3

Recording behavioral sequences

3.1 Recording units: Events versus intervals

The title of this chapter, Recording behavioral sequences, suggests two different but somewhat related topics. The chapter could deal primarily with mechanical matters and describe devices used to record data, or it could deal just with conceptual matters and describe different strategies for collecting data about behavior sequences. Actually, this chapter will be a mixture of both, although conceptual and strategic matters will be stressed.

One important issue has already been raised by the example of the Bakeman and Brownlee (1980) study of parallel play in chapter 1, and that is the issue of "units." Before selecting a particular recording strategy, an investigator needs first to decide what "units" are to be used for recording.

As we use the term, the recording unit identifies what prompts the observer to record, and usually is either an interval or an event. For example, an investigator might choose to code time intervals, as Bakeman and Brownlee did, assigning codes to successive time intervals. This is a common strategy, but for many purposes more accurate data result when the events themselves are coded instead. In such cases, observers wait for an event of interest to occur. When one occurs, they code it (i.e., note what kind of event it was) and perhaps record onset and offset times for the event as well.

Which is better, to code events or to code intervals? That depends on a number of factors, including the kind and complexity of the coding scheme, the desired accuracy for the data, and the kind of recording equipment available. These issues are discussed later on in this chapter in the context of talking about applications of specific recording strategies, but first we want to make another distinction, one between momentary and duration events.

3.2 Momentary versus duration events

Sometimes investigators are concerned only with how often certain events occur, or in what order they occur, and are not much concerned with how long they last. At other times, duration – the mean amount of time a particular kind of event lasts or the proportion of time devoted to a particular kind of event – is very much of concern. As a result, many writers have found it convenient to distinguish between "momentary events" (or frequency behaviors) on the one hand, and "behavioral states" (or duration behaviors) on the other (J. Altmann, 1974; Sackett, 1978). The distinction is not absolute, of course, but examples of relatively brief and discrete, momentary events could include baby burps, dog yelps, child points, or any of Gottman's thought unit codes described in section 2.11, whereas examples of duration events could include baby asleep, dog hunting, child engaged in parallel play, or any of Landesman-Dwyer's baby behavior codes described in section 2.12.

One particular way of conceptualizing duration events is both so common and so useful it deserves comment. Often researchers view the events they code as "behavioral states." Typically, the assumption is that the behavior observers see reflects some underlying "organization," and that at any given time the infant, animal, dyad, etc., will be "in" a particular state. The observers' task then is to segment the stream of behavior into mutually exclusive and exhaustive behavioral states, such as the arousal states often described for young infants (REM sleep, quiet alert, fussy, etc.; Wolff, 1966).

The distinction between momentary and duration events (or between discrete events and behavioral states) seems worth making to us, partly because of the implications it may have for how data are recorded. When the investigator wants to know only the order of events (for example, Gottman's study of friendship formation) or how behavioral states are sequenced (Bakeman and Brownlee's study of parallel play), then the recording system need not preserve time. However, if the investigator wants also to report proportion of time devoted to the different behavioral states, then time information of course needs to be recorded. In general, when duration matters, the recording system must somehow preserve elapsed time for each of the coded events. Moreover, when occurrences of different kinds of events are to be related, beginning times for these events need to be preserved as well. (Examples are provided by Landesman-Dwyer and by Tuculescu and Griswold; see section 3.5, Recording onset and offset times.)

3.3 Continuous versus intermittent recording

Before discussing particular recording strategies as such, there is one more distinction that we would like to make. Almost all strategies we describe here are examples of continuous, not intermittent, recording. The phrase "continuous recording" evokes an event recorder, with its continuously

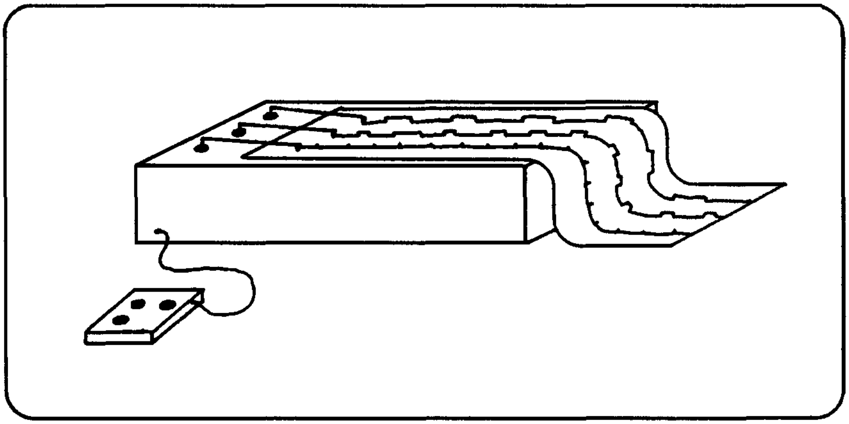

Figure 3.1. An example of continuous recording: A deflected-pen event recorder.

