JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1993, 26, 293–319 NUMBER 3 (FALL 1993)

DESCRIPTIVE AND EXPERIMENTAL ANALYSES OF VARIABLES MAINTAINING SELF-INJURIOUS BEHAVIOR

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Independent descriptive (correlational) and functional (experimental) analyses were conducted to determine the extent to which the two methods would yield data supporting similar conclusions about variables maintaining the self-injurious behavior (SIB) of 6 subjects. For the descriptive analyses, subjects were observed in their residences and at training sites at various times each day while observers recorded naturally occurring sequences of specified subject and staff behaviors. The subjects also participated in a day program for the assessment and treatment of SIB, in which they were exposed to functional analyses that manipulated potential maintaining variables in multielement designs. Both sets of data were analyzed via conditional probabilities to identify relevant antecedent and consequent events for subjects' SIB. Using outcomes of the experimental analysis as the standard for comparison, results indicated that the descriptive analysis was useful in identifying the extent to which SIB was related to social versus nonsocial contingencies, but was limited in its ability to distinguish between positive and negative reinforcement (i.e., attention versus escape).

DESCRIPTORS: descriptive analysis, assessment, functional analysis, self-injurious behavior

During the past 10 years, a growing emphasis on the use of functional analysis to assess severe behavior disorders has resulted in a proliferation of methodologies for identifying variables associated with the occurrence or nonoccurrence of self-injury, aggression, and disruption (see Iwata, Vollmer, & Zarcone, 1990, and Mace, Lalli, & Lalli, 1991, for recent reviews). Information gained through these assessments allows the development of treatment programs to alter antecedent events that occasion behavior problems (e.g., Weeks & Gaylord-Ross, 1981), eliminate access to maintaining reinforcers through extinction (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990), or provide those reinforcers contingent on alternative behavior (e.g., Carr & Durand, 1985).

Although a number of assessment techniques have been reported in the literature, including indirect (interview) methods, descriptive (correlational) analyses, and functional (experimental) analyses, most research has used the experimental analysis, which involves direct and systematic manipulation of potential maintaining variables. In particular, variables that maintain self-injurious behavior (SIB), a chronic and sometimes life-threatening disorder, have been examined extensively. Studies have shown that SIB can be maintained by social–positive reinforcement in the form of attention or materials provided by caretakers (Day, Rea, Schussler, Larsen, & Johnson, 1988) or by social–negative reinforcement in the form of escape from task demands (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). For some individuals, SIB appears to be maintained by automatic, nonsocial reinforcers, such as changes in sensory stimulation (Repp, Singh, Olinger, & Olson, 1990).

Advantages of the experimental analysis include its objectivity and quantitative precision (Iwata, Vollmer, & Zarcone, 1990). Compared to other assessment methods, the experimental analysis is superior for identifying causal relationships, and the validity and utility of this approach have been es-

This research was supported in part by a grant from the Developmental Disabilities Planning Council and the Florida Department of Health and Rehabilitative Services, and is based on a thesis submitted in partial fulfillment for the first author's Master of Science degree from the University of Florida. We thank Beth Duncan, Jodi Mazaleski, Teresa Rodgers, Bridget Shore, Richard Smith, Timothy Vollmer, and Jennifer Zarcone for their assistance in the development and implementation of this study; Kimberly Brown, Trey Dukes, Deborah Minsky, Christopher Niles, and Keith Ruckstahl for acting as observers in the naturalistic observations; and Keith Berg and Timothy Hackenberg for their helpful comments on an earlier draft on this manuscript.

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tablished for SIB (e.g., Day et al., 1988; Steege et al., 1990), stereotypy (Sturmey, Carlsen, Crisp, & Newton, 1988), aggression (Slifer, Ivancic, Parrish, Page, & Burgio, 1986), and disruption (Carr & Durand, 1985).

Despite the importance of functional analysis to assessment, the procedures may be complex and time consuming (Lennox & Miltenberger, 1989; Repp et al., 1990), and it may not always be possible to manipulate directly the variables related to problem behavior. Other potential limitations include the risk of establishing new behavioral functions during assessment and the inability of experimental analyses to identify all possible reinforcers for a behavior in its natural environment (Mace et al., 1991). When these problems are present or suspected, other assessment techniques should be considered. Because recent studies suggest that indirect methods (such as questionnaires or rating scales) may be unreliable for assessing problem behavior (Newton & Sturmey, 1991; Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991), descriptive analyses may be the most viable alternative to experimental methods.

Descriptive analyses involve direct observation of behavior and the relevant environments in which it occurs. Inferences about a behavior's maintaining variables are formulated when there is high correlation between specific environmental events and the behavior of interest. Three general classes of descriptive analysis have been examined. The simplest method, which reveals temporal distributions of behavior, is exemplified by the scatter-plot assessment (Touchette, MacDonald, & Langer, 1985). Observers using this technique record the occurrence of target behaviors within predetermined blocks of time to determine whether there is any reliable distribution of behavior across the day. If so, structural elements of the individual's daily schedule are then modified in an attempt to reduce the inappropriate behavior. Although the method generates quantifiable data, it contains no provision for identifying specific antecedents and consequences of behavior and will detect only those environmental conditions related to behavior on a regular temporal basis (Axelrod, 1987).

A second method reveals behavioral context but generally allows little or no quantification of behavior across time. This method, the narrative account, often employs a form called an A-B-C (antecedent–behavior–consequence) or "sequence analysis" chart (Sulzer-Azaroff & Mayer, 1977). Those working closely with the subject write brief descriptions of what occurs immediately prior to and following instances of the target behavior to determine the consistency with which specific antecedent or consequent events appear contiguous to the behavior. Coman and Houghton (1991) and Sasso et al. (1992) recently used this type of descriptive assessment to identify variables related to their subjects' problem behaviors. Although the procedure is easy to learn, it often requires extensive effort to implement (Pyles & Bailey, 1990) or results in subjective interpretations of events rather than objective descriptions (Lennox & Miltenberger, 1989). To circumvent these problems, Pyles and Bailey developed the "inappropriate record form," which lists prespecified antecedents, behaviors, and consequences for a given individual. When a target behavior occurs, observers simply check all relevant events. Like all narrative accounts, however, observers record events only when the target behaviors occur, and data obtained in this manner are difficult to quantify (i.e., it is possible that the same events are also highly correlated with the nonoccurrence of the target behavior).

A third type of descriptive assessment permits both the quantification of data on a fine scale and data collection on multiple events that occur independent of the target behavior. As described by Bijou, Peterson, and Ault (1968), observers use frequency or interval/time-sampling procedures to record occurrences of prespecified events and behaviors exhibited by the subject and those interacting with the subject during sessions that usually range from 15 to 45 min. This type of analysis is designed to reveal sequences of behaviors and their environmental correlates through time, and has been used in a wide range of settings to analyze variables relevant to aggression (Patterson, 1974), bizarre speech (Mace & Lalli, 1991), SIB (Maurice & Trudel, 1982), stereotypy (Repp, Singh, Karsh, &

Deitz, 1991), disruption (Baskett & Johnson, 1982; Strain & Ezzell, 1978), and multiple behavior problems (Vyse & Mulick, 1990; Wahler, Williams, & Cerezo, 1990).

Although the descriptive analysis is useful because it allows direct access to problem behavior in the natural environment, the method has certain limitations. It may be difficult to identify the reinforcing consequences of behaviors maintained on thin, intermittent schedules (Sulzer-Azaroff & Mayer, 1977), and relevant variables may not be apparent if caregivers manipulate the environment to make the occurrence of the behavior less likely. In other instances, irrelevant variables may mask relevant ones due to their relative frequencies (Iwata, Vollmer, & Zarcone, 1990). Most important, correlational data generated by descriptive analyses do not allow definitive conclusions about functional relations (Bijou et al., 1968).

Although numerous studies on the assessment of problem behaviors have presented descriptive data, few have demonstrated any clear environment–behavior relationships, directly incorporated the results into effective treatment procedures, or compared the results to those obtained from some other assessment method. In particular, the utility of descriptive analyses in identifying variables maintaining SIB remains unknown and should be examined to determine whether descriptive approaches to assessment could be useful alternatives to experimental approaches.

This type of inquiry could be undertaken by comparing data from descriptive analyses with those obtained using a well-established but different assessment method. Because a number of studies have demonstrated the utility of experimental analyses in the assessment and treatment of SIB, and because these methods are considered ideal for establishing functional relations more generally, the experimental analysis represents the best available standard for comparison.

In a recent study illustrating this type of comparison, Sasso et al. (1992) conducted descriptive and experimental analyses of 2 students' aggressive behavior. The two assessments yielded data that supported similar conclusions about variables maintaining the subjects' aggression. However, the descriptive analyses were conducted in an atypical manner: The subjects' classroom teachers recorded events occurring contiguous to instances of aggression during prespecified activities that were selected because of their similarity to conditions used in the experimental analysis. Thus, sampling methods used for the descriptive analysis increased the likelihood that data might resemble those from the experimental analysis, and it is unclear whether or not descriptive data that were more representative of the students' typical daily schedule would have shown any correspondence to the experimental data. A second limiting feature of the descriptive analysis was that, although data were collected in several environmental contexts, the analysis did not examine possible relationships between behavior and specific antecedent events (e.g., the presentation of instructions). If inappropriate behavior is maintained on thin schedules of reinforcement, the situational (antecedent) context in which the few reinforcers are delivered becomes highly significant in an attempt to identify behavioral function.

Mace and Lalli (1991) conducted independent descriptive and experimental analyses of an individual's "bizarre speech" that yielded somewhat different results. Descriptive data collected in the subject's group home were analyzed by way of conditional probabilities between behavior and either its antecedents or its consequences, and results suggested that the subject's behavior could have been maintained by either positive or negative reinforcement. A subsequent experimental analysis, designed to test these hypotheses, indicated that the behavior was maintained by positive reinforcement alone. Although the study's purpose was to show the advantage of linking experimental and descriptive analyses, the methodology allowed a direct comparison of the two approaches. Mace and Lalli thus provided one example in which descriptive and experimental data were not entirely consistent, and the generality of this finding is important to establish. The purpose of the present study was to conduct independent descriptive and experimental analyses for individuals who exhibited SIB and to determine the degree to which results

of both assessments led to similar conclusions about behavioral function.

METHOD

Subjects and Settings

Six adults—Chris, Sarah, Holly, Olivia, Stan, and Larry—participated. Their ages ranged from 27 to 43 years, and all were diagnosed as having profound mental retardation. All of the subjects lived in a public residential facility and had been referred to a day-treatment program for assessment and treatment of SIB that produced tissue damage and significantly interfered with progress in their educational programs. Their SIB consisted of head banging (Chris and Stan), head hitting (Olivia, Stan, and Larry), body hitting (Stan), hand biting (Chris and Larry), and hand mouthing (Sarah and Holly). All subjects had some receptive language skills, but none had any intelligible expressive language except for Sarah, who tended to repeat specific verbalizations without regard to context. None of the subjects had a medical diagnosis suggesting an organic etiology for their SIB, and the only subject having any sensory or motor impairment was Olivia, who was deaf and blind.

