EXPERIMENTAL ANALYSIS OF PRECURSORS TO PROBLEM BEHAVIOR

By

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To Patti, David, Heather, Helen, and Carl

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Standard functional analyses require the repeated observation of a target behavior to determine behavioral function, but this method can prove problematic in the case of severe or dangerous behaviors. Previous studies have shown, however, that individuals who engage in problem behaviors sometimes engage in both mild and severe forms and that severe behaviors are observed less frequently when reinforcement is delivered contingent upon the more mild behaviors. Studies also have shown that functional analyses of mild behaviors that reportedly precede severe behaviors can (a) be members of the same operant response class and (b) reduce the number of severe topographies that are observed during the assessment. These mild behaviors (i.e., precursors) are typically identified via caregiver verbal report or informal, direct observations, but it is possible that precursors could exist even when they are not readily identifiable. Therefore, we developed a checklist to identify precursors via videotaped trials in Study 1, and results showed that the empirical method of identifying precursors successfully identified at least 1 precursor for all 16 subjects. Separate functional analyses then were conducted of precursor and severe problem behaviors for 8 subjects in Study 2, and correspondence between outcomes was observed in 7 cases. Furthermore, few studies have evaluated treatments for severe problem behavior based upon the results of precursor

assessments. Therefore, we evaluated a sequential treatment consisting of a dense schedule of noncontingent reinforcement (NCR) followed by NCR schedule thinning plus differential reinforcement of alternative behavior to reduce precursors, increase appropriate behavior, and maintain low rates of severe behavior. Results showed that this treatment strategy was effective for behaviors maintained by positive reinforcement and negative reinforcement.

CHAPTER 1
INTRODUCTION

Functional Analysis of Problem Behavior

Experimental approaches to the assessment of problem behaviors (such as self-injurious behavior, aggression, property destruction, tantrums, stereotypy, etc.) have been reported in isolated studies since the 1960s, primarily for the purpose of demonstrating that a particular contingency could exacerbate problem behavior (e.g., Lovaas & Simmons, 1969). Since then, several approaches to identifying sources of reinforcement that maintain problem behavior have been developed and systematically evaluated, but the approach with the most empirical validity is the functional or experimental analysis (see Iwata, Kahng, Wallace, & Lindberg, 2000, for a recent review).

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) were the first to develop a general experimental model for identifying which of several common sources of reinforcement maintained a particular problem behavior – self-injurious behavior or SIB. They created a series of four conditions, three of which involved manipulation of antecedent and consequent events that formed contingencies previously shown to maintain SIB, plus a control. The conditions used in that study were: alone (antecedent event: austere environment; consequent event: none; test for automatic reinforcement), social disapproval (antecedent event: no attention; consequent event: statement of disapproval; test for positive reinforcement), academic demand (antecedent event: tasks presented; consequent event: break from work; test for negative reinforcement, and unstructured play (antecedent events: no demands, noncontingent attention, leisure materials available; consequent event: none; control condition). Differential responding in the form of higher rates of SIB in one of the three test conditions (or high rates across all conditions) identified the source of reinforcement maintaining subjects' SIB.

The functional analysis (FA) approach described by Iwata et al. (1982/1994) has been replicated in hundreds of studies and has become the standard method for assessing a wide range of problem behaviors (Hanley, Iwata, & McCord, 2003). In addition, the results of such an analysis can be used to design an intervention in which the reinforcement contingency is manipulated to reduce problem behavior and also to increase appropriate, alternative behaviors (Carr, Coriaty, & Dozier, 2000). An inherent limitation of all FA methods, however, is the explicit arrangement of conditions that increase the frequency of potentially dangerous behavior. Although such increases may be temporary and may present risks no greater than those already posed by the problem behavior, strategies that minimize risk during assessment would be beneficial to both researchers and clinicians. One promising approach is to assess mild behaviors that are members of the same operant response class as the severe problem behavior.

Operant Response Classes

As developed by Skinner, the concept of the operant response class has far-reaching implications for understanding the etiology and maintenance of complex human behavior. In its current usage, the operant refers to a class (or variety) of responses that can differ topographically but that are maintained by a common class of consequences (reinforcers) (Catania, 1973; Dews, 1966; Skinner, 1953).

The formation of response classes is essential for performing a variety of complex behaviors. The unifying principle of all of these behaviors is that they produce the same outcome, but, in the specific instance, the behaviors can vary on a large number of topographical dimensions. For example, one could exhibit any number of responses in order to obtain a snack. The individual might first look in the pantry by sliding open the door, scan the shelves for preferred snack foods, and select chips, which requires pulling the bag in opposing directions to access the chips. If chips were not available, the individual might then check the refrigerator,

which involves pulling open the door (a topographically dissimilar response that produces a similar outcome as the pantry example – visual access to food items), scanning the shelves for snacks, and selecting a container of fresh fruit. Opening the container involves very different responses than opening a bag of chips; the lid must be pulled from the corner in a vertical direction, whereas the chip bag required pulling both sides in a horizontal direction. The ultimate result of opening both containers is the same in both cases, however – tangible access to food items.

An understanding of how these response classes develop is essential for ensuring that an individual can function competently in various facets of daily life; thus, not surprisingly, the development of operant response classes has received extensive attention in applied research. For example, researchers have evaluated strategies for teaching various responses involved in developing imitation skills (e.g., Peterson, 1968; Werts, Caldwell, & Wolery, 1996; Young, Krantz, McClannahan, & Poulson, 1994), academic skills (e.g., Bonfiglio, Daly, Martens, Lin, & Corsaut, 2004; Cuvo, Ashley, Marso, Zhang, & Fry, 1995; Rosenbaum & Breiling, 1976), social skills (e.g., Barton & Ascione, 1979; Charlop & Milstein, 1989; Krantz & McClannahan, 1998; Reeve, Reeve, Townsend, & Poulson, 2007), self-help skills (e.g., Day & Horner, 1989; Nutter & Reid, 1978; Pierce & Schriebman, 1994), and various other socially important behaviors.

Problems arise, however, when one attempts to identify a particular response as a member of a particular response class. Early on, Skinner acknowledged this problem and posited that such an analysis cannot be "an act of arbitrary subdividing, and we cannot define the concepts of stimulus and response quite as simply as 'parts of behavior and environment' without taking account of the natural lines of fracture along which behavior and environment actually break" (Skinner, 1938; p. 33). In other words, operant behavior must be analyzed over time to identify

the environmental events that determine its occurrence. Functional analyses are used for this purpose during the assessment of problem behaviors, and behaviors (however dissimilar topographically) that are maintained by the same source of reinforcement are identified as members of a common response class.

Problem Behavior as an Operant Class

Within an operant response class, covariation among member responses has been documented extensively in applied research with respect to adaptive and problem behaviors (e.g., Koegel & Covert, 1972; Parrish, Cataldo, Kolko, Neef, & Egel, 1986; Sprague & Horner, 1992). Additionally, in some cases, an individual might allocate responding in such a way that members of a given response class generally are exhibited in a hierarchical order; in other words, some behaviors are more probable than other behaviors.