moving roll of paper and its pens, ready to record events by their deflection (see Figure 3.1). It is a rather cumbersome device, rarely used in observational research. Almost always, researchers prefer pencil, paper, and some sort of clock, or else (increasingly) an electronic recording device. Still, the phrase "continuous recording" seems appropriate for the strategies we describe here, not because the paper rolls on, but because the observers are continuously alert, paying attention, ready to record whenever an event of interest occurs, whenever a behavioral state changes, or whenever a specific time interval elapses.

Given that this is a book about sequential analysis in particular, and not just systematic observation in general, the emphasis on continuous recording is understandable. After all, for sequential analysis to make much sense, the record of the passing stream of behavior captured by the coding/recording system needs to be essentially continuous, free of gaps. However, we do discuss intermittent recording in section 3.9 (Nonsequential considerations: time sampling).

The purpose of the following sections is to describe different ways of collecting observational data, including recording strategies that code events and ones that code intervals. For each way of collecting data, we note what sort of time information is preserved, as well as other advantages and disadvantages.

3.4 Coding events

In this section we shall discuss event-based coding. The basic aspect to take note of is the observer's task, and, in particular what gets the observer

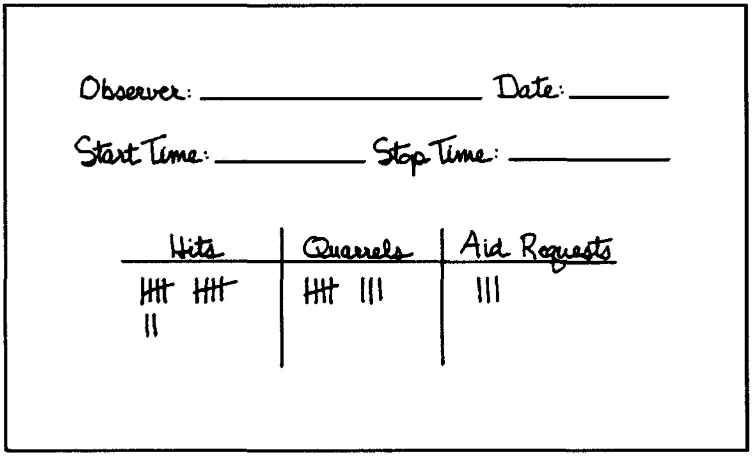

Figure 3.2. Tallying events with a simple checklist.

to record a particular code. When the events of interest, not a time interval running out, are what stir an observer into action, we would say that an event coding strategy is being used to record observational data. The simplest example of event coding occurs when observers are asked just to code events, making no note of time. For example, an investigator might be interested in how often preschool children try to hit each other, how often they quarrel, and how often they ask for an adult's aid. The observer's task then is simply to make a tally whenever one of these codable events occurs. Such data are often collected with a "checklist." The behavioral codes are written across a page, at the top of columns. Then when a codable event occurs, a tally mark is made in the appropriate column. No doubt our readers are already quite aware of this simple way of collecting data. Still, it is useful whenever investigators want only to know how often events of interest occur (frequency information) or at what rate they occur (relative frequency information) (see Figure 3.2).

Such data can be important. However, of more immediate concern to us, given the focus of this book, are event coding strategies that result in sequential data. For example, Gottman segmented the stream of talk into successive thought units. Each of these events was then coded, providing a continuous record of how different kinds of thought units were sequenced in the conversations Gottman tape-recorded. Similarly, Bakeman and Brownlee (who actually used an interval coding strategy) could have asked observers to note instead whenever the play state of the child they were observing changed. Each new play state would then have been coded, resulting in a record of how different kinds of play states were sequenced during free play (see Figure 3.3).

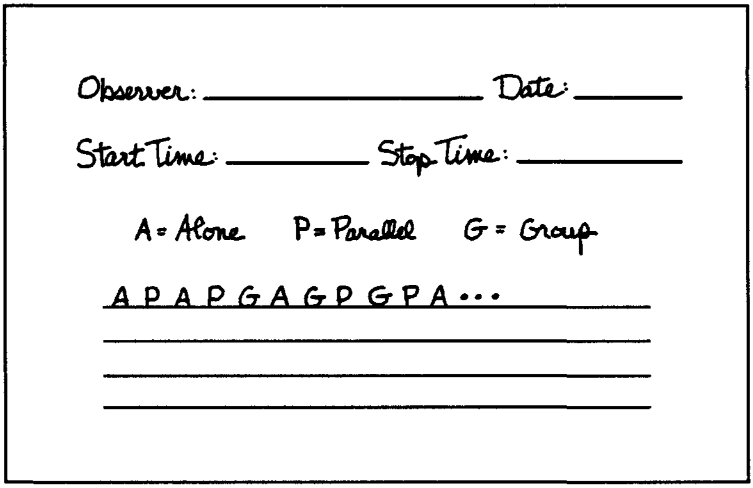

Figure 3.3. Recording the sequence of events.