For the experimental analyses, individual sessions were conducted during the day-treatment program in rooms measuring approximately 3.0 m by 4.8 m or 5.7 m by 10.5 m and containing a table and several chairs. For the descriptive analyses, observation sessions usually took place in the subjects' residences (each lived in a different residence at the facility). During these observations, the subjects' locations varied both inside and outside the residences, although usually they were in their bedrooms, television/play room, dining room, or outside sitting on benches. Some sessions were conducted during off-residence programs located on the grounds of the facility (i.e., prevocational training for Chris, Sarah, Olivia, Stan, and Larry, and physical therapy for Holly).

Response Measurement and Reliability

Experimental analysis. Response definitions were developed on the basis of staff interviews and informal observations of the subjects prior to the study. Self-injurious responses were defined as follows: hand mouthing—contact of the tongue with any part of the hand or wrist, or insertion of any part of the hand or wrist between the lips without biting; face/head or body hitting—contact of an open or closed hand with any part of the face, head, or other body part (e.g., leg, chest); head or body banging—forceful contact of any part of the head or body with a stationary environmental object (e.g., wall, floor, furniture); and hand biting—closure of the upper and lower teeth on the flesh anywhere on the hand or wrist. Data were also collected on the following subject and experimenter responses: compliance with instructions, aggression and disruption, appropriate interaction with leisure materials, experimenter delivery of instructions, experimenter delivery of attention, and experimenter instruction removal.

Observers collected data on response frequency using a hand-held computer (Assistant, Model A102) that audibly signaled 10-s intervals. Observers were graduate and undergraduate students who had previously demonstrated proficiency with this type of data collection by attaining a 90% agreement criterion for three consecutive sessions. Interobserver agreement was assessed during at least 25% of the sessions for all subjects. In comparing observers' records, session time was divided into consecutive 10-s intervals, and agreement percentages were calculated on an interval-by-interval basis. The smaller number of responses in each interval was divided by the larger number of responses. These fractions were then summed across all intervals and divided by the total number of intervals in the session to get the percentage agreement between the two observers. Mean interobserver agreement across subjects was 94% for SIB (range, 83% to 99%), 98% for compliance (range, 90% to 100%), 98% for attention delivery (range, 92% to 100%), 97% for instruction delivery (range, 91% to 100%), and 99% (range, 96% to 100%) for instruction removal.

Descriptive analysis. SIB responses were defined as above. Additional subject and staff responses and the presence of certain environmental events were also recorded. Subject responses were

defined as follows: aggression—hitting, throwing objects, kicking, and so forth, directed at others; disruption—stripping, pushing objects over, and so forth,; and compliance—completion of a requested action with or without prompts. Staff responses were defined as follows: attention delivery—interactions with the subject, including client care or delivery of materials in a noninstructional context, reprimands contingent on subject behavior, and blocking subject behavior; instruction delivery—any direction to complete an action, including prompts, or the presence of an ongoing instructional context (the staff member is near the subject, waiting for compliance or monitoring the work; task materials, if any, are still in front of the subject); attention removal—cessation of attention that occurred continuously for at least 10 s; and instruction removal—termination of an instruction or ongoing instructional context. The presence of other environmental events recorded during the descriptive analyses included materials—items such as food, games, or training tasks; staff—a staff member in the same room as the subject; and ambient stimuli—music, TV, or other loud noises.

Observers used partial-interval recording to score the occurrence of subject and staff behaviors, as well as environmental events, in sequential order within continuous 10-s intervals. Observers were trained graduate and undergraduate students who had attained a 90% agreement criterion for three consecutive sessions. Interobserver agreement was assessed during at least 25% of the sessions for all subjects. Agreement percentages were calculated two ways. First, agreement on all responses and events was calculated on an interval-by-interval basis by dividing the number of agreements for each category by the total number of agreements and disagreements and multiplying by 100%. For the second analysis, agreement on the antecedents and consequences for each occurrence of SIB was calculated. For each occurrence of SIB marked by the primary observer, an agreement was scored if the second observer's data sheet revealed the same antecedent and consequent events as well as the occurrence of SIB. The total number of antecedent–behavior–consequence sequence agreements was divided by the total number of intervals containing SIB. Mean interobserver agreement across subjects was 97% or above (range, 92% to 100%) for all recorded subject responses and environmental events except antecedent–consequent sequences (M = 87%; range, 77% to 96%).

Experimental Design and Procedures

Independent descriptive and experimental analyses were conducted shortly after each subject was referred for treatment. The order in which assessments were conducted varied depending on unrelated factors (such as schedule openings). For Chris, Olivia, and Stan, the descriptive analyses were completed prior to the experimental analyses. Sarah's descriptive analysis was conducted after her experimental analysis was completed. The assessments were conducted simultaneously for Holly and Larry.

Experimental analysis. Subjects were exposed repeatedly to four conditions similar to those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982). The conditions were presented in a multielement format (Sidman, 1960) in which three to five sessions were conducted each day in a semirandom sequence, with each session lasting 15 min.

In the attention condition, the therapist provided statements of concern and disapproval (e.g., "Stop, you'll hurt yourself") and physical contact (e.g., patting the subject's back) contingent on the occurrence of SIB. This condition was designed to assess the effects of attention (social–positive reinforcement) on the rate of SIB. In the demand condition, the therapist presented instructions to the subject every 30 s using a graduated prompting procedure (verbal instruction, modeling, physical guidance). The instructions included academic and self-care tasks typically experienced by the subjects. Contingent on the occurrence of SIB, the therapist terminated the trial by removing the materials and turning away for 30 s. This condition was designed to assess the effects of escape from tasks (social–negative reinforcement) on the rate of SIB. In the alone condition, the subject was placed in a therapy room containing no toys or other materials. No one was present in the room except the observer, and no interaction with the subject occurred. This con-

dition, intended to simulate a "barren" environment, was designed to assess the effects of automatic or self-stimulatory reinforcement on the rate of SIB. In the play condition, the therapist provided attention, physical contact, and access to leisure materials every 30 s. No instructions were delivered, and all instances of SIB were ignored. This condition, intended to simulate an "enriched" environment, was designed to serve as a control for the other three conditions.

Descriptive analysis. Each subject was observed during 15-min sessions at varied times between 9 a.m. and 5 p.m., Monday through Friday. Subjects were observed once or twice each day for several weeks. Prior to the initiation of data collection, a copy of each subject's daily schedule was obtained to ensure that observations included a representative sample of activities: meals, leisure time, group activities, prevocational training, self-care tasks, and client care. The proportion of observations conducted during each activity was roughly equivalent to the proportion of time the subjects engaged in the activity.

Prior to data collection, each residence supervisor received a memo describing the observations and requesting that staff members ignore the observer and interact with the subject as normally as possible. Upon entering the residence, the observer reminded staff members to continue any ongoing activities and to interact normally with the subject. Throughout the 15-min session, the observer followed the subject as unobtrusively as possible to any part of the residence. If the subject left the residence to go to another part of the facility (such as the campus store), the observer continued data collection if possible. The observer did not interact with the subject at any time. If a reliability observer was present, the two observers collected data independently and attempted to remain several feet apart.

The observer carried a clipboard holding the data collection forms and a tape recorder that signaled continuous 10-s intervals. When only one observer was present, he or she listened to the tape recorder via earphones. During reliability checks, the tape recorder was played at a low but audible level so both observers could hear the signals. Each response on the observational code was assigned a specific number (e.g., instructions were coded with a "4"). Observers recorded the occurrence and sequence of each response within 10-s intervals by writing sequences of numbers from left to right in each interval block on the data sheet. When a response was longer than 10 s, each new interval was coded with the response until it concluded. If both the staff member and subject continued responding across intervals, the initial order was maintained at the start of each new interval. For example, if a staff member asked a subject to go outside (instruction delivery), and the subject began to walk (compliance), each successive interval would be immediately coded with instruction and compliance ("4, 5") until the situation was terminated. Observers also noted the presence or absence of environmental events (staff, materials, stimuli) in each interval. All subjects except Olivia were observed for 24 sessions or a total of 6 hr. Olivia was observed for 48 sessions (12 hr) to determine if a lengthier assessment would yield clearer results.

Data Analysis

In the experimental analysis, antecedent and consequent events are both predefined and predetermined (controlled); thus, data typically are analyzed by calculating frequencies (or percentages of intervals) of SIB for each session and then are plotted to show responding given the presence or the absence of prearranged experimental conditions. For example, if SIB is observed in an instructional context in which a subject is allowed to escape from learning trials contingent on SIB, the presence of instructions as an antecedent event and escape (but not attention) as a consequent event can be assumed. This method did not seem appropriate for the descriptive analysis because antecedent and consequent events could vary in an ***uncontrolled*** manner within each observation session, so that a simple analysis of the frequencies of SIB would reveal nothing about the influence of specific variables. Even when the general context of a session is known (e.g., task related), it cannot be assumed that occurrences of behavior are related to some events (e.g., delivery of or escape from instructions) rather

Table 1
Conditional Probability Formulas for the Experimental and Descriptive Analyses

Experimental analysis	
Antecedents:	Intervals containing SIB that followed an antecedent event / Intervals scored with SIB
Consequences:	Intervals containing SIB that preceded a consequent event / Intervals scored with SIB
Other:	Intervals containing SIB with no antecedent or consequent event / Intervals scored with SIB
Descriptive analysis	
Antecedents:	(a) Intervals containing SIB that followed an antecedent event / Intervals scored with SIB
	(b) Intervals containing an antecedent event that preceded SIB / Intervals scored with the event
Consequences:	(a) Intervals containing SIB that preceded a consequent event / Intervals scored with SIB
	(b) Intervals containing a consequent event that followed SIB / Intervals scored with the event
Concurrent events:	(a) Intervals containing both SIB and a concurrent event / Intervals scored with SIB
	(b) Intervals containing both SIB and a concurrent event / Intervals scored with the event

than others (e.g., attention) because the extent to which any particular event occurred is unknown. For these reasons, data from descriptive observational studies usually have been summarized via conditional probabilities (Bakeman & Gottman, 1986; Sackett, 1979) or correlational analyses (e.g., Vyse & Mulick, 1990), which compare the relative frequencies of occurrence for events of interest. Although not typically done, this type of analysis could be applied to the experimental data as well as to the descriptive data in the present study, thereby allowing a direct comparison of results from the two data sets. Prior to analysis, the descriptive data were combined into consecutive 1-hr observation blocks, each generally containing a variety of activities and occurrences of all response measures. The experimental data were similarly blocked for purposes of comparison (i.e., data from each set of the four 15-min conditions were combined to produce 1-hr blocks).