The identification of response hierarchies with respect to the assessment and treatment of problem behavior has received increased attention in recent work (e.g., Borrero & Borrero, 2008; Harding et al., 2001; Lalli et al., 1995; Smith & Churchill, 2002). Results of these studies showed that mild behaviors sometimes occurred before severe problem behavior and that mild and severe problem behaviors were members of the same response class. As previously mentioned, standard FAs are sometimes contraindicated when the topography of problem behavior poses risks due to its severity, and these studies showed that one promising assessment approach to minimizing risk is to assess behaviors that predict occurrences of the target problem behavior (precursors). This approach minimizes risk because if mild and severe problem behaviors are members of the same operant response class, reinforcement contingencies arranged for behaviors that occur before the severe behavior could result in reduced rates of severe behaviors.

Such an analysis involves several steps: (a) identifying potential precursor responses, (b) verifying that these responses do, in fact, predict the occurrence of the target, and (c) determining whether precursors are members of the same response class as the target. Recent studies have provided evidence for the validity of this type of analysis by focusing on one or more of these steps in the assessment of severe problem behaviors.

After observing informally that an individual tended to engage in stereotypy (finger waving) prior to eye poking, Hagopian, Paclawskyj, and Kuhn (2005) calculated several conditional and unconditional probabilities to verify the correlation between the behaviors and found that stereotypy actually was predictive of eye poking. They also examined cumulative records of responding and observed a temporal contiguity between stereotypy and eye poking. Thus, results of both analyses suggested that stereotypy was a precursor to eye poking. Borrero and Borrero (2008) used similar procedures to identify response-response relations after informally observing that two individuals tended to emit loud vocalizations before engaging in severe problem behaviors (i.e., SIB, aggression, or property destruction). They conducted observations in the subjects' classroom on the occurrence of both vocalizations and problem behavior. Results of probability analyses showed that vocalizations and problem behavior were highly correlated, and results of lag-sequential analyses showed that vocalizations were most likely to occur immediately preceding an instance of problem behavior. Taken together, the results of these studies show that correlational analyses, and conditional probability analyses in particular, are useful for determining which behaviors in an individual's repertoire are predictive of severe problem behaviors.

Studies also have demonstrated via experimental analyses that less severe behaviors can be members of the same response class as more severe behaviors. For example, Lalli, Mace, Wohn,

and Livezey (1995) observed that the screams, aggression, and SIB exhibited by a young girl appeared to be maintained by negative reinforcement and often occurred in a particular sequence. Subsequently, escape from demands was provided contingent upon individual behaviors (SIB, aggression, and screams, respectively) while the other 2 behaviors were placed on extinction. They found that when the reinforcement contingency was placed on the last behavior in the sequence (SIB), all behaviors tended to occur in a hierarchical order (i.e., screams, aggression, then SIB). Conversely, when the reinforcement contingency was placed on behaviors occurring earlier in the sequence (screams or aggression), behaviors that tended to occur later were observed rarely. These data indicated that screaming (a relatively innocuous problem behavior) predicted the occurrence of more severe problem behaviors (aggression and SIB) and that all behaviors were members of the same response class.

In similar studies, Borrero and Borrero (2008); Richman, Wacker, Asmus, Casey, and Andelman (1999); and Smith and Churchill (2002) determined through direct observation and/or parental interviews that less severe problem behaviors apparently preceded the occurrence of the most severe form of problem behavior. Richman et al. conducted a functional analysis in which reinforcers were provided contingent upon all topographies of problem behavior and observed higher rates of less severe problem behaviors and near-zero rates of more severe problem behaviors. When the less severe problem behaviors were placed on extinction, increases were observed in the mores severe problem behaviors, thus demonstrating that all behaviors were maintained by the same source of reinforcement. Other studies have found similar effects when extinction is applied to the most commonly occurring response during assessment (e.g., Harding et al., 2001; Magee & Ellis, 2000). Smith and Churchill, and Borrero and Borrero, conducted

independent functional analyses of the precursor and target problem behaviors and found that the precursor and target behaviors were, in fact, members of the same response class.

Results of these studies are important in demonstrating that less severe behaviors may predict the occurrence of target problem behaviors and that programming reinforcement contingencies for less severe behaviors might decrease the rate of the severe behaviors during assessment. The extent to which individuals who engage in problem behaviors also exhibit precursors is unknown, however. Therefore, the primary purpose of this study was to determine whether precursor behaviors typically precede the occurrence of problem behaviors.

In addition, a limitation common to all studies was that no systematic method was used to initially identify the precursor behaviors. Potential precursors were defined in those studies based on caregiver verbal report or informal observations conducted by the experimenters prior to assessment (Borrero & Borrero, 2008; Hagopian et al., 2005; Smith & Churchill; 2002); however, no other systematic procedures for selecting precursors were described. These anecdotal sources may provide useful information, but correlations between precursor and target responses, to the extent that they exist, also should be readily observable and quantifiable. Also, it is possible that precursors (a) might exist even when caregivers cannot identify them, (b) may be different than those reported, or (c) are not readily detected during informal observations. Thus, by using informal methods of precursor identification, it is possible that an important step in the analysis of precursors could be based on inaccurate information or limited sampling of client behavior.

Finally, numerous instances of the target problem behavior were observed before the relation between precursor and target responses was determined, thereby making the procedure difficult to use in situations for which it is ideally designed – the assessment of severe problem

behavior. Therefore, a second purpose of this study was to evaluate a method for identifying precursors that (a) was based solely on direct observation and (b) minimized the number of occurrences of the target problem behavior required to identify the precursors. Conditional probability analyses were used to determine which of several potential precursors were predictive of target behavior (Study 1), and independent functional analyses of precursors and target problem behaviors then were conducted to verify that all behaviors were members of the same response class (Study 2). Finally, only one published study to date has developed an intervention based upon the results of precursor analyses only (Najadowski, Wallace, Ellsworth, MacAleese, & Cleveland, 2008). Thus, the third purpose of this study was to determine whether (a) an effective intervention could be designed based upon the results of precursor analyses alone and (b) the sequential introduction of noncontingent reinforcement (NCR) followed by NCR schedule thinning plus differential reinforcement of alternative behavior (DRA) would be effective in reducing precursors while maintaining low rates of severe problem behavior.

CHAPTER 2
STUDY 1: EMPIRICAL IDENTIFICATION OF PRECURSORS

Method

Subjects and Setting

Sixteen individuals diagnosed with developmental disabilities who engaged in problem behavior participated in Study 1. Subject characteristics (age, diagnostic classification, and definition of the target problem behavior) are listed in Table 2-1. All sessions were conducted in an observation room at a day program for adults or in designated areas of a classroom at a special education school.

Procedures

Study 1 was conducted in 3 phases: (a) caregiver interview, (b) structured observations to identify precursors (precursor assessment), and (c) probability analysis to select precursors. Next, a trial-based, precursor assessment was conducted, in which conditions known to evoke problem behaviors were presented sequentially until 10 instances of the target behavior were observed. A probability analysis then was used to select precursors. This analysis consisted of comparing several conditional and unconditional probability calculations to determine which responses that predicted the occurrence of the target behavior. Finally, results obtained from the empirical precursor analysis were compared with precursors reported by caregivers to determine the degree of correspondence between the two sets of data.