In these two examples, the basic requirement for sequential data – continuity between successive coded units – is assured because the stream of talk or the stream of behavior is segmented into successive events (units) in a way that leaves no gaps. However, sequential data may also result when observers simply report that this happened, then that happened, then that happened next, recording the order of codable events. Whether such data are regarded as sequential or not depends on how plausible the assumption of continuity between successive events is, which in turn depends on the coding scheme and the local circumstances surrounding the observation. However, rather than become involved in questions of plausibility, we think it better if codes are defined so as to be mutually exclusive and exhaustive in the first place. Then it is easy to argue that the data consist of a continuous record of successive events or behavioral states.

Whether behavior is observed "live" or viewed on videotape does not matter. For example, observers could be instructed to sit in front of a cage from 10 to 11 a.m. on Monday, 3 to 4 p.m. on Tuesday, etc., and record whenever an infant monkey changed his activity, or observers could be instructed to watch several segments of videotape and to record whenever the "play state" of the "focal child" changed, perhaps using Smith's social participation coding scheme (Alone, Parallel, Group). In both cases, observers would record the number and sequence of codable events. An obvious advantage of working from videotapes is that events can be played and replayed until observers feel sure about how to code a particular sequence.

Still, both result in a complete record of the codable events that occurred during some specified time period.

3.5 Recording onset and offset times

When time information is required, which usually means that the investigator wants to report time-budget information or else wants to report how different kinds of behavior are coordinated in time, observers can be asked to record, not just that a codable event occurred, but its onset and offset times as well. This is one way to preserve time information, but it is not the only way, as we discuss in the next section.

The task is made even easier when codes are mutually exclusive and exhaustive (or consist of sets of ME&E codes) because then offset times do not need to be recorded. In such cases, the offset of a code is implied by the onset of another mutually exhaustive code. As an example, consider Landesman-Dwyer's codes for baby's eyes (Closed, Slow Roll, Daze, Bright, etc.). She could have instructed observers to record the time whenever the "state" of the baby's eyes changed – for example, from Closed to Slow Roll. Then the elapsed time or duration for this episode of Closed would be the onset time of Slow Roll minus the onset time of Closed. Moreover, because the times when the baby's eyes were closed is known, she could also ask what kinds of face, head, and body movements occurred when the baby's eyes were closed.

This strategy of recording onset times (or onset and offset times when codes are not mutually exclusive and exhaustive) seems so simple, general, and straightforward to us that we are surprised that it is not used more often. The reason for this, we believe, is primarily technical. Before electronic devices that automatically record time became available, we suspect that observers found it distracting to write down times. Thus the older literature especially contains many examples of a "lined paper" approach to recording time information. Behavioral codes would head columns across the top of the page. Then each row (the space between lines) would represent a period of time. Observers would then make a check or draw a vertical line in the appropriate column to indicate when that kind of event began and how long it lasted. As we discuss later, such an "interval coding" strategy has the merit of requiring only pencil and paper, but it remains an approximation of what researchers often really want to do, which is to record the exact times when the behavior of interest begins and ends.

Timing onsets and offsets does not require electronic recording devices, of course, but such devices do make the task easy. In this paragraph and the next, we describe two applications, one that uses such devices and one