Experimental analysis. Data on SIB were analyzed by computing conditional probabilities (occurrences) based on the relative frequencies of SIB and antecedent or consequent events. The proportion of SIB that occurred prior to or following specific events was calculated by dividing the number of intervals containing SIB that occurred prior to or following each event (in the same interval as the SIB or in the adjacent interval) by the total number of intervals scored with SIB. Table 1 (top) shows the conditional probability formulas for the experimental analysis. Variables included in the analysis were those directly manipulated in the four experimental conditions. Antecedent events were instructions and the absence of noncontingent interaction (given therapist presence). Consequent events were the removal of instructions and the delivery of attention. In addition to these four conditional probabilities, the proportion of SIB that occurred with no therapist interaction prior to and following instances of SIB was calculated for each subject. These calculations were designed to answer the question: What is the probability that a response or event occurred (prior to or following SIB), given that SIB has occurred? For example, the probability that attention was delivered following SIB

was determined by calculating the proportion of SIB followed by presentation of attention.

Descriptive analysis. The descriptive data were analyzed by computing conditional probabilities (occurrences) for antecedent, consequent, and concurrent events. Conditional probabilities were calculated two ways so that all relevant information could be included in the analysis. Table 1 (bottom) shows the conditional probability formulas for the descriptive analysis. As with the experimental data, the proportion of SIB that occurred prior to and following each staff response category was calculated. Thus, the proportion of SIB occurring prior to and following staff attention, instructions, attention removal, and instruction removal was determined, generating eight conditional probabilities. In addition, the proportions of SIB that followed intervals containing no staff interaction and the proportion of SIB that occurred with no consequent events (in the same interval as the SIB or in the adjacent interval) were calculated. Although some previous studies have examined events removed more temporally from behavior (e.g., 30 s), a detailed inspection of the data in this study indicated that longer time intervals did not produce clearer results. In fact, Karpowitz and Johnson (1981) demonstrated that events occurring within the same or adjacent 10-s intervals were better predictors of behavior than were events occurring two or three intervals away. For chains of subject–staff behaviors across adjacent intervals (e.g., SIB–attention–SIB–attention, or instruction–SIB–instruction continuation–SIB), single occurrences of staff responses were not considered both antecedent and consequent to SIB. For example, an initial occurrence of a staff response (such as contingent attention) presented consequent to SIB was not also scored as an antecedent to SIB that immediately followed it. In addition to the above calculations, the proportions of SIB occurring concurrent with other environmental events (materials, no materials, staff, no staff, stimulation, no stimulation) and the proportions of intervals containing the simultaneous absence of staff, materials, and stimulation that occurred concurrent with SIB were determined.

A second type of analysis seemed necessary for the descriptive data, which, unlike the experimental data, included varying base rates of the responses and events. For example, some observation hours contained many more instruction intervals than did other hours. If an observation hour included many instruction intervals but little SIB for a subject whose SIB was maintained by positive reinforcement, the few instances of SIB could follow instructions by chance, and the resulting analysis would reveal a high conditional probability for SIB following instructions even though instructions rarely set the occasion for the subject's SIB. In the experimental analysis, this problem is not encountered because prespecified and constant amounts of all antecedent and consequent events are included in every observation hour. To correct this problem, the proportions of each staff response category occurring antecedent and consequent to SIB and the proportion of other events occurring concurrent with SIB were calculated. The proportion of intervals containing no staff interaction that preceded SIB was also determined. These calculations were designed to answer the question: What is the probability that SIB has occurred, given that another response or event has occurred (prior to, concurrent with, or following SIB)? For example, the probability that SIB occurred following presentation of an instruction was determined by calculating the proportion of instructions presented antecedent to SIB. Even with the addition of these conditional probabilities, however, the first type of analysis was still necessary. For example, an observation hour might include few instruction intervals and many instances of SIB for a subject whose SIB was self-stimulatory in nature (maintained by automatic reinforcement). If, by chance, some SIB followed the few instruction intervals occurring during the hour, the proportion of instructions preceding SIB would be high even though most SIB occurred in the absence of instructions. In all, these calculations generated 30 conditional probabilities. Total proportions of intervals containing each variable (i.e., base rates) were calculated for all subjects by dividing the total number of intervals containing each response or event by the total number of intervals the subjects were observed. (Base rates for these data are available upon request.)

After all conditional probabilities had been an-

alyzed, it was apparent that certain variables could be combined or eliminated. Data on compliance to instructions and the occurrence of other inappropriate behavior revealed nothing about the possible function(s) of SIB, so these data were not included in the analysis. Because subjects were rarely exposed to the simultaneous absence of staff, materials, and stimulation, nearly zero proportions of SIB occurred during these intervals. Thus, these calculations were also removed from the final data analysis. In addition, combining the staff response categories of instructions and attention led to clearer data displays yet produced no differences in data interpretation. The conditional probabilities for these categories were recalculated and presented as staff interaction. For example, the antecedent delivery of attention and the antecedent delivery of instructions were combined and analyzed as the antecedent delivery of interaction. Removal of attention and removal of instructions were similarly combined and presented as removal of interaction.

RESULTS

Chris

Results of Chris's experimental analysis, which was completed in 3 hr, are presented in Figure 1. SIB occurred exclusively during intervals either following instructions or preceding instruction removal, both of which were components of the demand condition. SIB never followed intervals containing no interaction, preceded intervals containing attention, or occurred in the absence of antecedent and consequent therapist interaction. These results indicated that Chris's SIB was maintained by social–negative reinforcement (escape from tasks).

Before describing the results of Chris's descriptive analysis (shown in Figure 2), some general comments on data organization are in order. The descriptive analyses examined a number of variables, each potentially supporting one of three hypotheses: social–positive reinforcement, social–negative reinforcement, or automatic reinforcement. The top panel (Panel A) shows the proportion of event intervals (materials, no materials, stimulation, no stimulation, staff, no staff) occurring concurrent with SIB (left figures) and the proportion of SIB intervals occurring concurrent with these events (right figures). Individuals whose behaviors are maintained by social consequences (positive or negative reinforcement) might be more likely to exhibit these behaviors in the presence of materials and staff because these events usually are paired with the delivery of positive reinforcers (such as attention or tangible items) or the presentation of aversive events (such as instructions). Conversely, individuals whose behaviors are maintained by some type of automatic reinforcement might be more likely to exhibit these behaviors in the absence of staff, materials, and stimulation because these events may sometimes constitute sources of competing or alternate reinforcement. For example, leisure materials or staff attention may provide reinforcement that is functionally similar to that maintaining SIB (e.g., increased sensory stimulation).

For Chris, the top left and right figures in Panel A show that his SIB was not differentially related to the presence or absence of materials and stimulation. These data, which are shown for completeness, did not provide much useful information about behavioral function for any of the subjects. In most cases, the proportion of SIB occurring in the absence of materials and stimulation was higher than that occurring in the presence of these events (top right figure) simply because subjects were rarely exposed to these events. Thus, a discussion of these data will be omitted from the results for the rest of the subjects. For Chris, the bottom left figure in Panel A shows that larger proportions of staff intervals contained SIB than did no-staff intervals. These data suggest that staff presence was discriminative for SIB and are consistent with a social (either positive or negative) reinforcement hypothesis. The bottom right figure in Panel A shows that all SIB occurred with staff present, a result that would be expected if Chris's SIB was maintained by social consequences.

Panel B shows proportions of staff responses occurring antecedent to SIB (left figure) and proportions of SIB following the staff responses (right figure). If an individual's behavior is maintained by social–negative reinforcement, the presentation of attention or instructions would sometimes occasion SIB. On the other hand, the removal of

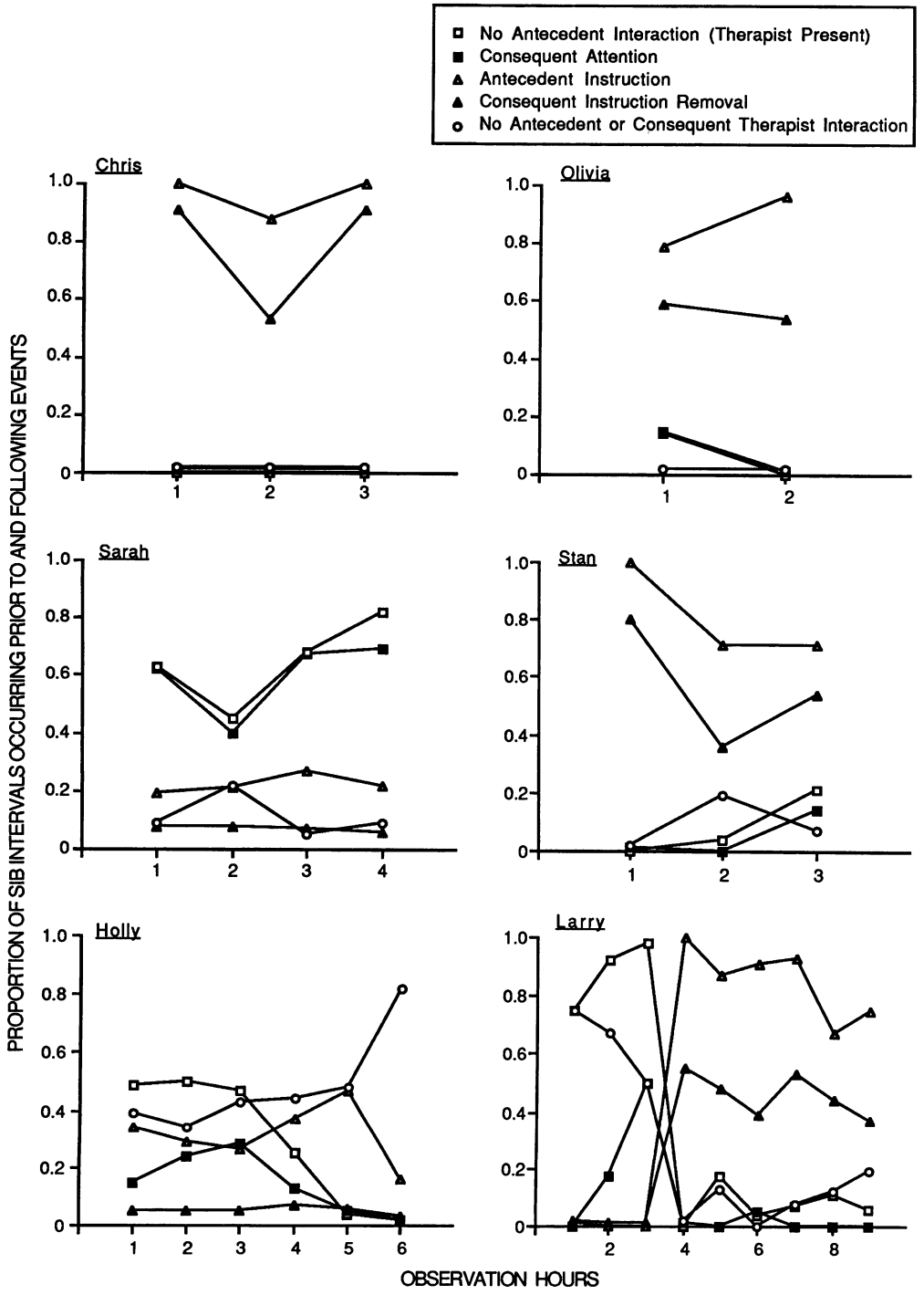

Figure 1. Results of the experimental analyses for all 6 subjects. Data reflect proportions of intervals containing SIB that occurred prior to and following events manipulated in the experimental conditions.