Response Measurement and Reliability

Because potential precursors were unknown prior to assessment, all trials were videotaped and were scored later by two observers using a checklist. Responses were grouped topographically in the checklist as: (a) vocalizations, (b) facial expressions, (c) postures, (d) repetitive motor movements, (e) locomotion, (f) object manipulation, and (g) other problem

behaviors. Examples of possible response topographies were listed within each category, and additional space was provided to allow observers to write in behaviors that were observed but not included on the checklist (Table 2-2). All responses that were included in the topographical definition of the target behavior or could be considered mild forms of the target (e.g., pushing the therapist when the target was aggression) were excluded as potential precursors. The precursor assessment was conducted in two phases: (a) potential precursor topographies were identified and operationally defined and (b) potential precursors were scored as occurrence or nonoccurrence in all assessment trials.

Interobserver agreement was assessed by having a second observer score the occurrence of precursors and the target behaviors during all assessment trials. After scoring a trial, observers' data records were compared. If scoring discrepancies were found, the observers discussed the operational definitions, watched the video, and/or modified the operational definitions of precursors, then rescored the trial(s). This process was repeated until 100% interobserver agreement was achieved for the occurrence of all precursors and targets during the precursor assessment.

Caregiver Interview

Prior to the precursor assessment, an experimenter conducted an open-ended interview with a caregiver for each subject in an attempt to identify potential precursors. Caregivers were either a parent or teacher who had known the subject for at least 6 months and who had observed instances of the target problem behavior. During the interview, the caregiver first was asked to identify the subject's most severe class of problem behavior (SIB, aggression, or property destruction), which was selected as the target problem behavior for assessment during subsequent phases. If the target behavior was identified previously, caregivers were asked if they had observed the occurrence of problem behavior and if they could identify situations in which

problem behavior was likely to occur. Caregivers then were asked if they had observed any behaviors that tended to precede the target behavior (i.e., if they could identify any potential precursors). The experimenter noted any responses that were mentioned and clarified any vague descriptions. For example, if a caregiver reported that the individual "got upset" before engaging in the target behavior, the experimenter asked the caregiver to describe "getting upset" in greater detail in an attempt to identify observable responses that might function as precursors.

Precursor Assessment

The precursor assessment consisted of discrete trials in which antecedent conditions that might serve as establishing operations (EOs; Michael, 1982) for the target behavior were presented and were similar to the attention and demand conditions of a functional analysis (Iwata et al., 1982/1994). If caregivers reported that the target behavior was likely to occur when preferred items were removed or access to items was denied or if the experimenters observed that the target behavior occurred under these conditions, a tangible condition also was included in the assessment. Given that many problem behaviors are maintained by positive reinforcement (access to attention or preferred items) or negative reinforcement (escape from demands), presenting these conditions presumably increased the likelihood of observing the target behavior in a relatively short period of time. If the target behavior was observed in a trial, the consequence relevant to the antecedent condition (attention, escape, and/or access to leisure items) was delivered. A trial was terminated following the occurrence of the target behavior or after 5 min in which the target behavior did not occur (described in more detail below), whichever came first.

During attention trials, the therapist did not interact with the subject, unless the target behavior was observed, at which time the therapist delivered a reprimand (e.g., "Don't do that, you will hurt yourself.") and gentle physical contact. The therapist continued to interact with the subject (e.g., rubbing the subject's back, talking about preferred topics, etc.) until the target

behavior was not observed for 30 s. Once the target behavior was not observed for 30 s or if the target behavior was not observed in 5 min, a demand trial was conducted.

During demand trials, the therapist presented instructions to complete tasks appropriate to the subject's functioning level. The therapist used a 3-step prompting procedure (vocal instruction, model, physical guidance) but terminated the instructional sequence and moved away from the subject contingent upon the first occurrence of the target behavior. The next trial began once the target behavior was not observed for 30 s or if the target behavior was not observed in 5 min. If a tangible condition was included in the assessment, it was conducted following the demand trial. If a tangible condition was not included, another attention trial was conducted.

During tangible trials, the therapist allowed the subject brief (1-2 min) access to preferred items and then removed the items. Contingent upon the target behavior, the items were returned to the subject. Once the target behavior was not observed for 30 s or if the target behavior was not observed in 5 min, the toys again were removed, and another attention trial was conducted.

The assessment was considered complete after 10 instances of the target behavior were observed, except for Adam and Amy. Only 7 trials with the target problem behavior were included in Adam's precursor assessment due to an oversight. Amy engaged in the target problem behavior during every one of the first 10 trials of the precursor assessment, thus precluding some of the probability calculations. Therefore, 3 play trials were conducted in which Amy had noncontingent access to preferred leisure and edible items, as well as the therapist's attention. The target problem behavior was not observed during these play trials, and Amy's precursor assessment was considered complete with 10 trials containing the target behavior and 3 play trials in which the target behavior was not observed. In general, the total duration of trials in

which the target behavior was not observed was approximately equal to or greater than the total duration of trials in which the target behavior was observed. In addition, if the target behavior was observed during a trial, the next trial was not conducted until the target behavior had not occurred for 30 s to reduce the likelihood that the subject would engage in multiple, consecutive instances of the target behavior. Presumably, it was unlikely that the subject could engage in precursor behaviors while exhibiting a burst of target behaviors; thus, the requisite 30 s of the absence of the target behavior increased the likelihood of observing potential precursor behaviors during the assessment.

The above method differed from those used by Hagopian et al. (2005) and Borrero and Borrero (2008), in which numerous instances of the target behavior were observed before the relation between precursors and target behavior was established. For example, Borrero and Borrero required a minimum of 45 target behaviors before the descriptive analysis was considered complete. Similarly, 18 eye pokes were depicted in the cumulative records of the Hagopian et al. study, which represented only 2 of 31 assessment sessions that were conducted. By using a trial-based format and by restricting the number of target behaviors to 10 occurrences, we hoped to have an adequate sample from which to identify precursors but to greatly limit the frequency of problem behavior.

All trials were videotaped for subsequent data collection. When the assessment was complete, two observers watched the videos and used the checklist to mark any potential precursor topographies observed in trials in which the target problem behavior occurred. The checklist contained examples of a wide range of possible behavioral topographies, as well as space for observers to record behaviors that were not listed. Thus, all behaviors that occurred in trials in which the target behavior was observed were scored to identify responses that had the

potential to predict the target behavior. Responses that occurred after the target behavior were not scored, however.

The checklist contained examples of response topographies within 7 general categories of behavior, including vocalizations, facial expressions, postures, locomotion, repetitive motor movements, object manipulation, and other problem behaviors that differed from the target behavior. The observers compared the topographies marked on each checklist and developed operational definitions of all potential precursors.

Finally, two observers recorded the presence or absence of behaviors during all trials using a binary scoring code (1 = occurrence of precursors and/or the target behavior within a trial, 0 = nonoccurrence). Following each trial, the observers compared their data records. In the event of any discrepancies, the observers watched the video together and discussed the observed behaviors. The observers then rescored the trial until 100% agreement was attained for each precursor and the target behavior.