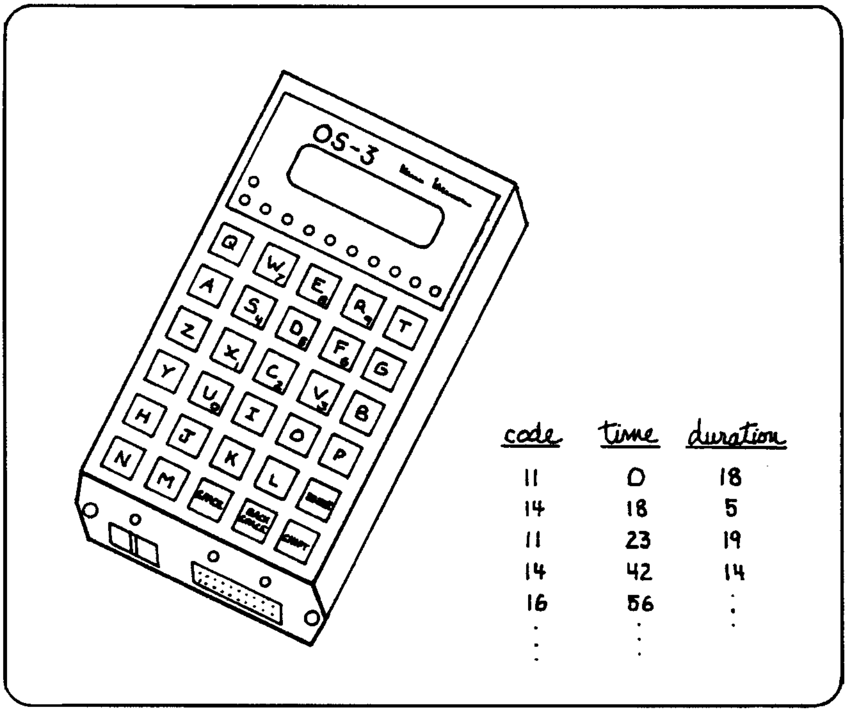

Figure 3.4. An example of a hand-held electronic recording device: The OS-3 (Observational Systems, Redmond, WA 98052). Data production in the form shown is just one of many options.

that does not. First, imagine that observers using the Landesman-Dwyer baby's eyes code were equipped with electronic recording devices. They would learn to push the correct keys by touch; thus they could observe the baby continuously, entering codes to indicate when behavior changed. (For example, an 11 might be used for Closed, a 12 for Slow Roll, a 16 for Bright, etc.) Times would be recorded automatically by a clock in the device (see Figure 3.4). Later, the observer's record would be "dumped" to a computer, and time budget (i.e., percentage scores for different behavioral codes) and other information would be computed by a computer program. (In fact, Landesman-Dwyer used such devices but a different recording strategy, as described in the next section.)

The second application we want to describe involves pencil and paper recording, but couples that with "time-stamped" videotapes. For a study of preverbal communication development, Bakeman and Adamson (1984) videotaped infants playing with mothers and with peers at different ages.

At the same time that the picture and sound were recorded, a time code was also placed on the tape. Later, observers were instructed to segment the tapes into different "engagement states" as defined by the investigators' code catalog. In practice, observers would play and replay the tapes until they felt certain about the point where the engagement state changed. They would then record the code and onset time for the new engagement state.

In summary, one way to preserve a complete record of how behavior unfolds in time (when such is desired) is to record onset (and if necessary offset) times for all codable events. This is easy to do when one is working from time-stamped videotapes. When coding live, this is probably best done with electronic recording devices (either special purpose devices like the one shown in Figure 3.4 or general-purpose handheld or notebook computers, programmed appropriately, which increasingly are replacing special purpose devices). When such devices are not available, the same information can be obtained with pencil, paper, and some sort of clock, but this complicates the observers' task. In such cases, investigators might want to consider the approximate methods described in section 3.7, on Coding intervals.

3.6 Timing pattern changes

There is a second way of preserving complete time information, but it applies only to coding schemes structured like the Landesman-Dwyer Baby Behavior Code described earlier. That is, the scheme must consist of groups of mutually exclusive and exhaustive codes, with each group referring to a different aspect of behavior. Paradoxically, this approach seems like more work for the observers, but many observers (and investigators) prefer it to the simple recording of onset times discussed above.

To describe this recording strategy, let us continue with the example of the Baby Behavior Code. Recall that there were five groups of codes: External Stimulation, Eyes, Face, Head, and Body. Observers are taught to think of this as a 5-digit code: The first digit represents the kind of External Stimulation, the second digit represents the Eyes, the third the Face, etc. Thus the code 18440 means that external stimulation was a reflex (code 1), REM movement was evident in the eyes (code 8), there was a smile on the face (code 4), the head was up (also code 4), and the body was in repose (code 0). If code 18440 were followed by code 18040, it would mean that nothing had changed with respect to External Stimulation, Eyes, Head, and Body but that the Face was now in repose (code 0), not smiling as before.

Each time there is a change in codable behavior, even if it involves only one of the five superordinate groups, a complete 5-digit code is entered. On the surface of it, this seems like more work than necessary. After all, why require observers to enter codes for external stimulation, eyes, head, and body when there has been no change just because there has been a change in facial behavior? In fact, observers who use this approach to recording data report that, once they are trained, it does not seem like extra work at all. Moreover, because the status of all five groups is noted whenever any change occurs, investigators feel confident that changes are seldom missed, which they might not be if observers were responsible for monitoring five different kinds of behavior separately.