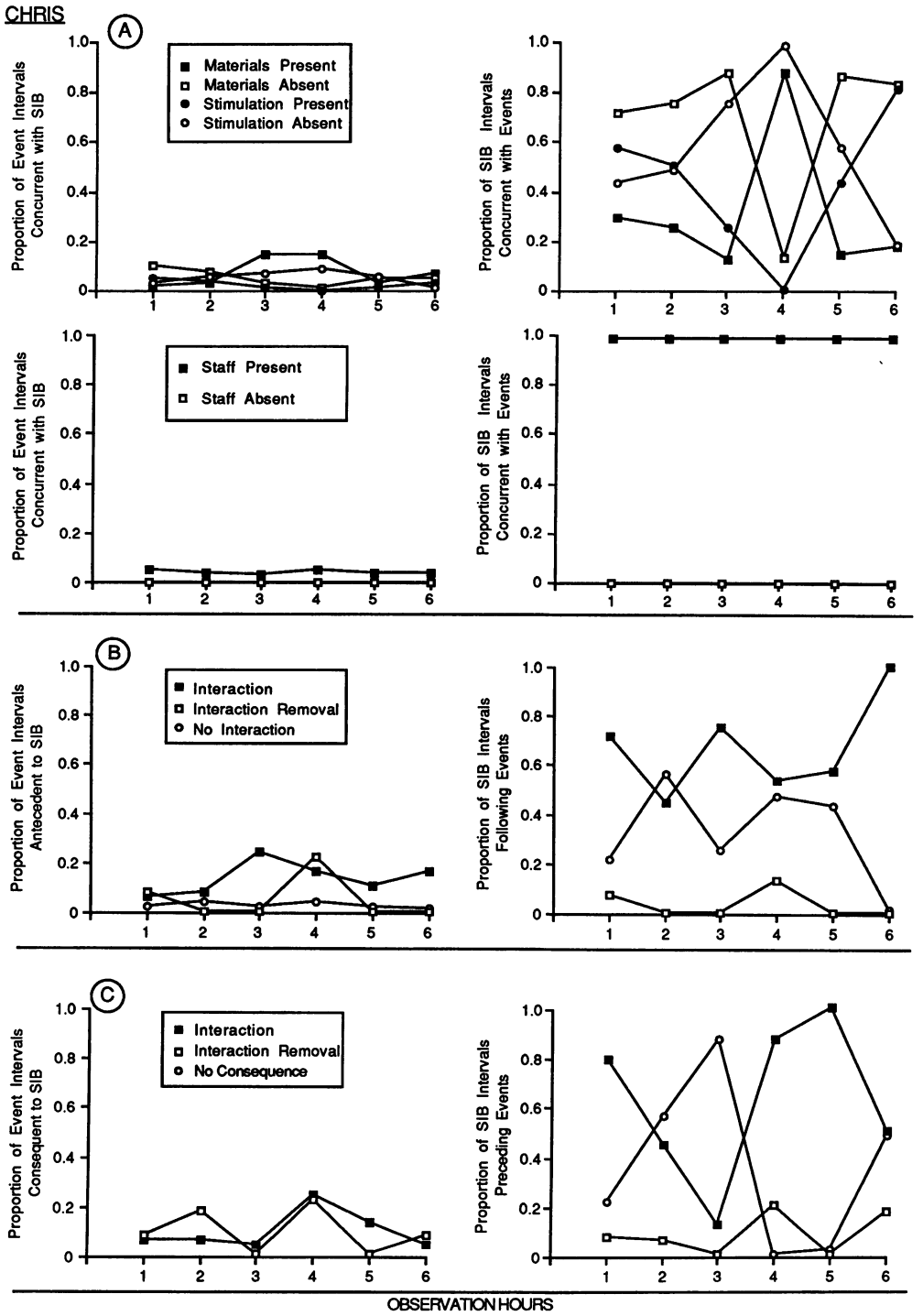

Figure 2. Results of Chris's descriptive analysis. Panel A: the proportion of event intervals concurrent with SIB (left) and the proportion of SIB intervals concurrent with these events (right). Panel B: proportions of staff response intervals antecedent to SIB (left) and proportions of SIB intervals following instances of staff responses (right). Panel C: proportions of staff response intervals consequent to SIB (left) and proportions of SIB intervals preceding instances of staff responses (right).

these events or the absence of staff interaction would sometimes occasion SIB if an individual's behavior is maintained by social–positive reinforcement. For Chris, the left figure in Panel B shows that a small proportion of intervals containing staff interaction occurred antecedent to SIB, whereas fewer intervals containing interaction removal occurred antecedent to SIB, and nearly zero intervals containing no interaction occurred antecedent to SIB. These data are probably most consistent with a social–negative reinforcement account for his SIB because the highest proportions of staff interaction occurred antecedent to SIB. The right figure in Panel B shows that moderate proportions of SIB intervals followed staff interaction and no interaction, and very small proportions of SIB intervals followed interaction removal. These data are equivocal because SIB was not differentially correlated with the presence or absence of antecedent staff interaction.

Panel C shows proportions of intervals containing staff responses that occurred consequent to SIB (left figure) and proportions of SIB intervals preceding the staff responses (right figure). The right figure also shows proportions of SIB that occurred with no consequences (i.e., nothing presented or removed). If an individual's behavior is maintained by social–negative reinforcement, the removal of instructions (or possibly attention) would sometimes follow SIB. Conversely, the presentation of these events would sometimes follow SIB if an individual's behavior is maintained by social–positive reinforcement. If SIB was rarely followed by any events, the behavior might be maintained by directly produced, nonsocial consequences. For Chris, the left figure in Panel C shows that small proportions of intervals containing staff interaction and interaction removal followed SIB, suggesting that his SIB could be maintained by either attention or escape. The right figure in Panel C shows that variable but high proportions of SIB intervals preceded staff interaction or occurred with no consequences, whereas small proportions were followed by the removal of interaction. These data are most consistent with a positive reinforcement (attention) hypothesis, because his SIB more often resulted in attention or additional instructions rather than the removal of these events.

Results of Chris's descriptive analysis, then, reveal the social nature of the variable(s) maintaining his SIB, although they do not differentiate well between attention and escape (positive vs. negative reinforcement). Chris sometimes exhibited SIB when staff members did not interact with him or when they provided either attention or instructions. They responded to most instances of SIB with social disapproval ("Stop that!") or additional instructions and occasionally removed an instruction during instructional contexts. Results of Chris's experimental assessment, however, clearly indicated that his SIB was maintained by negative reinforcement only. These data complement those presented by Mace and Lalli (1991), in which a descriptive analysis suggested either attention- or escape-maintained "bizarre speech" but a subsequent experimental analysis suggested only attention as the maintaining variable.

Sarah

Results of Sarah's experimental analysis, which was completed in 4 hr, are presented in Figure 1. The highest proportions of SIB followed intervals containing no interaction and preceded intervals containing attention, both indicating that her SIB was maintained by social–positive reinforcement. Although some proportion of SIB occurred following instructions, very little resulted in instruction removal because SIB usually occurred between instructional sequences. Very little SIB occurred in the absence of antecedent or consequent therapist interaction.

Results of Sarah's descriptive analysis are presented in Figure 3. As was the case with Chris, the presence or absence of materials and stimulation was not differentially related to Sarah's SIB (Panel A, top left and right). She was more likely to engage in SIB when staff were present than when they were absent (Panel A, bottom left). Nearly all SIB occurred with staff present, whereas little SIB occurred concurrent with no-staff intervals (Panel A, bottom right). These data, like those for Chris, suggest a social function for Sarah's SIB.

Panel B (left) shows that moderate proportions of intervals containing staff interaction and no interaction occurred antecedent to SIB, and small

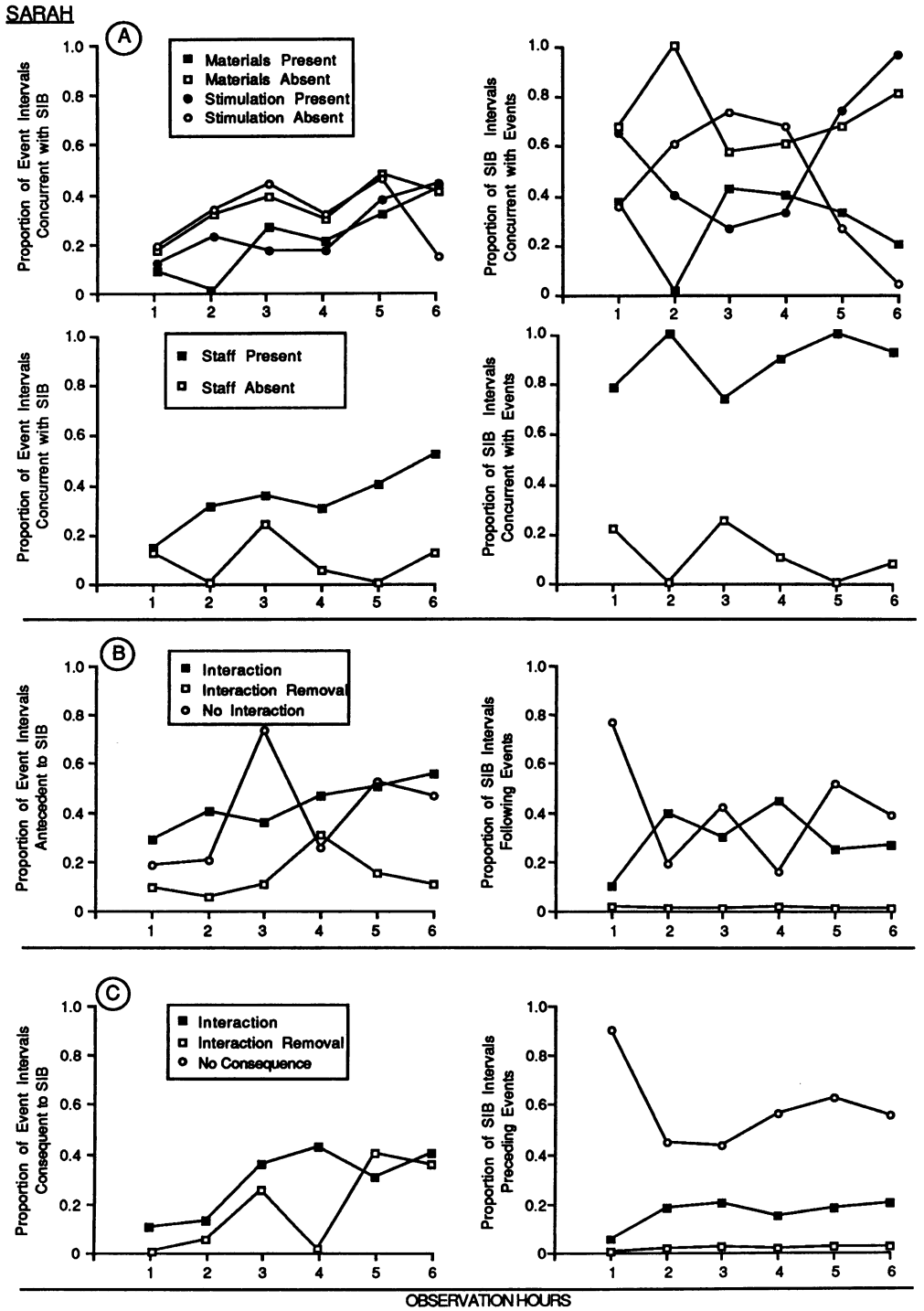

Figure 3. Results of Sarah's descriptive analysis. See Figure 2 for a description of the data presented in each graph.

proportions of interaction removal occurred antecedent to SIB. Panel B (right) also shows that moderate proportions of SIB intervals followed staff interaction and no interaction. These data, although ambiguous, could support either the social–positive or social–negative reinforcement hypothesis: If Sarah's SIB were maintained by the presentation or the removal of staff interaction, some proportion of SIB would follow no interaction or the delivery of instructions and attention.