Probability Analyses

The purpose of the probability analysis was to determine which behaviors predicted the occurrence of the target behavior (i.e., precursors) in a quantitative manner. Several probabilities were calculated based on all trials of the precursor assessment. The probability of the target behavior given the precursor [$p(\mathrm{T}|\mathrm{P}_n)$] was calculated by dividing the number of trials in which that precursor and the target behavior were observed by the total number of trials in which that precursor was observed. The probability of the target given the absence of the precursor [$p(\mathrm{T}|\sim\mathrm{P}_n)$] was calculated by dividing the number of trials in which the target behavior was observed but the precursor was not by the total number of trials in which that precursor was not observed. The unconditional probability of the target [$p(\mathrm{T})$] was calculated by dividing the

number of trials in which the target behavior was observed by the total number of trials in the assessment.

Similar calculations were performed to determine probabilities for each of the precursors. The probability of that precursor given the target behavior [$p(P_n|T)$] was calculated by dividing the number of trials in which both the precursor and target behavior occurred by the number of trials in which the target behavior occurred. The probability of the precursor given the absence of the target behavior [$p(P_n|\sim T)$] was calculated by dividing the number of trials in which the precursor was observed but the target behavior was not by the total number of trials in which the target behavior was not observed. Finally, the unconditional probability of the precursor [$p(P_n)$] was determined by dividing the number of trials in which the precursor was observed by the total number of trials in the assessment. (Formulas for each of the probabilities are listed in Table 2-3.)

The relative probability values for each response were compared to select the precursors. First, the probability of the target behavior given each potential precursor was compared to (a) the probability of the target behavior given the absence of each precursor and (b) the unconditional probability of the target behavior. Next, the probability of each precursor given the target behavior was compared to (a) the probability of each precursor given the absence of the target behavior and (b) the unconditional probability of each precursor. Behaviors were selected as precursors if they satisfied both of the following criteria. First, the probability of the target behavior given the precursor was higher than the probability of the target behavior given the absence of the precursor <u>and</u> the unconditional probability of the target behavior, or $p(T|P_n) > p(T|\sim P_n)$ <u>and</u> $p(T|P_n) > p(T)$. Second, the probability of the precursor given the target behavior was higher than the probability of the precursor given the absence of the target behavior <u>and</u> the

unconditional probability of the precursor, or $p(P_n|T) > p(P_n|\sim T)$ <u>and</u> $p(P_n|T) > p(P_n)$. If numerous potential precursors were observed, some response topographies were combined if the responses (a) met the criteria for classification as either precursors or non-precursors and (b) could be described succinctly based upon similar topographical features (e.g., "crawl", "run", and "climb" were combined into "move around room" for Amy).

Results and Discussion

Analysis of Precursor Behaviors

Results of the precursor assessments are shown in Figures 2-1 through 2-4. The top panel of each subject's graph shows the probability analysis for the target behavior. In these panels, the dark, solid gray bars show the probability of the target behavior given that precursor, the striped bars show the probability of the target behavior given the absence of that precursor, and the horizontal line that bisects each bar shows the unconditional probability of the target behavior. The bottom panel of each subject's graph shows the probability analysis for the potential precursors. In these panels, the light, solid gray bars show the probability of that precursor given the target behavior, the striped bars show the probability of that precursor given the absence of the target behavior, and the small, horizontal lines that bisect each bar show the unconditional probability of that precursor.

Figure 2-1 shows results for Liv, Billy, Chuck, and Amanda. Three precursors were identified for Liv. All 3 of her precursors were highly correlated with the occurrence of target problem behavior: Property destruction always occurred in trials in which the precursor was observed ($p(T|P) = 1.0$), although the probability of the target behavior given the absence of the precursors ($p(T|\sim P)$) also was high. In addition, Liv's precursors never occurred in trials in which the target behavior was not observed (i.e., $p(P|\sim T) = 0$). Billy always engaged in the target behavior in trials in which at least 1 of the 3 selected precursors also occurred. In addition, these

precursors never occurred in trials in which the target behavior was not observed. Chuck's precursors were somewhat less predictive than Liv's and Billy's precursors in that the target behavior was not always observed following the selected precursors, and his precursors were sometimes observed in the absence of the target behavior. Three precursors were identified for Amanda. Hand postures and stretching did not occur very often, but when they did they only occurred in trials with the target behavior. Reaching for the therapist was not as predictive of the target behavior, as the target was not always observed in trials with this response, and the response sometimes occurred in trials without the target. Amanda's caregivers reported that she seemed to engage in higher rates of SIB (the target behavior) in the presence of food. Therefore, food items were included in the tangible condition, and signing for food also met the precursor selection criteria.

Figure 2-2 shows results for Kelly, George, Amy, and Sammy. Three precursors were selected for Kelly. She always engaged in the target behavior in trials in which she put her hand inside her clothes, although this behavior was observed in few trials. Mouthing her fingers and toes, as well as whining, were observed more frequently, and the target behavior occurred more often in trials in which these responses were observed. She also frequently engaged in these precursors in trials in which the target was observed compared to trials in which the target was not observed. Six precursors were identified for George. Like Amanda, he also engaged in appropriate behavior (i.e., signs such as "more," "play," etc.) in trials in which the target behavior was observed. He did not, however, engage in the target behavior in all trials in which any of the precursors were observed, and he sometimes engaged in each of the precursors in trials in which the target was not observed. Ten precursors were identified for Amy. She always engaged in the target behavior in trials in which 9 of these behaviors occurred, and she never

engaged in these precursors in trials in which the target behavior was not observed. Mouthing objects also was highly predictive of the target behavior; however, the target behavior occurred in trials in which this behavior was not observed and mouthing objects also occurred in trials in which the target behavior was not observed. Six precursors were identified for Sammy. Tugging on the therapist's shirt occurred in only 1 trial of the assessment in which the target also was observed. His other precursors occurred more frequently, but the target behavior frequently occurred in trials in which the precursor was not observed, and the precursors occurred in trials in which the target behavior was not observed.

Figure 2-3 shows results for Renee, Curtis, Gerald, and Adam. Only 1 precursor was selected for Renee, although this behavior was not highly predictive of the target behavior. In other words, the precursor frequently occurred in trials in which the target behavior was not observed, and the target behavior frequently occurred in trials in which the precursor was not observed. Two precursors were selected for Curtis. Leg scratching only was observed during 1 trial of the precursor assessment, but it occurred during a trial in which aggression also was observed; thus, the behavior met the precursor selection criteria. Blocking the therapist from touching items also was selected, and it occurred more often overall, even though aggression occurred during several trials in which blocking the therapist was not observed. Four precursors were identified for Gerald. The target behavior always occurred in trials in which three of the responses were observed, and those behaviors never occurred in trials without the target behavior. The 4th precursor occurred more frequently; however, the target behavior sometimes occurred in trials in which the behavior was not observed, and the precursor often occurred in trials without the target behavior. Six precursors were identified for Adam, all of which were strongly predictive of aggression. In other words, Adam always engaged in the target behavior in

trials in which the precursors were observed, and he never engaged in the precursors in trials in which the target behavior was not observed.