Paradoxically, then, more may sometimes be less, meaning that more structure – that is, always entering a structured 5-digit code – may seem like less work, less to remember. This is the approach that Landesman-Dwyer actually uses for her Baby Behavior Code. We should add, however, that her observers use an electronic recording device so that time is automatically recorded everytime a 5-digit code is entered. In fact, we suspect that the Baby Behavior Code would be next to impossible to use without such a device, no matter which recording strategy (timing onsets or timing pattern changes) were employed. Given proper instrumentation, however, the same information (frequencies, mean duration, percents, cooccurrences, etc.) would be available from data recorded using either of these strategies. When a researcher's coding scheme is structured appropriately, then, which strategy should be used? It probably depends in part on observer preference and investigator taste, but we think that recording the timing of pattern changes is a strategy worth considering.

3.7 Coding intervals

For the recording strategies just described – coding events, recording onset and offset times, recording pattern change times – observers are "event triggered," that is, they are stirred to record data whenever a codable event occurs. When using an interval coding (or interval recording) strategy, on the other hand, observers are "time triggered," that is, typically they record at certain predetermined times.

The essence of this strategy is as follows. A child, a dyad, an animal, a group, or whatever, is observed for a period of time. That period is divided into a number of relatively brief intervals, typically on the order of 10 or 15 seconds or so. Observers then either categorize each interval or else note which codable events, if any, occurred during each interval.

Such data can be collected easily with pencil and paper via a "checklist" format. As mentioned briefly earlier, behavioral codes head columns across the top of a page, whereas the rows down the page represent successive

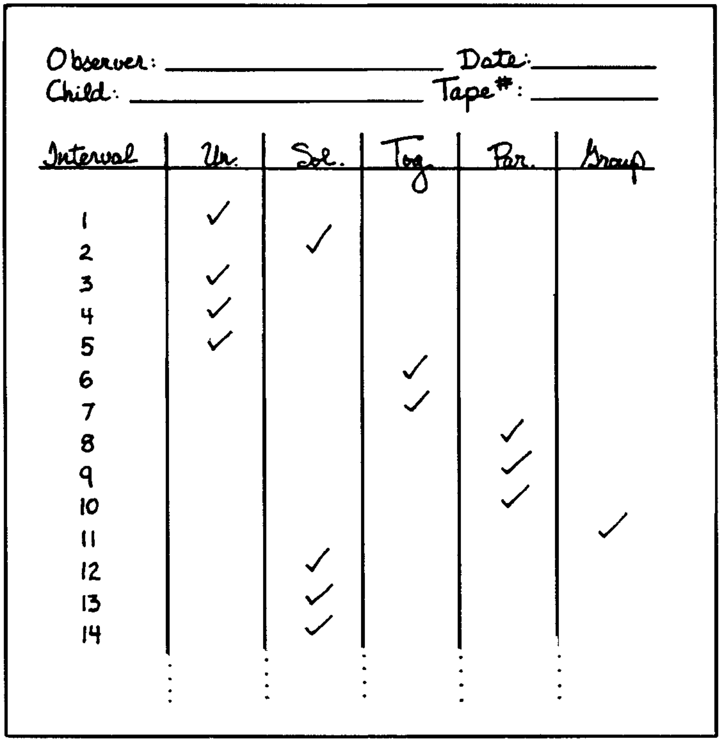

Figure 3.5. Coding intervals using a checklist format.

intervals of time. When a codable event happens within an interval, observers place a check in the appropriate row and column. Even though observers may actually first move pencil to paper when an event happens, and so are "event-triggered" in that sense, the end result is to characterize intervals as containing or not containing an event of interest, which is why we call this an "interval coding" strategy.

An even simpler example of interval coding is provided by the Bakeman and Browenlee study of parallel play, described in chapter 1. Their observers watched 12–15 7-minute video recordings for each of 41 children. The tapes were played at normal speed without stopping, in effect simulating live "real time" observation. Every 15 seconds, a simple electronic device delivered a "click" to the ear, at which time observers wrote down the social participation category that they felt best characterized the time since the last click (see Figure 3.5).

Interval coding, or some variant of it, has been both widely used and much criticized in the literature. We think the reason it has been so widely used has something to do with historical precedent, a human propensity to impose clock units on passing time, the ready availability of lined paper, and the unavailability until quite recently of electronic recording devices. It has been criticized because it simply cannot provide as accurate information as an event coding strategy. The major problem is that more than one code may occur within an interval or near the boundaries of intervals. What would a coder do in this case? If a hierarchical decision rule is employed, sequential and other information within the interval is lost. This problem is minimized, of course, if the time intervals are short relative to the behavior observed.

