar elements to enhance

subject recall). Such training is a critical component of any project using the LEC, and the more complex the instrument, the more extensive the training will need to be. Especially with computerized calendars, the practice sessions are important not only to ensure the skill and comfort of the interviewer but also to ensure that all bugs in the computer program have been detected.

From the discussion above, it is clear that designing a calendar study requires synthesizing good survey methodology with a number of pragmatic considerations. In deciding whether to employ the LEC in any particular study, the researcher will want to weigh the costs involved in the method against the benefits to be obtained from its use. An important part of that assessment is the quality of the data obtained with the LEC, which we address in the next section.

QUALITY OF LEC DATA

Several approaches have been used to assess the quality of data obtained through the use of the LEC. Most have involved comparing the data collected retrospectively with the LEC to data obtained through another source. In some cases, that other source is a self-report by the same respondent that was given at a time closer to the status or event in question and is therefore assumed to be more accurate than a more distant report. In other cases, official records provide the alternative source for the data. In most assessments, the LEC has been evaluated as the only retrospective method, either focusing on the absolute accuracy of the data, or comparing LEC accuracy under differing conditions, such as the length of the recall period. A few studies, however, have directly compared the accuracy of data collected with the LEC to data collected through more traditional survey methods, with the strongest of these studies using randomized experimental designs.

Comparisons of Retrospective LEC Data to Earlier Self-Reports

Both Freedman et al. (1988) and Caspi et al. (1996) employed the LEC in the context of ongoing prospective longitudinal studies and were thus able to compare the retrospective accounts respondents gave for a particular time period using the LEC with the same respondents' reports given previously at that actual time period. Freedman et al. as part of a panel study of mothers and their children in Detroit, employed the LEC to interview approximately 900 23-year olds to obtain month-by-month retrospective accounts of key features of their lives back to the time they were 15 years old. These same young adults had been interviewed at the age of 18, at which time they described their current status on a number of dimensions. To assess the quality of the LEC data, Freedman et al. compared the LEC reports (1985) for the month in which the respondents had been interviewed in 1980 with the original reports for that month.

At least 90% of the respondents gave the same date for marriages and births, 87% gave identical responses as to whether they were attending school full-time, part-time, or not at all, and 72% gave the same classification in describing their employment as full-time, part-time, or no employment. Freedman et al. suggested that memory for employment was somewhat less accurate than for schooling because at age 18 employment was generally changing more frequently.

Caspi et al. (1996) also reported on LEC data quality in the context of a prospective longitudinal study. Like Freedman et al. (1988), they assessed the accuracy of retrospective reports on schooling and employment. In addition, they considered reports on whether or not the respondent was living with parents, cohabiting with a partner, serving as a primary caregiver for a child, and involved in job training. Caspi et al. used the LEC to obtain month-by-month accounts of the respondents' life circumstances between age 15 and 21. In order to assess the quality of the retrospective data, they compared the LEC reports for the month in 1990 when the respondents, then age 18, had last been interviewed to the reports given at that earlier time. Complete data for both reporting periods were available for 951 persons. With a 3-year retrospective recall period, they found that "(o)ver 90% of the reports about each of the seven different content domains were reported in the exact month on both occasions" (p. 105).

As Caspi et al. (1996) noted, the validity data in their study as well as the Freedman et al. (1988) study were limited to sociodemographic variables. A very different focus is found in the study by Roberts et al. (2005), who assessed the quality of LEC data on involvement in violent events. In a prior study[2] researchers identified, through a validated screening process, a group of individuals admitted to a psychiatric center emergency room who were expected to be repeatedly involved in violence when they were released back into the community. Subjects who were enrolled in the study were interviewed in the community once a week for 6 months and asked about their drinking, drug use, relationship quality, general living situation, and involvement in violence during the previous week.

For the Roberts et al. (2005) project, 75 of the 132 participants in the original study were interviewed using the LEC at times that were 1, 2, or 3 plus years after their first interview in the original study. The recall period for the LEC overlapped with the period during which they had participated in weekly interviews and thus allowed a comparison of retrospective accounts of events with accounts given almost concurrently. The correspondence in reporting violent events was considerably lower than those found in the studies of sociodemographic variables. Retrospective reports of whether or not violence occurred in specific months matched reports from the weekly interviews in 59% of the cases, but most of the matches were for reports of no violence. Using the LEC, respondents retrospectively reported violence in only 18% of the months in which violence had been originally reported. Violence was more likely to be reported when the violent events were serious rather than minor (reported in 14% of the months in which serious violence was previously reported compared to 5% of the months with minor violence). Surprisingly, the length of the recall period was unrelated to concordance between the retrospective and weekly reports.