Figure 2-4 shows results for Donald, Leigh, Guy, and Kevin. Six precursors were identified for both Donald, although the target behavior only occurred in all trials in which 2 of the precursors were observed, and those precursors never occurred in trials in which the target behavior was not observed. Six precursors also were identified for Leigh; the target always occurred in trials in which 4 of those behaviors were observed, and those precursors never occurred in trials without the target behavior. Sixteen precursors were identified for Guy, although the target behavior only always occurred in the same trials as 8 of these precursors, and those same precursors never occurred in trials without the target behavior. The other precursor occurred somewhat more frequently; however, those precursors were less predictive of the target behavior. Twelve precursors were selected for Kevin, and the target always occurred in trials in which these behaviors were observed. His precursors were never observed in trials in which the target behavior was not observed.

In summary, results show that each of the 16 subjects engaged in behaviors that were predictive of the occurrence of their target problem behaviors. The number of identified precursors ranged from 1 precursor (Renee) to 16 precursors (Guy).

Comparison of Caregiver Report and Precursor Data

When the precursors reported by caregivers were compared to those identified by the precursor assessment (Table 2-4), caregivers for 6 of 16 subjects (Billy, Chuck, Renee, Leigh, Amanda, and Sammy) were unable to report any precursors whatsoever. Results for the remaining 10 subjects showed that caregivers reported only 10 of the 90 precursors identified via the precursor assessment (approximately 12%). Furthermore, caregivers of 7 subjects (George, Amy, Curtis, Gerald, Adam, Donald, and Kelly) reported additional potential precursors that

differed from those identified via the precursor assessment. Even though it was possible for the subject to engage in the caregiver-reported precursors during the precursor assessment, either the behaviors were never observed (George, Amy, Curtis, Gerald, Adam, and Donald) or they occurred but did not predict the occurrence of the target problem behavior based upon the results of the probability analysis (Curtis, Gerald, and Kelly). Finally, the precursor assessment identified precursors for all subjects that were not reported by caregivers, ranging from 1 (Renee) to 16 (Guy). Therefore, results of this analysis suggest that caregivers are relatively inaccurate in identifying precursors.

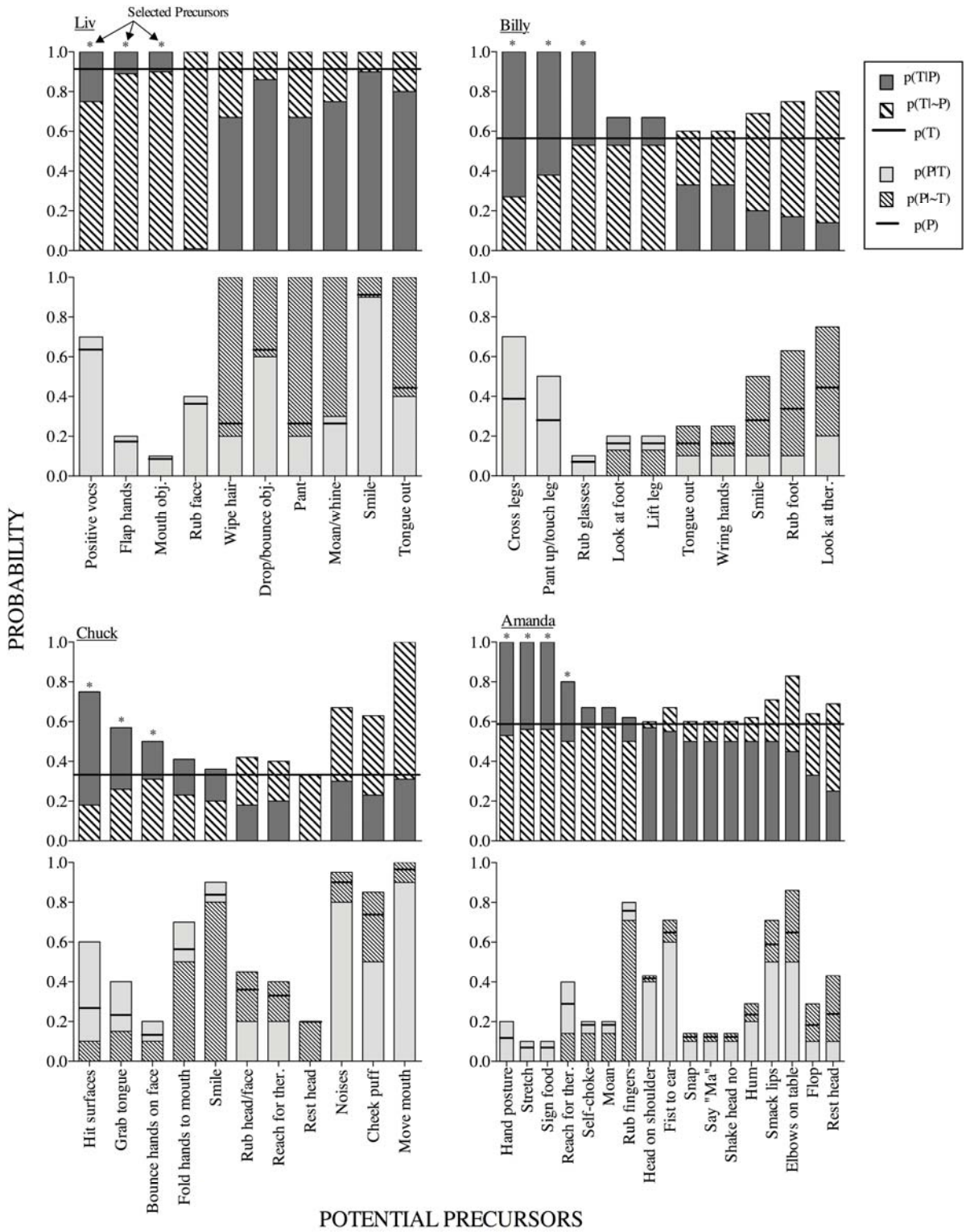

Figure 2-1. Precursor-assessment results for Liv, Chuck, Billy, and Amanda. The top and bottom graphs for each subject show probabilities for target behavior and precursor behaviors, respectively.