However, we can see no good theoretical reason ever to use interval coding; its merits are all practical. It requires only pencil, paper, and some sort of simple timing device. No sophisticated electronic recording devices or computers need be involved. In addition, as mentioned earlier, sometimes observers find it easier to categorize intervals than to identify when codable events began. (We suspect, however, that this is more of a consideration when behavior is recorded live, and is much less of a consideration when observers can play and replay videotaped behavior, as for the Bakeman and Adamson study of infant engagement states described in section 3.5.)

Clearly, the key consideration when an interval coding strategy is used is the length chosen for the interval. If that interval is somewhat shorter than the shortest duration typically encountered for a codable event, then little distortion should be introduced into the data (Smith & Connolly, 1972; cf. J. Altmann, 1974). No doubt, most investigators who use an interval coding strategy understand perfectly well that the interval used should not be so long as to mask onsets and offsets of the events being studied because if it is, then not only will estimates of frequencies, durations, and percentages be inaccurate, but behavioral sequences will be distorted as well.

For example, imagine that the codable event is baby within arm's length of mother and that the interval used for recording is 10 seconds. We should be able to assume that when a checked interval follows an unchecked interval, the baby approached the mother. More importantly, we should also be able to assume that when a string of checked intervals follow each other, the baby did not leave the mother and return but rather stayed near her. Clearly, an interval of 5 minutes would not be satisfactory, 10-second intervals are probably acceptable, and 1-second intervals might be even better. Whether the 1-second interval provides sufficiently more accurate data to be worth the extra effort, however, is debatable, although the matter could be determined with a small pilot study.

In sum, when simplicity and low cost of instrumentation matter more than accuracy, or when the interval is shorter than most codable events and observers prefer checking or categorizing intervals to recording onset times, then an interval coding strategy probably makes sense. For all other cases, some variant of event coding should probably be used.

3.8 Cross-classifying events

In sections 3.4, 3.5, and 3.6, we referred to event coding. By that we meant a recording strategy that requires observers to detect codable events whenever they occur in the passing stream of behavior. Once a codable event has been detected, it is then the observers' task to classify the event, that is, to assign to it one of the codes from the coding scheme. This strategy becomes a way of recording behavioral sequences when continuity between successive events can be assumed, as was discussed in section 3.4.

There is a second way of coding events, however, which does not require any kind of continuity between successive events but which nonetheless results in behavioral sequences being captured. This method does not simply classify events (on a single dimension) but instead cross-classifies them (on several dimensions). The key feature of this approach is the coding scheme. Sequential data result when the superordinate categories of the scheme represent logically sequential aspects of the event.

For example, imagine that observers were asked to note whenever children quarreled. If observers did only this, the result would be a frequency count for quarrels but no sequential information. However, observers could also be asked to note what the children were doing just before the quarrel began, what kind of quarrel it was, and how the quarrel was resolved. Assuming that a mutually exclusive and exhaustive set of codes was defined for each of these three questions, the observer would be cross-classifying the quarrel. This is essentially the same kind of task as asking a child to classify a set of objects by shape (circles, squares, and triangles), color (red, blue, and green), and material (wood, metal, plastic). However, there is a key difference between these two classification tasks. The three schemes used to cross-classify quarrels have a natural temporal order – preceding circumstance, quarrel, resolution – whereas the three schemes used to cross-classify objects do not. Thus the strategy of cross-classifying events is not necessarily sequential. Whether it is or not depends on how the coding scheme is defined.

A second example of this strategy is provided by the Bakeman and Brownlee study of object struggles. (Their coding scheme was described in section 2.13.) In that study, the event of interest was an object struggle. Whenever one occurred, observers recorded (a) whether the child attempting to take the object had had prior possession or not, (b) whether the current possessor resisted the take attempt or not, and (c) whether the child attempting to take the object was successful or not. Note that the possible answers to each of these three questions (yes/no) are mutually exclusive and exhaustive and that the three questions have a natural temporal order.

The cross-classification of events is a recording strategy with many advantages. For one thing, techniques for analyzing cross-classified data (contingency tables) have received a good deal of attention, both historically and currently, and they are relatively well worked out (see chapter 10). Also, clear and simple descriptive data typically result. For example, in another study, Brownlee and Bakeman (1981) were interested in what "hitting" might mean to very young children. They defined three kinds of hits (Open, Hard, and Novelty) and then asked observers to record whenever one occurred and to note the consequence (classified as No Further Interaction, Ensuing Negative Interaction, or Ensuing Positive Interaction). They were able to report that open hits were followed by no further interaction and novelty hits by ensuing positive interaction more often than chance would suggest, but only for one of the age groups studied, whereas hard hits were associated with negative consequences in all age groups.