The Roberts et al. study represents an especially rigorous test of the LEC methodology. The sample was not only diagnosed as suffering from various mental health disorders, but was, in addition, screened into the original study based upon significant histories of substance use and violence. The respondents' mental health status, their use of prescribed medications, and their additional substance use were likely to make the recall task especially problematic. In addition, the screening for involvement in violence means that such events were probably more frequent and therefore less salient for this group than they would be for a general population. Although this sample shares some characteristics with a sample of criminal offenders, it may be even more extreme in terms of problems that would affect memory. An important

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[2] "Intensive follow-up of violent patients," funded by the National Institute of Mental Health (NIMH); Edward Mulvey, Ph.D. and Charles W. Lidz, Ph.D., co-principal investigators.

question not addressed by the Roberts et al. study is whether, under these challenging circumstances, the quality of data obtained with the LEC was different from what would have been obtained with a traditional questionnaire method.

Comparisons of Retrospective LEC Data to Records Data

The criterion data compared to LEC data in the three studies described previously were earlier reports given by the same individuals at or very close to the time of the life circumstances in question. Other studies have assessed LEC data quality by comparing them to external records. For example, Morris and Slocum (forthcoming), Roberts and Wells (2009), and Mulvey and Schubert (personal communication, October 15, 2008) compared offenders' self-reports of arrests to official records. In the Morris and Slocum study (Women's Experience of Violence data), almost 88% of the jailed women correctly reported whether they had been arrested during the reference period. Roberts and Wells (Second Nebraska Inmate Study data) found that 74% of the male inmates gave accurate reports as to whether they had been arrested, and that they reported roughly 51% of the officially recorded arrests.

In both studies, reports on the timing of arrests in specific months produced the least concordance with official records. Morris and Slocum found that 24% of the calendar months with an official arrest were accurately reported as an "arrest month" using the LEC, while Roberts and Wells reported correct identification in only 14.5% of the official arrest months. Both studies additionally found that those individuals who reported the highest number of offenses had the greatest numbers of errors in reporting. Results using officially recorded arrests as criteria for evaluating the quality of self-reports should be interpreted cautiously, as prior researchers have commented on the ambiguous nature of the arrest incident (see for example, Rojek 1983; Weis 1986; Johnson et al. 2002). Incarcerated individuals have likely had numerous contacts with criminal justice officials, and accurately distinguishing an arrest from another form of criminal justice contact may be difficult for these offenders.

Roberts and Wells also examined the self-reports of adult jail and prison terms against official records and found that recall of these events was much better than the recall of arrests. Fifty-seven percent of the respondents accurately reported their frequency of adult jail terms, and 90% accurately reported frequency of adult prison terms. Similarly, Mulvey and Schubert (personal communication) found 92% agreement between the self-reported occurrence and timing of juvenile facility placement and official records of these incarceration periods.

Roberts and Mulvey (2009), in additional analyses of the LEC reports of released mental patients, compared the self-reports of mental health hospitalizations against hospital intake records, and found that 63% of the respondents accurately reported the total number of hospitalization months. As with jail and prison terms, accuracy with respect to timing was much lower. Their respondents accurately reported 19% of the officially recorded "hospitalization months" as such using the LEC.

Better recall of jail and prison terms and hospitalizations than of arrests is to be expected. A jail/prison stay or stay in a mental hospital has an impact on many aspects of a person's life, including living arrangements, employment status, and significant relationships. This change across life domains naturally makes these events memorable, and also makes the LEC methodology especially likely to facilitate recall. In contrast, an arrest, which might only inconvenience a person for a few hours or days, is less likely to be tied to other domains on the LEC, and therefore will be harder to remember. In addition, jail terms, prison terms, and hospitalizations occurred relatively infrequently during the short reference periods used in these studies, and were therefore more likely to stand out in memory.