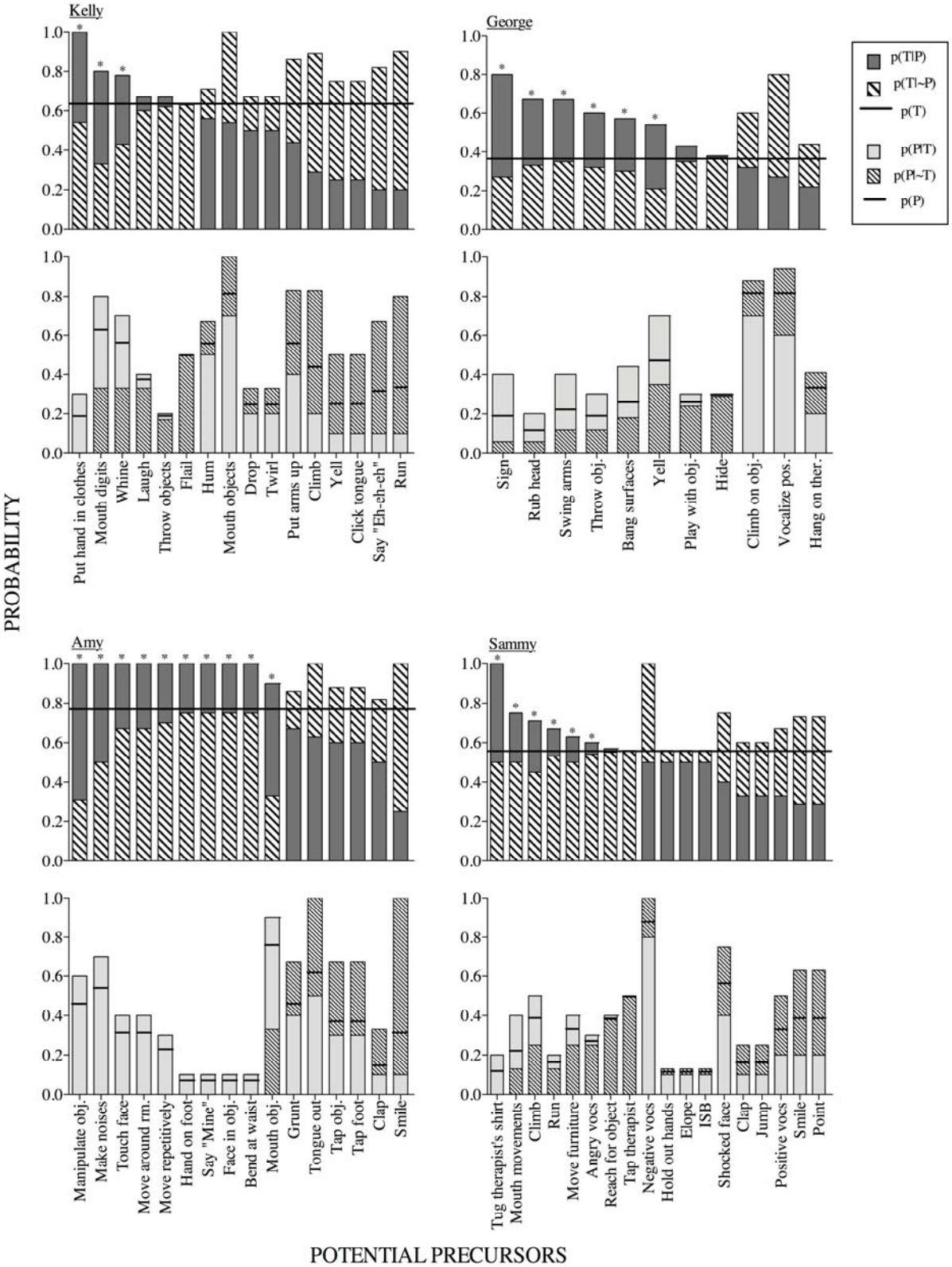

Figure 2-2. Precursor-assessment results for Kelly, George, Amy, and Sammy

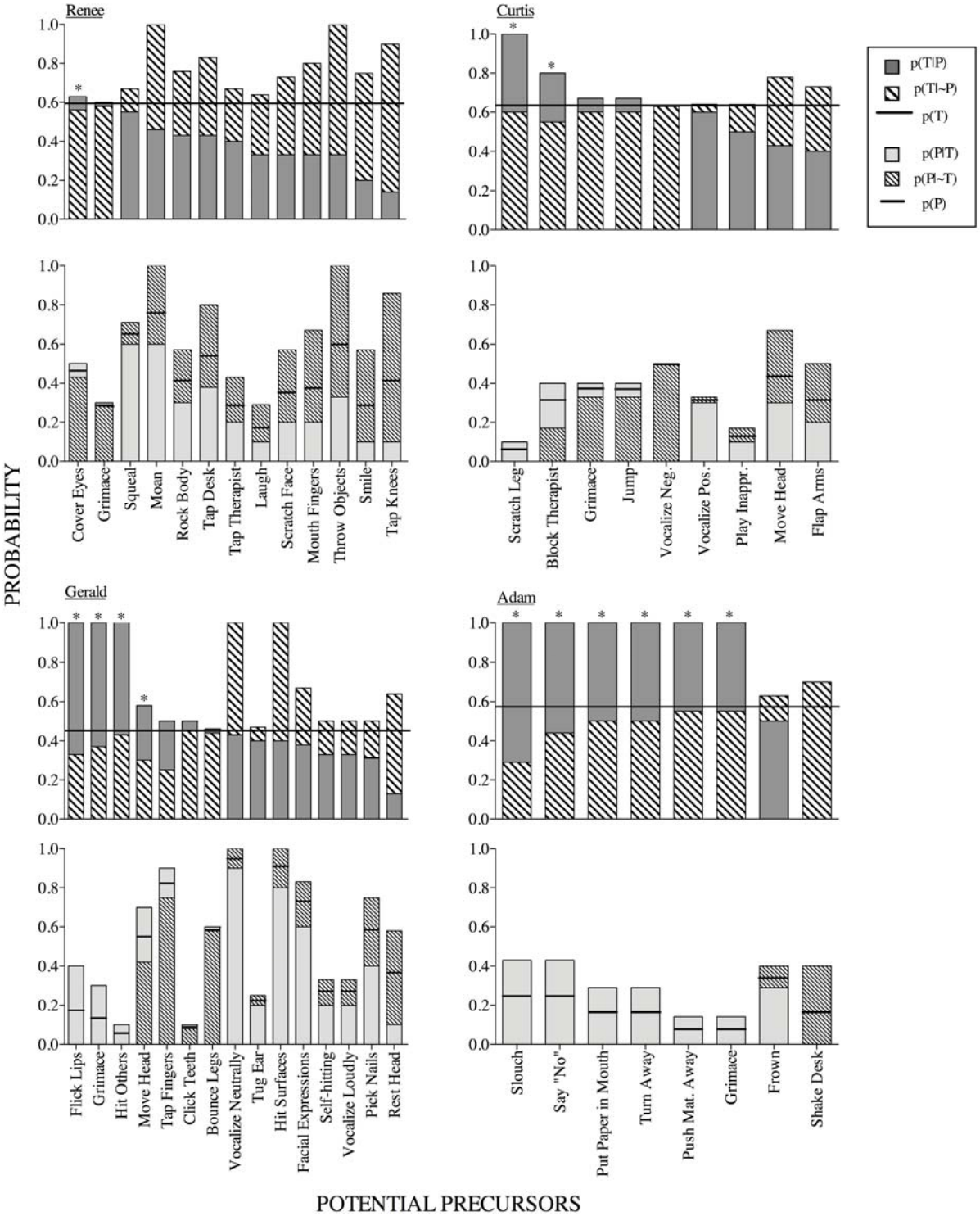

Figure 2-3. Precursor-assessment results for Renee, Curtis, Gerald, and Adam

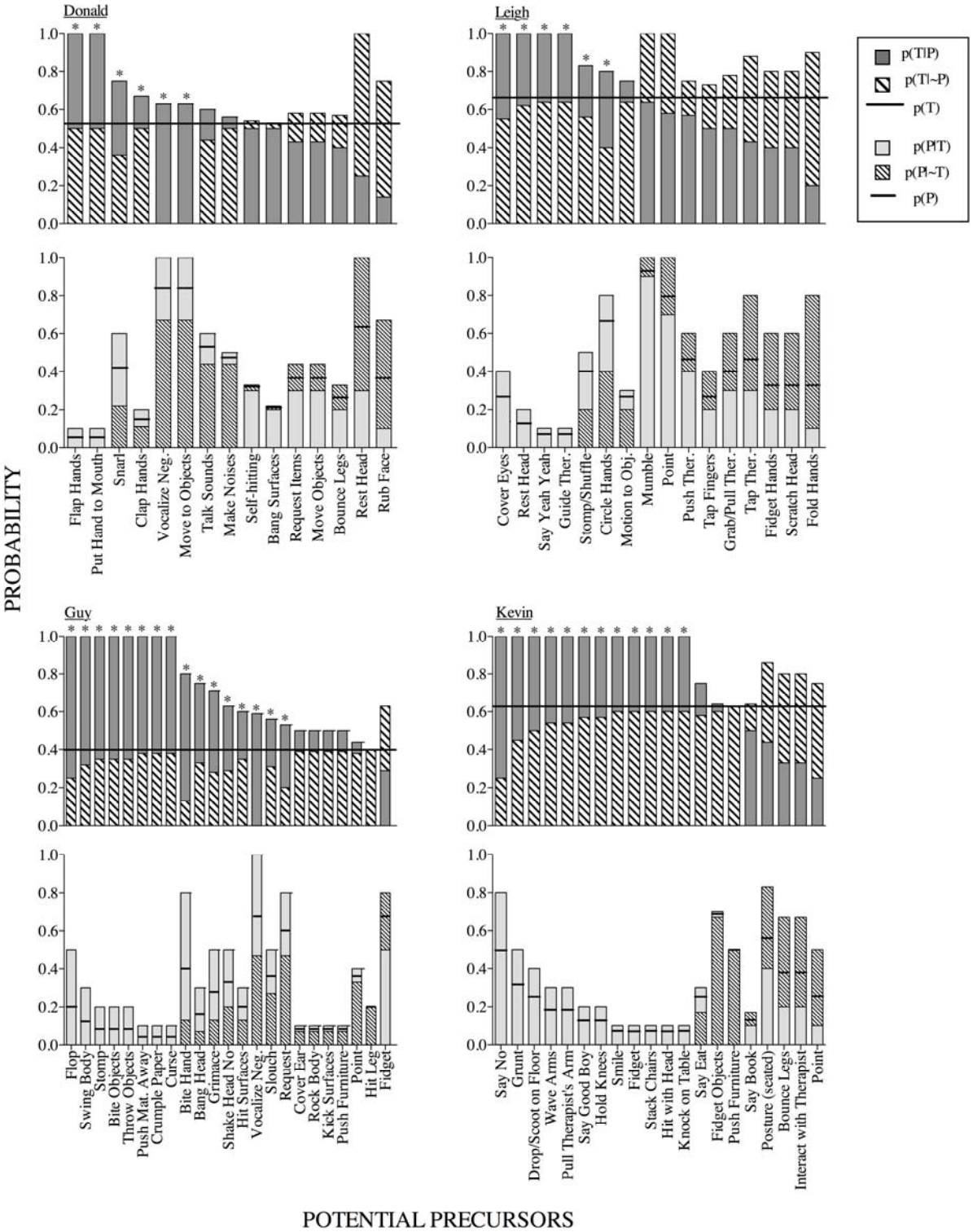

Figure 2-4. Precursor-assessment results for Donald, Leigh, Guy, and Kevin

CHAPTER 3
STUDY 2: FUNCTIONAL ANALYSIS OF PRECURSOR AND PROBLEM BEHAVIORS

Although the precursor assessment conducted in Study 1 identified behaviors that predicted (i.e., were correlated with) the target problem behavior, the extent to which these behaviors were members of the same response class remained unknown. Therefore, independent functional analyses (FAs) were conducted for a subset of subjects from Study 1 to identify the function of the identified precursors as well as the function of the target behavior. Unlike Smith and Churchill (2002) and Borrero and Borrero (2008), we conducted the functional analysis of the precursors (precursor FA) first to determine whether the function of the precursors matched the function of the target behavior (i.e., the target behavior was observed at the highest rates in the same condition of the target FA as precursors had been observed during the precursor FA) and to perhaps limit the number of occurrences of the target behavior. If precursors and target behaviors were determined to be members of the same response class, and if the majority of subjects did not engage in the target behavior during the precursor FA, this information might prove useful to clinicians during assessment and treatment of severe forms of problem behavior by minimizing risk to the subject and/or therapist.

Method

Subjects and Setting

Eight individuals from Study 1 (Renee, Curtis, Gerald, Adam, Donald, Leigh, Guy, and Kevin) participated in Study 2. Subjects were selected based on results of their precursor assessments, which identified different numbers of precursors across subjects. Therefore, FAs were conducted on a variety of response topographies identified as precursors for these subjects, ranging from 1 (Renee) to 12 (Kevin) precursors in the initial assessments. All sessions were

conducted in an observation room at a day program for adults or in designated areas of a classroom at a special education school.