A further advantage is that a coding scheme appropriate for cross-classifying events (temporally ordered superordinate categories, mutually exclusive and exhaustive codes within each superordinate category) implies a certain amount of conceptual analysis and forethought. In general, we think that this is desirable, but in some circumstances it could be a liability. When cross-classifying events, observers do impose a certain amount of structure on the passing stream of behavior, which could mean that interesting sequences not accounted for in the coding scheme might pass by unseen, like ships in the night. Certainly, cross-classifying events is a useful and powerful way of recording data about behavioral sequences when investigators have fairly specific questions in mind. It may be a less useful strategy for more exploratory work.

3.9 Nonsequential considerations: Time sampling

The emphasis of this book is on the sequential analysis of data derived from systematic observation. However, not all such data are appropriate for sequential analyses. Recognizing that, we have stressed in this chapter recording strategies that can yield sequential data. There exist other useful and widely used recording strategies, however, which are worth mentioning if only to distinguish them from the sequential strategies described here.

Perhaps the most widely used nonsequential approach to recording observational data is time sampling, or some variant of it. We have already discussed this approach in reference to Parten's classic study of social participation described in chapter 1. The essence of time sampling is that observing is intermittent, not continuous. Repeated noncontiguous brief periods of time are sampled, and something about them is recorded. There is no continuity between the separate samples, and thus the resulting data are usually not appropriate candidates for sequential analysis.

A variant of time sampling, which at first glance might appear sequential, requires observers to intersperse periods of observing and periods of recording. For example, an observer might watch a baby orangutan for 15 seconds, then record data of some sort for the next 15 seconds, then return to a 15-second observation period, etc. Assuming that the behavior of interest occurs essentially on a second-by-second basis, this might be a reasonable time-sampling strategy, but it would not produce sequential data. Even if the events being coded typically lasted longer than 15 seconds, it would still be a dubious way to collect sequential data because of all the gaps between observation periods.

For every general rule we might state, there are almost always exceptions. Imagine, for example, that we were interested in how adults change position when sleeping. One obvious way to collect data would be to use time-lapse photography, snapping a picture of the sleeping person every minute or so. Now surely this fits the definition of a time-sampling strategy. Yet assuming that sleeping adults rarely change position more than once within the time period that separates samples, such data would be appropriate for sequential analysis. Logically, such data are not at all different from the data produced for Bakeman and Brownlee's study of parallel play described in chapter 1. In each case, the data consist of a string of numbers, with each number representing a particular code. The only difference lies with the unit coded. For the sleeping study, the unit would be an essentially instantaneous point in time, whereas for the parallel play study, observers were asked to characterize an entire period of time, integrating what they saw.

As the previous paragraph makes clear, time sampling can be regarded as a somewhat degenerate form of interval coding (section 3.7 above). Nonetheless, sequential data may result. Whether it does or not, however, is a conceptual matter, one that cannot be mechanically decided. To restate, whether data are regarded as sequential depends on whether it is reasonable to assume some sort of continuity between adjacent coded units. Usually, but not always, time-sampled data fail this test. This does not mean that a time-sampling recording strategy is of little use, only that it is often not appropriate when an investigator's concerns are primarily sequential. However, when researchers want to know how individuals spend time, time sampling may be the most efficient recording strategy available.

3.10 The pleasures of pencil and paper

Throughout this chapter, we have made occasional comments about the mechanics of data recording. Although there are other possibilities, mainly we have mentioned just two: pencil and paper methods, on the one hand, and the use of electronic recording devices, on the other. In this section, we would like to argue that pencil and paper have their pleasures and should not be shunned simply because they seem unsophisticated.

Pencil and paper methods have many advantages. For one thing, it is difficult to imagine recording instruments that cost less or are easier to replace. There are no batteries that may at a critical moment appear mysteriously discharged. Also, pencil and paper are easy to transport and use almost anywhere. Moreover, there is a satisfying physicality about pencil marks on paper. The whole record can be seen easily and parts of it modified with nothing more complicated than an eraser. Almost never does the record of an entire observation session disappear while still apparently is one's hands. Although paper can be lost, it almost never malfunctions.

Pencil and paper methods are equally usable when the researcher is observing live behavior, is viewing videotapes, or is working from a corpus of written transcripts. For example, pencil and paper recording was used for Brownlee and Bakeman's study of hitting, mentioned in section 3.8 (children were observed live for the study proper, although researchers developed the codes while watching videotapes); for Bakeman and Adamson's study of communication development in infants, referred to in section 3.5 (observers worked with videotapes, stopping, reversing, and replaying as appropriate); and for Gottman's study of friendship formation, described in section 2.11 (observers worked with transcripts, segmented into thought units).