Direct Comparisons of the LEC to Traditional Methods

All of the assessments of data quality described above compared reports obtained through LEC methodology with either earlier self-reports or with official records data in order to determine the accuracy of LEC retrospective reports. Although useful in assessing absolute level of accuracy, these studies have not determined whether using the LEC methodology leads to improvement over traditional methods of collecting retrospective accounts. Direct comparisons of the LEC to traditional methods are especially important.

Yacoubian (2000, 2003) assessed the impact in two Arrestee Drug Abuse Monitoring (ADAM) Program sites of adding a calendar component to the standard ADAM interview used to question arrestees about their recent drug use. Arrestees' reports of drug use during the 30 days previous to their arrest are typically compared to urinalysis results to assess validity. Yacoubian compared the correspondence of self-reports to urinalysis results in 1999, when standard survey methodology was used, to results obtained in 2000, when a calendar component was added to the interview, for Oklahoma City (Yacoubian 2000) and Portland (Yacoubian 2003). The kappa statistics computed to measure the extent of agreement between self-reports and urinalysis results for marijuana, crack cocaine, powder cocaine, and heroin were substantially the same for 1999 and 2000, indicating no improvement in the self-reports with introduction of the calendar methodology. It is important to note that the recall period in this study was 30 days, a period for which recall would be assumed to be relatively easy. Yacoubian did not describe the calendar employed except to say that "the assumption is that the reporting of personal drug use, treatment history, and criminal justice involvement will be enhanced when recalled in conjunction with more personal events (e.g., birthdays, anniversaries, and holidays)" (2003, p. 28). It seems likely that the calendar was designed to improve the memory of life circumstances occurring over a longer term rather than specifically to cue recall of events in the last 30 days. The finding of no difference thus would not be surprising.

Yoshihama et al. (2005) compared two studies in which they obtained women's accounts of their lifetime experience with intimate partner violence (IPV). They compared a small methodological study, in which they employed the LEC, to a larger epidemiological study (the Mothers' Well-Being Study (MWS), in which they used traditional survey methods. Both studies used the same sampling frame and the same sampling criteria. For the comparisons, they selected a subset of the sample from the larger study who matched the race and county of residence of the smaller sample in the LEC study.

Interviewers in the LEC study used women's reports of their experiences in a number of domains to enter timing and duration data on a pre-printed calendar that the women then referred to when they were questioned about IPV. Calendar entries were made for residence, schooling, employment, births of children, receipt of public assistance, relationship history, pregnancy outcomes, as well as other particularly memorable life events that the women identified.

There were no criterion data available against which to compare the reports gathered by the two methods. Instead, the researchers hypothesized several results that should follow if the LEC led to more accurate reporting. They predicted that the calendar method should lead to more reports of IPV over the life course, that it should lead to more reports especially in more distant time periods, and that the differences between the two methods should be greater for recall of far distant periods than of recall for the past year. They found, as predicted, that the women in the LEC study were more likely to report having experienced IPV, reported that the first IPV occurred at an earlier age, and had a higher estimated cumulative probability of experiencing IPV by age 50. They tested their second hypothesis by comparing women in

different age groups and found differences between the two studies. Women in the LEC study reported similar patterns of IPV regardless of age group, whereas women in the traditional method study reported patterns that varied by age group, with younger women reporting more and earlier IPV. Finally, as predicted, they found no difference between the two study samples in their reports of IPV experience in the previous 12 months.

Although the previous two studies directly compared the LEC methodology with traditional survey methodology, neither employed an experimental design to make that comparison. We now turn to three important studies in which respondents were randomly assigned to be interviewed either by the LEC method or by traditional methods.

Comparisons of Interviewing Methods Through Randomized Experiments

Belli et al. (2001, 2005, 2007) have employed randomized experimental designs to compare the quality of self reports of various life-events obtained using the LEC to reports obtained with more traditional survey methodologies. Their experimental comparisons involved randomly selected subsets of respondents from the Panel Study on Income Dynamics (PSID) whose responses could be compared to their reports in earlier waves of that survey.

Belli et al. (2001, 2005) randomly assigned participants to be interviewed by telephone in 1998 either with LEC methodology or with traditional survey questions, covering the same domains about which they had been questioned in the 1997 PSID (asking mostly about 1996 life circumstances). The smallest time units used with the LEC were a third of the month (respondents were asked whether events occurred, started, or stopped near the beginning, in the middle, or at the end of a month). The reference period was 1 year and it ranged between 1 and 2 years before the date of the experimental interviews.