Response Measurement and Reliability

One precursor, covering her eyes, was included in the precursor FA for Renee. Two precursors (scratching his leg and blocking the therapist from moving) were included for Curtis. Four precursors were included for Gerald (flicking his lips, grimacing, hitting the therapist, and jerking his head). Although 6 precursors were identified for Adam, only 5 precursors (slouching, saying "No," putting paper in his mouth, turning away from the therapist, and pushing materials away) were included in his precursor FA. Grimacing was excluded because Adam frequently turned his head such that observers were unable to view his facial expression. Six precursors were included for Donald (hand flapping, pressing his hand to his mouth, snarling, clapping his hands, vocalizing negatively, and moving toward objects), as well as for Leigh (covering her eyes, resting her head, saying "Yeah yeah yeah," guiding the therapist around the room, stomping or shuffling her feet, moving her hands in circles by her side, and motioning toward objects). Numerous precursors were identified in Study 1 for Guy; however, only the 8 precursors (flopping on the ground, swing his body side to side, stomping his feet, biting objects, throwing objects, pushing materials away, crumpling paper, and cursing) that most strongly predicted the occurrence of the target behavior were included in his precursor FA. Finally, twelve precursors (saying "No," grunting, dropping to or scooting on the floor, waving his arms in the air, pulling the therapist's arm, saying "Good boy," holding his knees, smiling, fidgeting, stacking chairs, head butting the therapist, knocking on the table) were included in Kevin's precursor FA because all of the precursors were highly predictive of his target behavior.

Observers recorded the frequency of (a) target behaviors, (b) precursors, and (c) therapist interactions and their delivery of consequences during continuous, 10-s intervals for each subject

using a handheld PDA. The target problem behavior was the most severe form of behavior reported by caregivers during the initial interview and/or direct observation by the experimenters. Operational definitions of the target problem behaviors for each subject are listed in Table 2-1.