Panel C (left) shows that moderate proportions of intervals containing staff interaction and the removal of interaction followed instances of SIB. Panel C (right) also shows that the highest proportions of SIB intervals were followed by no consequences, and small proportions were followed by staff interaction. Nearly zero proportions were followed by interaction removal. These data (Panel C, right) probably provide the most support for the social–positive reinforcement hypothesis because so little SIB resulted in the removal of either attention or instructions. However, these results suggest that her SIB was generally maintained on thin schedules of reinforcement (i.e., SIB produced some attention but usually no consequences).

Data from Sarah's descriptive analysis were similar to those obtained for Chris in that her results were inconsistent with an automatic reinforcement account of SIB but did not differentiate between attention and escape as the maintaining social reinforcer. Sarah's SIB seemed to be related to the presence of staff and either the presentation or removal of interaction, suggesting that the SIB might be multiply controlled. By contrast, the experimental assessment clearly indicated that her SIB was maintained by social–positive reinforcement in the form of attention.

Holly

Holly's experimental analysis was completed in 6 hr. Results (Figure 1) initially indicated that moderate proportions of intervals containing SIB were contiguous to all manipulated variables except consequent instruction removal. During the final 3 observation hours, however, the proportion of SIB occurring in the absence of antecedent and consequent interaction gradually increased, while all other proportions decreased to near zero levels. These data suggested that her SIB was not maintained by social consequences. Although moderate proportions of SIB followed instructions during all but the final observation hour, very little resulted in instruction removal because most SIB occurred between prompting sequences. These data suggest that Holly's hand mouthing was maintained by automatic consequences, and that the presence of alternate sources of stimulation (in the instruction, attention, and play conditions) resulted in some suppression of SIB.

Results of Holly's descriptive analysis are presented in Figure 4. Panel A (top) shows no relationship between the presence or absence of materials or stimulation and SIB. Panel A (bottom left) also shows that similar proportions of staff and no-staff intervals occurred concurrent with SIB (although data were more variable for no-staff intervals), indicating that Holly's SIB was unrelated to staff presence or absence. These results are consistent with an automatic reinforcement hypothesis. On the other hand, the bottom right figure in Panel A shows that Holly exhibited small proportions of SIB during no-staff intervals and large proportions of SIB during staff intervals (inconsistent with an automatic reinforcement account). However, these data could be the result of a high base rate of staff intervals in Holly's assessment; that is, staff members rarely were absent.

Panel B (left) shows that relatively small proportions of intervals containing staff interaction and interaction removal occurred antecedent to SIB, whereas large proportions of intervals containing no staff interaction occurred antecedent to SIB. These data are consistent with either the automatic or positive reinforcement hypotheses. That is, the absence of interaction could occasion SIB maintained by either attention or automatic reinforcement. Panel B (right) also shows that nearly all of Holly's SIB followed the absence of staff interaction.

Panel C (left) shows that small proportions of intervals containing staff interaction occurred consequent to SIB, whereas nearly zero proportions of interaction removal occurred consequent to SIB (with the exception of the final observation hour). These

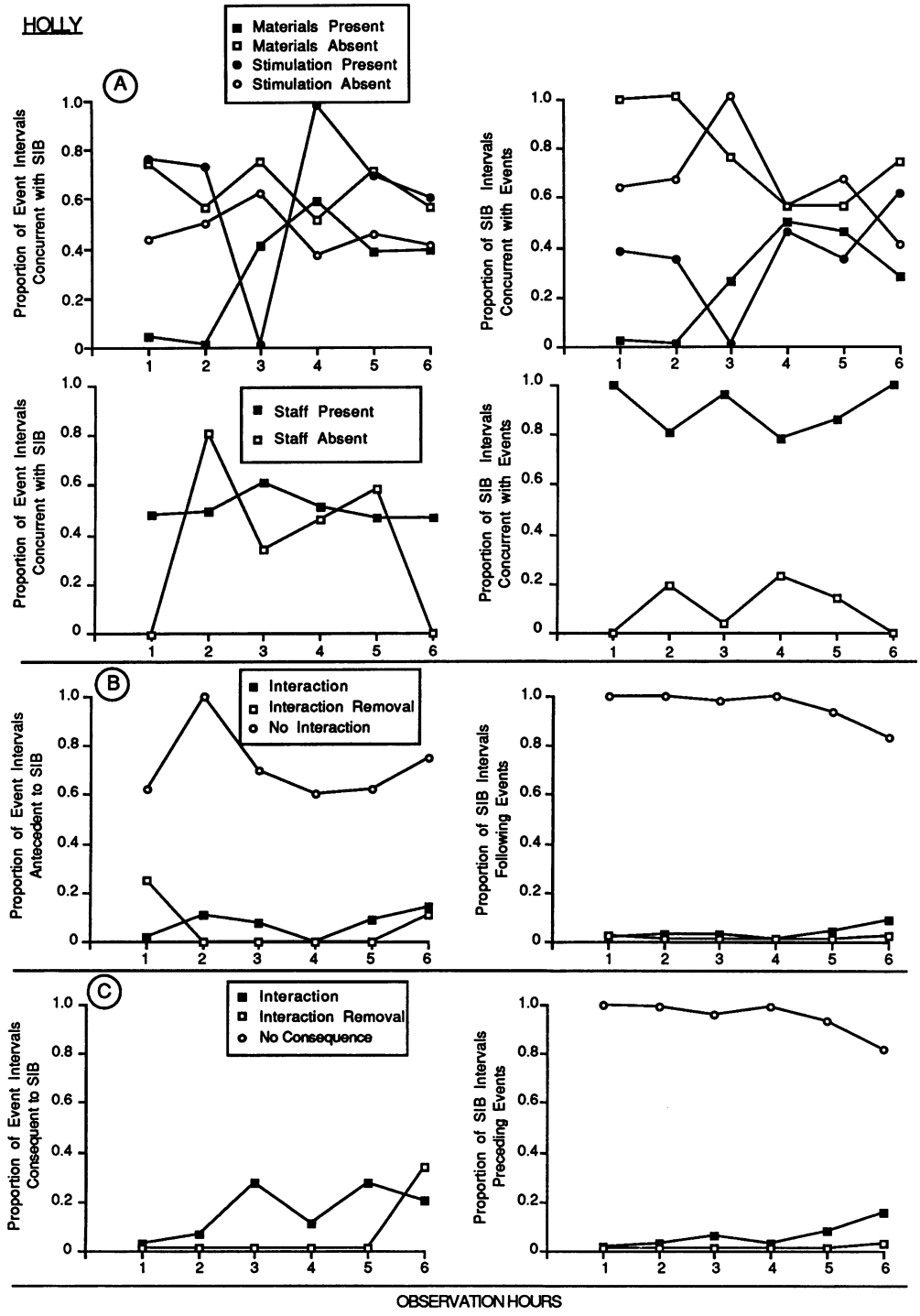

Figure 4. Results of Holly's descriptive analysis. See Figure 2 for a description of the data presented in each graph.

results are most consistent with the positive reinforcement hypothesis because some proportion of staff interaction followed SIB during all the observation hours, but the removal of interaction rarely followed SIB. The right figure in Panel C, however, shows that nearly all SIB occurred in the absence of consequences, providing little support for a social reinforcement account of her SIB.

Holly's descriptive data reveal the nonsocial nature of the variable(s) maintaining her SIB and most strongly support the automatic reinforcement hypothesis. Although some proportion of the staff responses occurred antecedent and consequent to SIB, the majority of Holly's hand mouthing occurred independent of staff interaction. It is unlikely, although not impossible, that her SIB would have been maintained on such thin schedules of social reinforcement or would have occurred so frequently in the absence of clear antecedent staff responses. Results of Holly's experimental analysis also indicated that her SIB was maintained by automatic consequences; thus, the two assessment procedures produced data leading to similar conclusions.

Olivia

Data from Olivia's experimental analysis (Figure 1) seemed quite clear after only 2 hr of observation, so additional sessions were not conducted. The highest proportions of intervals containing SIB followed instructions and preceded instruction removal, both indicating that her SIB was maintained by escape (negative reinforcement). No SIB occurred in the absence of antecedent and consequent interaction, and small proportions of SIB followed the absence of interaction (therapist present) and preceded the delivery of attention.

Results of Olivia's descriptive analysis are presented in Figure 5. Panel A (left) shows that no particular event seemed to be correlated with the presence of SIB. Panel A (bottom right) also shows that large proportions of SIB occurred in the presence of staff and small proportions of SIB occurred in the absence of staff, suggesting that her SIB probably was not maintained by automatic consequences.

Panel B (left) shows that similar proportions of intervals containing staff interaction, interaction removal, and no interaction occurred antecedent to SIB. Panel B (right) also shows that the highest proportions of SIB intervals followed the absence of staff interaction, and moderate proportions followed staff interaction. Small proportions followed the removal of interaction. These findings are consistent with a social reinforcement account for Olivia's SIB. Panel C (left) shows that small to moderate proportions of intervals containing the removal of staff interaction followed SIB, and small proportions of intervals containing staff interaction followed SIB. Panel C (right) also shows that small proportions of SIB preceded staff interaction and interaction removal, and that nearly all SIB occurred in the absence of staff consequences.