3.11 Why use electronics?

As a general rule, users are attracted to more complex and sophisticated devices of any kind because, once mastered, savings in time and labor result. The key phrase here is "once mastered," because almost inevitably, more sophisticated devices – such as electronic recording devices instead of pencil and paper – require that the user pay an "entry cost." This entry cost includes, not just the initial cost of the device, but the time it takes to learn how to use the device and to keep the device working properly. Nonetheless, many researchers find that the entry costs of electronic recording devices are well worth paying. (To our knowledge, such devices have no common generic name or acronym; they are not, for example commonly called ERDs.)

Electronic recording devices can be either special purpose (see Figure 3.4) or, increasingly, general purpose laptop or notebook computers, programmed to collect data for a particular study. A major advantage of such devices is that data are recorded in machine-readable form from the start. There is no need for data to pass through the hands of a keypuncher, and hence keypunchers cannot introduce errors into data later. Such devices work as follows. To indicate the sequence of codable events, observers depress keys corresponding to the appropriate behavioral codes. A record of the keys "stroked" is stored in an internal memory. Once the observation session is complete, the contents of memory can be transferred to a file on the computer's hard disk or written to some external storage medium, like a floppy disk or a magnetic backup tape. The stored data are then available for whatever subsequent processing is desired.

A second major advantage of electronic recording devices is that they usually contain an internal clock. This means that whenever an observer enters a code, the time can be stored as well, automatically, without the observer having to read the time. Reading the time and writing it down are, of course, quite distracting for an observer. That is why we think interval coding has been used so often in the past (a click every 10 seconds, for example, can be delivered to the ear, leaving the eye free) and why, given the availability of electronic recording devices, event coding (with the automatic recording of onset and offset times or of pattern changes) is becoming much more common than in the past.

A final advantage likewise has to do with minimizing distractions, leaving observers free to devote their full attention to whatever or whomever is being observed. Observers easily learn to push the appropriate keys without looking at them, like a good typist. With these keyboard devices, then, observers do not need to shift their eyes away from the recording task, as they do when recording with pencil and paper. This matters most, of course, when observing live.

Electronic devices for recording data, then, are recommended when a machine-readable record is required, and it seems advantageous to avoid a keypunching step during data preparation. They are also recommended when observers need to keep their eye on the task without the distractions of writing down codes, or worse, their times of occurrence. A code such as the Baby Behavior Code described in section 3.6, which requires the frequent entering of 5-digit codes along with the times they occurred, is probably unworkable with anything other than an electronic recording device.

Other, more sophisticated possibilities for recording data electronically should be mentioned. One common strategy involves time-stamped videotapes (i.e., videotapes on which the time, usually accurate to the nearest second or some fraction of a second, forms part of the picture). Observers

Table 3.1. *Summary of recording schemes*

Recording scheme	Definition	Advantages	Disadvantages
Event recording	Events activate coders	May provide a realistic way of segmenting behaviors	Could lose time information unless onsets and offsets were noted
Interval recording	Time activates coders	Easy to use	1. May artificially truncate behavior 2. Need to select interval small enough or could lose information
Cross-classifying events	Events activate coders, but only a specific kind of event	1. Speed 2. Can still preserve sequential information 3. Statistics well worked out 4. Requires conceptual forethought	Could lose valuable information not accounted for by the highly selective scheme
Time sampling	Time activates coders	Easy to use	Coding is intermittent so sequential information is usually lost

view tapes, slowing down the speed and rewinding and reviewing as necessary. The times when events occurred are read from the time displayed on the screen. This time may be written down, using pencil and paper, or keyed along with its accompanying code directly into a computer. An improvement on this strategy involves recording time information on the videotape in some machine-readable format and connecting a computer to the video player. Then observers need only depress keys corresponding to particular behaviors; the computer both reads the current time and stores it along with the appropriate code. Moreover, the video player can be controlled directly from the computer keyboard. Then, with appropriate hardware and software, coders can instruct the system to display all segments of tape previously coded for a particular code or set of codes. Such systems are very useful but, as you might expect, have a relatively high entry cost both in terms of money and time (e.g., see Tapp & Walden, 1993).

3.12 Summary

Table 3.1 is a summary of the four major conceptual recording schemes we have discussed in this chapter, together with their advantages and disadvantages. The particular recording scheme chosen clearly depends on the research question. However, in general, we find event recording (with or without timing of onsets and offsets or timing of pattern changes) and cross-classifying events to be more useful for sequential analyses than either interval recording or time sampling.