The LEC approach produced higher quality data in a number of domains. Belli et al. found overall higher levels of agreement and less underreporting for reported moves; smaller differences in mean absolute error for weeks away from work for illness of self or other; and significantly larger correlation coefficients for income, weeks unemployed, weeks away from work because of illness and weeks away from work for other reasons. In contrast, standard survey techniques produced less over-reporting of numbers of jobs and of others moving into the residence. There were no consistent over- or under-reporting biases with either method for the continuous measures, and no data quality differences between the two methods with regards to whether the respondent received AFDC/Food stamps, whether household members had left the residence, and the number of weeks per year that the respondent was working, out of the labor force, or on vacation.

In contrast to the previous study, which covered a 1-year recall period, Belli et al. (2007) compared the quality of data produced by the LEC and by standard survey methods when asking respondents about the 30-year period during which PSID data were collected annually (between 1968 and 1997). This study also employed a computerized LEC rather than the paper and pencil version.

In 2002, a subset of PSID respondents were randomly assigned to LEC or standard survey methodologies and were interviewed by telephone, using questions that referred to their entire lifetimes. Domains covered included residence, marriage, cohabitation, employment, and smoking. Their reports for each year were compared to reports obtained during the original panel study. The results indicated that correspondence to earlier reports was significantly better for those in the LEC condition for cohabitation, employment, amount worked,

and smoking. The improvement achieved with the LEC for employment reports was even greater for the more distant reporting periods. The standard methodology produced greater agreement for one domain – marriage, although the data quality was high for both methods. There were no statistically significant differences between the two conditions in reporting of residential changes.

The two randomized experiments conducted by Belli and colleagues represent an important advance in determining the value of the LEC methodology. Both found generally greater agreement between retrospective reports and earlier reports from the same individuals when the LEC was used, but the differences between methods were not overwhelming for the most part, and they were not always in favor of the LEC. It is important to note that both studies were conducted using telephone interviews, and, therefore, one very important feature of the LEC – it's serving as a visual aid to facilitate the respondent's recall – was missing from these tests. The *interviewers* were able to take advantage of the visual aid (either in the form of the paper calendar or the computerized version) to spot inconsistencies in the respondent's reports, but the *respondents* had no record of responses to stimulate sequential or parallel (cross-domain) cuing of memory. We might thus expect these studies to underestimate the benefits of the LEC over traditional methods.

Telephone interviewing was also used in a randomized experiment conducted by Van der Vaart and Glasner (2007), but it was supplemented by a calendar mailed to respondents in advance of the interview. In this study, 233 clients registered with Dutch opticians were questioned about their purchases of eyeglasses for a 7 year time frame; their reports gathered either with the LEC or with a standard interview were compared to opticians' records. Before the scheduled interview, respondents in the LEC condition were sent a calendar with instructions for entering monthly information about age, residence, domestic situation, jobs, schooling, and personal landmarks. During the interview in the LEC condition, respondents were asked to mark any purchases of a pair of glasses on the calendar and to refer to the calendar as they were asked questions about the purchase price and date of purchase for the most recently purchased pair of eyeglasses.

The researchers found that, for price and date of purchase of the last pair of eyeglasses, errors were significantly smaller in the LEC condition than in the standard survey condition. Errors in total number of glasses purchased were also smaller in the LEC condition, but the difference was not significant, a result the authors attributed to "the fact that 91% of all the respondents had bought two pairs of glasses, at most" (p. 233).

The researchers hypothesized that there would be greater reduction in errors in the LEC condition relative to the standard condition when the task was more difficult, as when the purchase was less salient (glasses were less expensive) or less recent. Their hypotheses were supported. The reduction in recall error using the LEC was 25% with higher priced glasses and 61% with the less expensive glasses. Similarly, the LEC method led to a 32% reduction in error with recently purchased glasses (the last $2^1/_2$ years) and a 55% reduction in error with those purchased from $2^1/_2$ to 7 years earlier.

Conclusions on LEC Data Quality

Several general conclusions can be drawn from these studies of the quality of LEC data. First, across the studies, data obtained with LEC methods are more frequently of higher quality than

data obtained with standard survey methods. In some cases, there is little difference between the methods, but the standard methods are rarely more effective than the LEC.