Results of Olivia's descriptive analysis are more ambiguous than those of the preceding subjects, even though twice as many observation sessions were conducted in an attempt to obtain clearer results. Olivia was somewhat more likely to exhibit SIB when staff were present rather than absent. She exhibited much of her SIB in the absence of staff interaction but, as the left figure in Panel B shows, equivalent proportions of intervals containing the delivery of interaction and no interaction preceded SIB. In addition, the removal of ongoing instruction or attention sometimes occasioned SIB. When Olivia exhibited SIB, staff members most often ignored it by providing no interaction or continuing an ongoing instruction. At times, however, they responded to her SIB with social disapproval ("Stop that!") or statements of concern ("What's wrong?") or by removing an instruction. These patterns of interaction appear to support either the social–positive or social–negative reinforcement hypothesis. However, results of her experimental analysis clearly indicated that her SIB was maintained primarily by social–negative reinforcement (escape from instructions).

Stan

Results of Stan's experimental analysis are presented in Figure 1. His assessment was completed in 3 hr, and the results were similar to those ob-

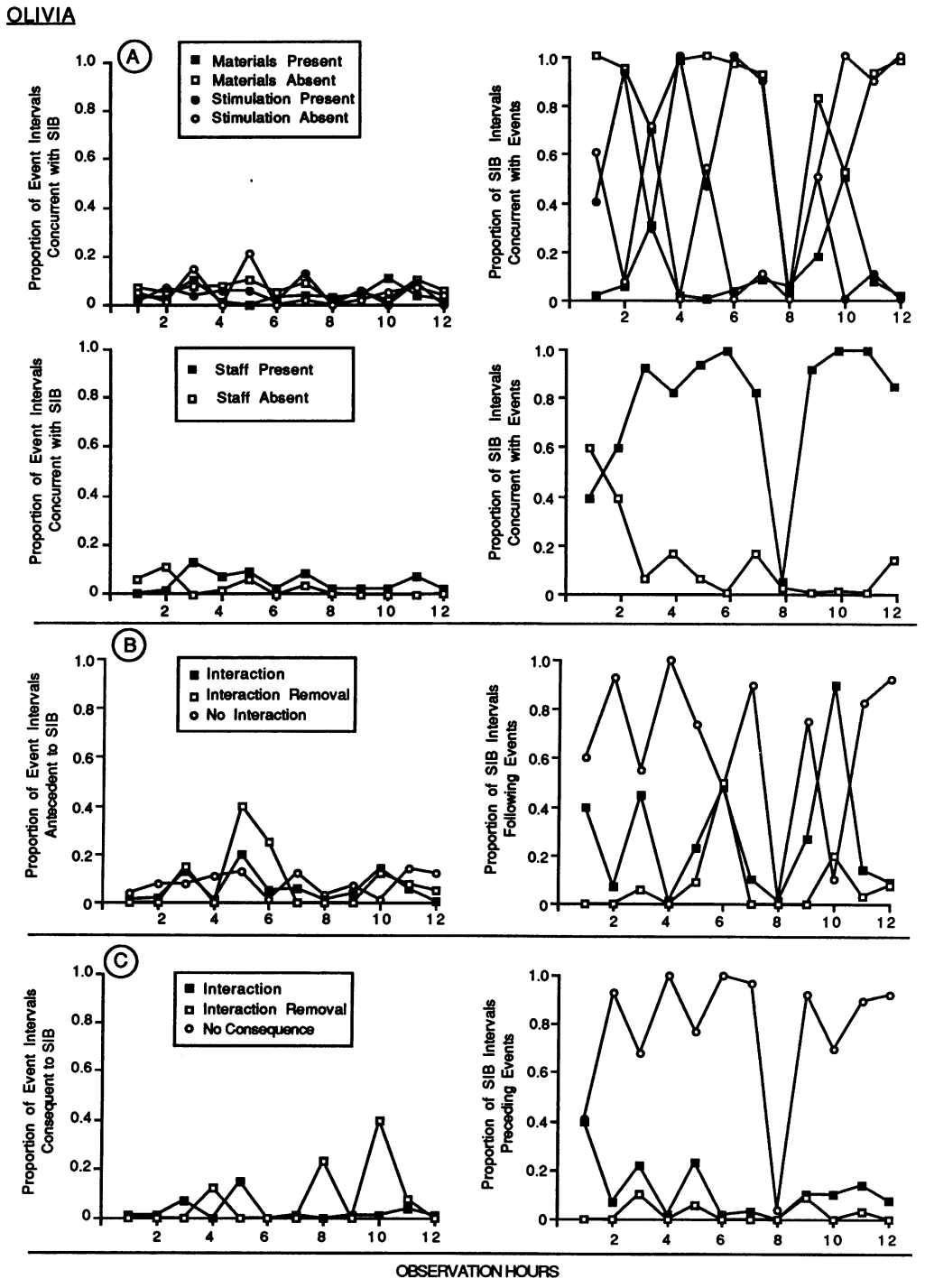

Figure 5. Results of Olivia's descriptive analysis. See Figure 2 for a description of the data presented in each graph.

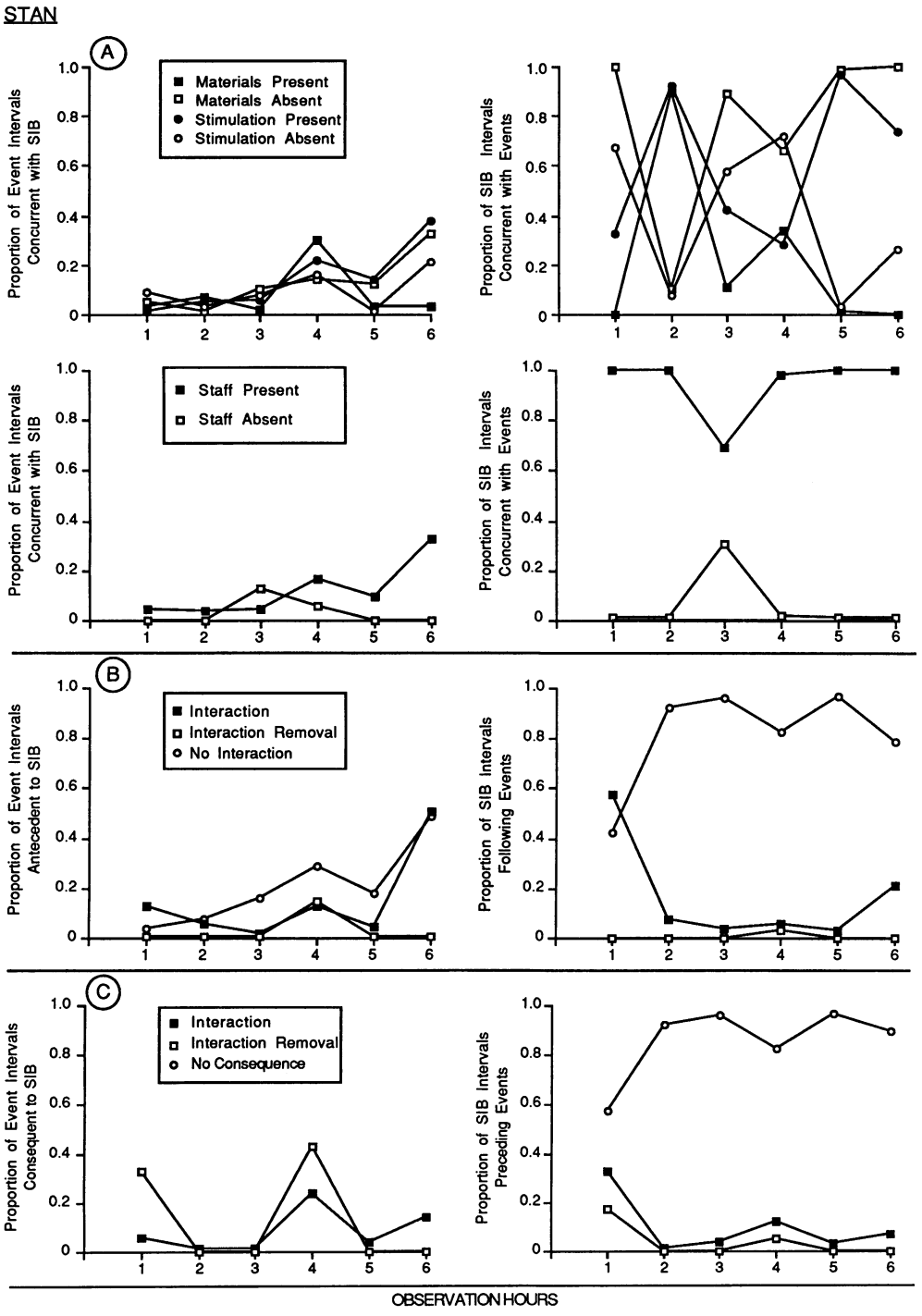

Figure 6. Results of Stan's descriptive analysis. See Figure 2 for a description of the data presented in each graph.

tained for Chris and Olivia. The highest proportions of SIB followed instructions and preceded instruction removal, both indicating that his SIB was maintained by social–negative reinforcement.

Results of Stan's descriptive analysis are presented in Figure 6. Panel A (bottom left) shows that, with the exception of the third observation hour, he consistently exhibited SIB during a higher proportion of intervals containing staff presence than in those containing staff absence. Panel A (bottom right) also shows that Stan exhibited more SIB when staff members were present than when they were absent. These data suggest that Stan's SIB was maintained by social consequences.

Panel B (left) shows that small proportions of intervals containing staff interaction and no interaction occurred antecedent to SIB and that during most observation hours, no intervals containing interaction removal occurred antecedent to SIB. Panel B (right) also shows that the majority of SIB followed intervals containing no interaction, whereas a small proportion of SIB followed staff interaction. These data, considered in combination with those from Panel A (right), provide the most support for the social–positive reinforcement hypothesis because nearly all of Stan's SIB occurred in the presence of staff but following no interaction.

Panel C (left) shows that small and variable proportions of intervals containing interaction and the removal of interaction occurred consequent to SIB. These data could support either the social–positive or social–negative reinforcement hypothesis. However, Panel C (right) also shows that the majority of SIB occurred with no consequences. These data, which are similar to the results of Holly's descriptive analysis, do not provide much support for either an escape or attention account of Stan's SIB.

Results of Stan's descriptive analysis indicate that he was more likely to exhibit SIB in the presence of staff, although staff members generally ignored his SIB in nontraining contexts and continued to deliver instructions in training contexts. Thus, the social nature of his SIB seemed apparent, but the reinforcer (attention or escape) was rarely delivered. When these reinforcers were delivered consistently during Stan's experimental analysis, the effects of escape from educational tasks on SIB were clear.

Larry

Results of Larry's experimental analysis are presented in Figure 1. His assessment, which was completed in 9 hr, initially showed the highest proportions of SIB preceding no interaction (therapist present) and with no antecedent or consequent interaction. As assessment continued, these proportions decreased, and the highest proportions of SIB occurred following instructions and preceding instruction removal. These data indicate that Larry's SIB was maintained by social–negative reinforcement.

Results of Larry's descriptive analysis are presented in Figure 7. Panels A, B, and C (left) show relatively undifferentiated results, but the bottom right figure in Panel A shows that higher proportions of SIB occurred when staff were present than when they were absent, suggesting that Larry's SIB was maintained by social consequences. Panel B (right) shows that the highest proportions of intervals containing SIB followed either no interaction or the delivery of interaction, and Panel C (right) shows that the highest proportions of SIB occurred with no consequences.

Results of Larry's descriptive analysis discounted an automatic reinforcement account of SIB but did not reveal a specific social reinforcer because the typical staff response was to provide few interactions antecedent or consequent to SIB. Results of his experimental analysis indicated that escape (negative reinforcement) was the maintaining contingency.

Summary of Results for the Experimental and Descriptive Analyses

Table 2 shows the variables included in the experimental and descriptive analyses grouped according to the hypotheses they would support if found to be associated with SIB. The descriptive analyses contain larger numbers of potentially relevant events due to the uncontrolled nature of the observed interactions. For example, the category of "Staff/Materials Present" is not included in the experimental analysis because it was perfectly correlated with "No Antecedent Interaction" and "Consequent Attention" in the attention condition (social–positive reinforcement) or "Antecedent In-

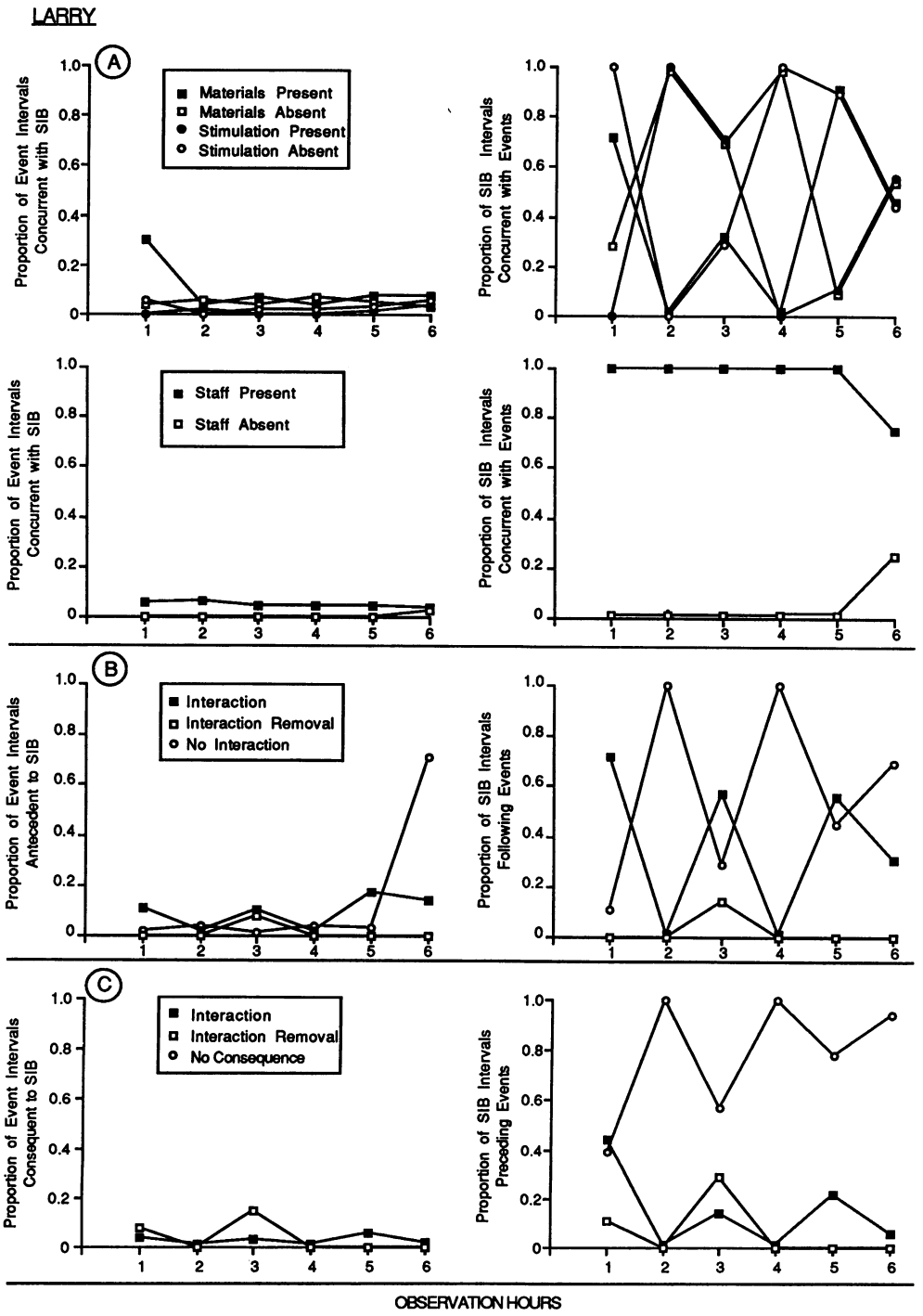

Figure 7. Results of Larry's descriptive analysis. See Figure 2 for a description of the data presented in each graph.

Table 2

Summary of Results for Experimental and Descriptive Analyses. Variables Are Grouped According to Behavioral Function. Those Found to be Associated with SIB Are Noted by a "+."

	Chris	Sarah	Holly	Olivia	Stan	Larry
Experimental analysis						
Social–positive reinforcement (attention)						
No antecedent interaction (therapist present)	−	+	−	−	−	−
Consequent attention	−	+	−	−	−	−
Social–negative reinforcement (demand)						
Antecedent instruction	+	−	−	+	+	+
Consequent instruction removed	+	−	−	+	+	+
Automatic reinforcement (alone)						
No antecedent or consequent interaction	−	−	+	−	−	−
Descriptive analysis						
Social–positive reinforcement						
Staff/materials present	+	+	+	+	+	+
No antecedent interaction	+	+	+	+	+	+
Antecedent interaction removal	−	−	−	−	−	−
Consequent interaction	+	+	−	−	−	−
Social–negative reinforcement						
Staff/materials present	+	+	+	+	+	+
Antecedent interaction	+	+	−	+	−	+
Consequent interaction removal	−	−	−	−	−	−
Automatic reinforcement						
Staff/materials/stimuli absent	−	−	+	−	−	−
No antecedent interaction	+	+	+	+	+	+
No consequent interaction	+	+	+	+	+	+

struction" and "Consequent Instruction Removal" in the demand condition (social–negative reinforcement). During the naturalistic observations, however, "Staff/Materials Present" was not necessarily predictive of any particular staff response; therefore, it is potentially relevant to both the social–positive and social–negative reinforcement hypotheses for the descriptive analysis because it could be discriminative for either attention- or escape-maintained SIB.

In the experimental analysis, subjects' SIB showed very consistent patterns correlated with a specific assessment condition: Chris, Olivia, Stan, and Larry during the demand condition; Sarah during the attention condition; and Holly during the alone condition. Such consistency in responding is not as evident in the descriptive analysis because antecedent and consequent events often were (a) uniform across subjects (e.g., "No Antecedent Interaction," "Antecedent Interaction Removal," "Consequent Interaction Removal," and "No Consequent Interaction"), (b) inconsistent across subjects whose SIB had a similar function (e.g., the presentation of instructions ["Antecedent Interaction"] was correlated with SIB for Chris, Olivia, and Larry, but not for Stan), or (c) variable within subjects (e.g., even though instructions were correlated with SIB for Chris, Olivia, and Larry, SIB rarely resulted in escape ["Consequent Interaction Removal"]). Only the category of "Staff/Materials/Stimuli Absent" seemed to show clear differences: Chris, Sarah, Olivia, Stan, and Larry rarely engaged in SIB when these events were absent, whereas Holly frequently engaged in SIB under these conditions.

DISCUSSION

Independent descriptive (correlational) and functional (experimental) analyses were conducted to determine the extent to which the two methods would yield data supporting similar conclusions about variables maintaining SIB. Results of the experimental analyses replicated the findings of a number of studies in which systematic manipulation of relevant antecedent and consequent events revealed behavioral function. For 5 of the 6 subjects, the descriptive analyses did not yield consistent data leading to similar conclusions. These results extend the findings of Mace and Lalli (1991) and suggest that formal descriptive analyses may be neither necessary nor sufficient for identifying reinforcers for problem behavior.

The findings are significant because inaccurate assessments may result in the implementation of treatments that are contraindicated for certain behaviors. For example, results of the descriptive analyses for Chris, Sarah, Olivia, Stan, and Larry suggested that their SIB could have been maintained by attention or escape. Based on these findings, two different treatment programs might be implemented for each subject, incorporating removal of the supposed maintaining reinforcer (extinction). One procedure, implemented in noninstructional contexts, might require staff to ignore SIB or terminate ongoing interaction when the behavior occurred. The other procedure, implemented when SIB occurred in instructional contexts, might require staff to continue delivering instructions. This latter procedure would probably be ineffective with Sarah, whose SIB was maintained by attention. In fact, the increased attention delivered during an escape extinction procedure might strengthen her SIB. Although the first procedure (ignoring) might effectively reduce her SIB, the combined effects of both procedures would probably result in little decrease in SIB. Conversely, planned ignoring, timeout, or attention withdrawal procedures would be ineffective with Chris, Olivia, Stan, and Larry, whose SIB was maintained by escape. Indeed, these procedures would exacerbate the problem. Such difficulties may be intensified for individuals whose analyses suggest two different (opposing) maintaining variables, a potential outcome that did not occur with the subjects in this study.

During the experimental analyses, the subjects' SIB quickly (in some cases, immediately) became associated with specific environmental variables, revealing those contingencies most likely responsible for maintaining their behavior. Consistent application of these variables and the distinct stimuli paired with each experimental condition may have facilitated discrimination of the contingencies associated with the different assessment conditions. On the other hand, such consistency was uncharacteristic of the variables operating in their natural environments. Staff implemented training programs inconsistently, and activity schedules were changed often. Staff members responded differently to the same subjects' SIB, and, in fact, individual techniques for dealing with the SIB seemed to vary from day to day. These inconsistencies may have made it particularly difficult to obtain clear descriptive data. Attempts to clarify the nature of ambiguous descriptive data might include conducting observations during specific times or activities with specific trainers, who may even be instructed on how to conduct those activities. Each of these strategies entails some systematic manipulation of the natural enviroment, thereby providing a closer approximation of the experimental analysis.

Specific limitations of descriptive analyses have been discussed extensively in the literature (e.g., Iwata, Vollmer, & Zarcone, 1990) and include complex data collection and analysis, inability to identify effects of intermittent variables, and potential "masking" of relevant events by irrelevant ones. Several of these factors were probably responsible for the findings in this study. Data for 5 subjects (Chris, Sarah, Olivia, Stan, and Larry) were thoroughly reviewed to develop specific hypotheses about the lack of correspondence between the two assessment procedures.