Second, the LEC appears to have greater benefits over traditional methods when the task places a heavier burden on recall, as when the events to be recalled are less salient, more frequent, or more distant. For very recent events or major events such as marriages and births, the two methods are likely to produce similarly high quality recall data.

Third, even when the LEC is used, the difficulty of the task or the characteristics of the respondents may seriously limit the accuracy of recall. The lowest levels of accuracy were reported for respondents with serious mental health problems, problems of substance abuse, and high rates of involvement in violence, who were asked to recall specific violent events in which they were involved over 1–3 years earlier. We do not know, however, how accurate their recall would have been with traditional survey methods.

CONCLUSIONS AND FUTURE DIRECTIONS

As the research on LEC data quality indicates, the calendar methodology has the potential to improve individual recall of life circumstances, events, and behavior. While many questions remain about the limits of the method, the potential benefits for capturing time-based data are considerable. The LEC is particularly well suited to capturing data applicable to questions about the sequencing of events or about the correspondence of events in time. Researchers, of course, have to consider the costs of the approach. Costs of instrument development depend on the complexity of the instrument. The simplest paper calendars involve very low development costs, whereas computerized calendars can require substantial investments in programming. Those costs, however, are likely to decrease significantly as more calendars are developed and shared with other researchers.

The costs of using the LEC must always be assessed against alternatives. If the LEC allows the retrospective collection of high quality data that could otherwise only be gathered through costly prospective studies, savings can be substantial. If used in conjunction with prospective longitudinal research to produce more detail on events and behavior during the periods between waves of data collection, the marginal cost of the LEC may be quite small.

In order for the costs and benefits to be more adequately understood, further methodological research on the LEC is needed. The only randomized experiments conducted to date compared LEC telephone interviews with more traditional questioning and, therefore, evaluated the LEC without the visual calendar cues that many consider a critical feature for cuing recall. Randomized experiments with face-to-face interviews will be important for assessing the full potential of the LEC.

Research on design and implementation details is also needed. More research on the length of reference periods and on the interaction between time units and reference periods is necessary for establishing reasonable limits for producing valid data with the LEC. Research to determine the impact of different approaches to moving through time with the LEC (forward, backward, or mixed) will help researchers get the maximum benefit from the methodology.

New ways of enhancing the LEC should also be explored. We described earlier the Van der Vaart and Glasner study which supplemented a telephone-administered LEC with a calendar mailed in advance to respondents. In typical face-to-face LEC interviews, entering life circumstances on the calendar can be quite time consuming. Providing calendars in advance

and asking respondents to enter some of the basic data could save on interview time and might also improve recall by giving respondents more time to think about what was going on during a certain period of their lives.

Besides research on the basic elements of the LEC, there is also a need for research specific to the populations in which criminologists are interested. Many of these populations present serious challenges for researchers collecting retrospective data. The challenges arise because respondents in criminological studies often are educationally and economically disadvantaged, report substantial histories of drug and alcohol use/abuse, and have higher rates of mental illness than the general population (see for example, Beck et al. 1993; Teplin 1994). These conditions make them likely to have memory problems that decrease the accuracy of their retrospective accounts. In addition, their memory for offending and victimization may be less clear because of their more frequent involvement. These challenges, although making the LEC, with its built-in cues for recall, a particularly attractive technique, also call for attending to special needs of these populations when designing the LEC.

We suggest that more research is needed to enhance the LEC effectiveness for these populations and to determine its limits. Population-specific research to determine what events serve best as time markers, for example, could improve the LEC cuing of recall. Individuals for whom arrests or violent events occur with some frequency may not find such things effective in aiding their memory, but researchers may find that they have in common other kinds of events that serve well as cognitive landmarks. Researchers might consider obtaining consent to access respondents' official records (e.g., arrest, court, prison, and mental health) prior to the interviews so that key events could be entered on the calendar in advance of the interview.

With more theoretical and empirical interest in the timing, duration, and interconnectedness of events, self-report methods like the LEC will play an increasingly important role in criminology. With more attention to fine-tuning the method for use with special populations, we see great promise in the LEC for producing useful, high-quality data on the lives of the individuals we study.

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