For Sarah, irrelevant events (such as the presentation of instructions) appeared to have some sig-

nificance when observed under naturalistic conditions, because the events were sometimes correlated with SIB. Results of her experimental assessments demonstrated that instructions were not relevant to SIB, even though the instructions given in the demand condition were similar to those observed in her natural environment. Possibly, staff interactions sometimes occasioned her SIB, because these events were discriminative for SIB that might produce additional attention. A review of Sarah's data, however, showed that staff members responded to SIB in several different ways. When SIB followed instructions, staff members sometimes provided both social disapproval and instruction removal. In other instances, they continued the instruction but provided additional attention. At other times, they simply ignored the behavior. These complex and varied patterns of interaction made it difficult to determine which variables were relevant to SIB.

These difficulties were also associated with the descriptive analyses for Chris, Olivia, Stan, and Larry. For example, staff members often responded to Chris's SIB with social disapproval (in and out of instructional contexts) but rarely terminated instructions. Assuming a negative reinforcement account for these 4 subjects' SIB, results indicated that behavior was maintained on extremely thin schedules, which made it difficult to identify escape as the maintaining variable. In fact, the higher relative frequency of attention masked the importance of instruction removal as the maintaining consequence. Results of these assessments were further complicated because Olivia, Stan, and Larry exhibited substantial amounts of SIB in the absence of clear antecedent staff responses, an unexpected result for individuals whose behavior is maintained by negative reinforcement. These results are difficult to explain, with the exception of Olivia, whose physical disabilities may have prevented her from accurately discriminating the presence or absence of aversive events. However, researchers have noted that individuals whose behaviors are maintained by negative reinforcement may exhibit the behavior in the absence of the aversive event if, by doing so, they avoid further contact with the event (e.g., Mace et al., 1991). Such avoidance contingencies might be difficult to identify in the natural environment, particularly if instructions are presented inconsistently from day to day.

The tendency for descriptive analyses to suggest both attention and escape as maintaining variables is consistent with the findings of previous studies (e.g., Coman & Houghton, 1991; Mace & Lalli, 1991). Coman and Houghton, who compiled narrative accounts of their subject's SIB, concluded that the behavior did not appear to be self-stimulatory but was maintained by both escape from demands and presentation of staff attention. The validity of these results is unknown, however, because the authors did not implement treatment procedures based on these findings or conduct an experimental analysis following the descriptive assessment.

In some cases, the descriptive analysis may accurately reveal the variables maintaining problem behavior. For 1 subject, Holly, both assessment methods revealed the nonsocial or automatic nature of the consequence(s) maintaining SIB. These results suggest that automatic reinforcement may be easier to identify through descriptive analysis than other variables, such as contingent attention or escape. These latter variables may be difficult to discriminate under naturalistic conditions because both are related to social interaction, whereas behavior maintained by automatic reinforcement occurs independent of such interaction. We offer this conclusion tentatively, however, because it is based on the results of only 1 subject. This finding may be specific to assessments conducted in institutionalized settings, where subjects commonly spend much of their day in relatively nonstimulating environments.

In the descriptive analyses, methods used to collect and summarize data were similar to those used in previous research; however, we attempted to develop a more objective observational code. For example, any topography of staff attention (whether or not it was directed toward SIB) was considered a consequence of SIB if it occurred in the same interval as the behavior or in the next interval. The

subsequent data analysis, which included two types of conditional probabilities, was also more extensive than those used in previous studies. Both methods were necessary because of the varying frequencies of responses and events in the natural environment. Results of the descriptive assessment for 2 subjects (Chris and Stan) clearly demonstrated the importance of this multiple analysis. For Chris, the proportion of SIB intervals preceding consequent events suggested that his SIB was maintained by positive reinforcement, whereas the other proportions in the analysis suggested either positive or negative reinforcement. Similarly, the proportion of SIB intervals following antecedent events suggested that Stan's SIB was maintained by positive reinforcement, whereas other proportions suggested either positive or negative reinforcement. Thus, a limited analysis might have resulted in different conclusions regarding the maintaining variables of these subjects' SIB. In fact, their experimental and descriptive analyses might have suggested two different (opposing) variables.

The experimental analysis was chosen as the standard for comparison based on its assumed validity for identifying functional relationships between SIB and its maintaining contingencies, and the results of numerous studies support this assumption (e.g., see reviews by Iwata, Vollmer, & Zarcone, 1990, and Mace et al., 1991). Nevertheless, it is intuitively appealing to consider the descriptive analyses superior in identifying the "true" maintaining variables operating in the natural environment, or to consider both assessments valid in their own contexts. For example, it could be argued that both attention and escape from particular staff members maintained SIB in the natural setting, whereas only one variable influenced the behavior in the experimental setting. This assumption, if true, could be verified by recreating those situations found to be associated with problem behavior in the natural environment; in short, by conducting further experimental analyses. Sasso et al. (1992) found similar results when comparing data from two types of experimental analyses—those conducted by the authors outside the classrooms and those conducted by teachers in the classrooms—which suggested that the setting in which assessment is performed may not be a critical variable.

Results of this study are limited in several respects. Lengthier or additional observation sessions might have produced clearer results for the descriptive analyses. However, session length (15 min) and total observation times (6 and 12 hr) were similar to those used in previous studies; therefore, it is unlikely that the obtained results were related to length of observation. For 1 subject (Olivia), the descriptive assessment was extended to determine whether additional sessions would produce clearer results; because they did not, assessment for the last 2 subjects was limited to 6 hr. More important, data from this study indicate that the experimental analysis may produce more rapid results than those obtained from the descriptive analysis. For all subjects except Larry, the experimental assessment contained ~~the same or fewer sessions than~~ the descriptive assessment did. Even if descriptive analyses of extended durations could identify maintaining variables of problem behavior, the experimental analysis may be more efficient.

A second limitation is that no treatment data are presented here to verify hypotheses about maintaining variables based on either the descriptive or experimental analyses. Following the completion of this study, all subjects participated in treatment programs implemented either during the course of routine intervention or as part of several studies examining issues beyond the scope of this research. Treatment procedures were based on outcomes of the experimental analyses. Briefly, Sarah's primary treatment involved the time-based delivery of noncontingent attention, similar to that described by Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993). Treatment for Larry consisted of extinction of escape behavior as described by Iwata, Pace, Kalsher, Cowdery, and Cataldo (1990). The procedures for Chris, Olivia, and Stan also included an extinction component, presented in conjunction with a fading procedure in which the frequency of learning trials was increased gradually across sessions (see Pace, Iwata, Cowdery, Andree, & McIntyre, 1993, as an example). Finally, Holly's treatment included the increased availability of leisure

materials and the application of mitts to her hands to attenuate stimulation from hand mouthing (Rincover & Devaney, 1982). All treatments immediately resulted in near-elimination of SIB, an outcome not expected if the subject's SIB was controlled by more than one variable. Nevertheless, a study comparing the effects of treatments based on separate experimental and descriptive analyses would have provided additional data on the relative clinical utility of the two assessment procedures. With respect to the present subjects, treatment would not have differed for Holly because the results of both assessments suggested that her SIB was maintained by automatic reinforcement. The other subjects would have been exposed to two treatments because results of their descriptive analyses suggested that SIB could have been maintained by either attention or escape. One treatment would have been identical to that actually used, and the other would have been aimed at reducing SIB maintained by a different source of social reinforcement.

Finally, the current study is a preliminary comparison of results obtained from experimental and descriptive analyses, and the generality of our findings across subjects, behaviors, and settings may be limited. It is possible that descriptive analyses conducted in settings with more consistently applied variables and activities (e.g., classrooms, workshops) would produce clearer results. Two recent studies by Sasso et al. (1992) and Lalli, Browder, Mace, and Brown (1993) showed that results of experimental and descriptive analyses can be congruent under certain conditions. In both studies, the descriptive analyses were conducted in classroom settings during prespecified activities. Unlike residents in institutions, these students probably were exposed to organized activities, fairly consistent schedules, and the same teachers and teachers' aides each day. Sasso et al. (1992) collected descriptive data during classroom activities that most closely approximated the conditions of their experimental analysis. Such an arrangement may lead to clearer results but could also limit the usefulness of the descriptive analysis by restricting observations to prespecified times. In addition, all necessary conditions may not be present in some settings, such as large institutions. Lalli et al. (1993) conducted descriptive analyses of 3 students' inappropriate behaviors. Teachers then directly manipulated the hypothesized variables to test the results of the descriptive analyses. For 2 of 3 subjects, the experimental manipulation verified the results of the descriptive analyses. For 1 subject, results of the descriptive analysis suggested that both attention and escape were the maintaining variables, whereas results of the experimental manipulation indicated that escape was the only reinforcer. The authors argued that such consistency was possible because they conducted the experimental manipulation in the natural environment. However, this assumption has not received empirical support (e.g., Sasso et al., 1992) and needs to be examined further. Even if some advantages could be gained by conducting experimental analyses in the natural environment, the benefits would have to outweigh the inefficiency of conducting these assessments in all relevant settings with all relevant caregivers.

In several recent studies, experimenters have recommended that a formal descriptive analysis be conducted prior to an experimental analysis (Lalli et al., 1993; Mace & Lalli, 1991; Sasso et al., 1992), suggesting that this approach results in shorter, more efficient experimental analyses because only events that appear to be relevant through descriptive analysis are included in the experimental analysis. Although the recommendation seems reasonable, no studies have demonstrated that this combined methodology actually reduces assessment time and effort. In the present study, the experimental conditions included specific events (e.g., forms of attention, types of instructions) that were observed informally in the subjects' natural environment. That is, the variables manipulated in the experimental analyses were based on information gained through interviews and a few informal observations of subjects prior to assessment, and this approach may be even more efficient than conducting a formal descriptive analysis prior to an experimental analysis.

Further research is needed to delineate those variables responsible for the congruence (or lack thereof) between the results of descriptive and experi-

mental analyses. A valid descriptive analysis technique could be a useful alternative to, or even substitute for, the experimental analysis. Additional studies should examine variations of the assessment procedures used in the current study. If additional data collected via independent methods (i.e., those in which results obtained with one method are not used as the basis for designing the other method) indicate that the descriptive analysis is often insufficient for identifying maintaining variables of problem behavior, researchers should investigate the nature of these limitations in more detail in order to improve the descriptive analysis. Improvements to experimental analysis procedures also should be examined in future research. Limitations of these assessments, which remain hypothetical, should be identified and eliminated when found. Continued evaluation and refinement of both methods will yield maximal benefits through the development of a variety of efficient and accurate assessment techniques for use by researchers and clinicians.

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Received November 2, 1992
Initial editorial decision January 13, 1993
Revision received May 14, 1993
Final acceptance May 14, 1993
Action Editor, James W. Halle