Interobserver agreement was assessed by having a second observer independently collect data during at least 25% of sessions. Proportional agreement percentages were calculated for each response by comparing the two observers' recorded frequencies for all responses in each 10-s interval. The smaller number of responses was divided by the larger number of responses in each interval with a disagreement, the fractions were summed across all intervals, and the total was added to the total number of agreement intervals in the session. The sum was divided by the total number of intervals in the session and multiplied by 100% to yield reliability scores for each measure. Mean reliability scores were as follows: Renee, 97.5% for target behaviors (range, 93.6% to 100%), 97.9% for precursors (range, 90.8% to 100%), and 96.5% for therapist responses (range, 91% to 100%); Curtis, 99.4% for target behaviors (range, 92.5% to 100%), 99.3% for precursors (range, 93.3% to 100%), and 98.9% for therapist responses (range, 91.6% to 100%); Gerald, 100% for target behaviors, 99.8% for precursors (range, 94.7% to 100%), and 97.5% for therapist responses (range, 83.3% to 100%); Adam, 99.9% for target behaviors (range, 99.2% to 100%), 99.4% for precursors (range, 89.3% to 100%), and 92.6% for therapist responses (range, 76.4% to 100%); Donald, 99.8% for target behaviors (range, 98.3% to 100%), 99.6% for precursors (range, 91.7% to 100%), and 97.9% for therapist responses (range, 90% to 100%); Leigh, 98.7% for target behaviors (range, 90.3% to 100%), 98.7% for precursors (range, 88.6% to 100%), and 95.6% for therapist responses (range, 80% to 100%); Guy, 98.2% for target behaviors (range, 86.1% to 100%), 99.9% for precursors (range, 98.3% to 100%), and 97.7% for

therapist responses (range, 91.7% to 100%); and Kevin, 97.6% for target behaviors (range, 90% to 100%), 99.4% for precursors (range, 88.3% to 100%), and 92.7% for therapist responses (range, 78.3% to 100%).

Procedures

Two independent FAs were conducted using procedures similar to those described by Iwata et al. (1982/1994). During the precursor FA, consequences were delivered for the occurrence of precursor behaviors but not for occurrences of the target problem behavior(s) (i.e., the target behavior was ignored). During the target FA, consequences were delivered for occurrences of the target behavior(s) but not for occurrences of the precursor behaviors. Attention, play, and demand conditions were included in all FAs. An alone or ignore condition was not included if the target behavior was aggression, and a tangible condition was included if caregivers indicated that the subject tended to engage in problem behavior when preferred items were removed or access to preferred items was denied.

During attention sessions, the subject had access to 2-3 moderately preferred toys identified via a paired-stimulus (Fisher et al., 1992) or a multiple-stimulus (DeLeon & Iwata, 1996) preference assessment. At the start of session, the therapist told the subject, “I have some work to do, but you can play with these toys, if you’d like.” The therapist then sat next to but did not interact with the subject. Contingent upon each occurrence a precursor (in the precursor FA) or target (in the target FA) behavior, the therapist delivered a brief reprimand (e.g., “Stop doing that; that’s not nice!”) and gentle physical contact (e.g., placed a hand on the subject’s arm).

During play sessions, the subject had access to 2-3 highly preferred toys (identified in the preference assessment), and the therapist interacted with the subject at least every 30 s or any time the subject initiated interaction. No consequences were delivered following occurrences of either precursor or target behaviors.

During demand sessions, the therapist continuously presented learning trials appropriate to the subject's functioning level using a 3-step prompting sequence and delivered praise following compliance. Contingent upon each instance of a precursor (in the precursor FA) or target (in the target FA) behavior, the therapist removed the work materials and provided a 30-s break from the task.

If the target behavior was SIB or property destruction, an alone or ignore condition was included in the FAs. During alone sessions, the subject was seated alone in a room without any materials. If an ignore condition was conducted, the subject was seated in an area of the room away from all other individuals, and no consequences were delivered contingent upon any behaviors emitted by the subject.

If caregivers reported that problem behaviors occurred when preferred items were removed or access to these items was denied, a tangible condition was included in the FAs. At the start of the session, the therapist removed all toys and remained near the subject. If the subject initiated interaction with the therapist during this condition, the therapist briefly responded to the subject (e.g., quickly answered a question) then terminated interactions (e.g., "We can talk later."). Contingent upon the occurrence of a precursor (in the precursor FA) or target (in the target FA) behavior, the therapist provided access to the toys for 30 s.

Results and Discussion

Figure 3-1 shows results of the independent FAs for Renee, Curtis, Gerald, and Adam. Renee engaged in higher rates of eye covering during the demand condition of the precursor FA (aggression also was observed in this condition, although the rate of aggression was much lower than the rate of eye covering except during one session). During the target FA (aggression), aggression maintained only in the demand condition throughout the assessment. (Renee also continued to engage in eye covering in the demand condition of the target FA, as well as during

the play condition.) These results indicated that Renee's eye covering and aggression were maintained by negative reinforcement (i.e., escape from academic tasks).

Curtis engaged in higher rates of precursors in the tangible condition of the precursor FA (zero instances of aggression were observed). During the target FA, Curtis engaged in higher rates of aggression in the tangible condition (rates of precursors also were observed). Thus, Curtis' precursors and aggression were maintained by positive reinforcement (i.e., access to preferred leisure items).

Gerald engaged in higher rates of precursors in the demand condition of the precursor FA (SIB was observed during two demand sessions). During the target FA, Gerald engaged in higher rates of SIB (as well as precursors) in the demand condition. These results indicate that Gerald's precursors and SIB were maintained by negative reinforcement (i.e., escape from academic tasks).

Adam engaged in higher rates of precursors during the demand condition of the precursor FA (aggression was never observed). During the target FA, Adam engaged in higher rates of aggression (and precursors) in the demand condition. These results indicate that Adam's precursors and aggression were maintained by negative reinforcement (i.e., escape from academic tasks).

Figure 3-2 shows the results of the independent functional analyses for Donald, Leigh, Guy, and Kevin. Donald engaged in higher rates of precursors in the tangible condition of the precursor FA (aggression was never observed). During the target FA, Donald engaged in higher rates of aggression (and precursors) in the tangible condition. These results indicate that Donald's precursors and aggression were maintained by positive reinforcement (i.e., access to preferred items).

Leigh engaged in higher rates of precursors in the tangible condition of the precursor FA (a higher rate of aggression was observed in one attention session). During the target FA, Leigh engaged in high rates of SIB in the tangible and demand conditions (her precursors also occurred initially during these conditions, but did not maintain in the demand condition). Thus, results of the precursor FA indicated that precursors were maintained by positive reinforcement (access to tangible items), whereas results of the target FA indicated that SIB was maintained by both positive reinforcement (access to tangible items) and negative reinforcement (escape from academic tasks). In other words, the precursor FA was effective in identifying one of two sources of reinforcement that maintained the target behavior.

Guy engaged in higher rates of precursors in the demand condition of the precursor FA (somewhat lower rates of aggression also were observed in this condition). During the target FA, Guy engaged in higher rates of aggression (and precursors) in the demand condition. These results indicate that Guy's precursors and aggression were maintained by negative reinforcement (i.e., escape from academic tasks).

Finally, Kevin engaged in higher rates of precursors in the demand condition of the precursor FA (and even higher rates of property destruction). During the target FA, Kevin engaged in higher rates of property destruction (and precursors) during the demand condition. These results indicate that Kevin's precursors and property destruction were maintained by negative reinforcement (i.e., escape from academic tasks); however, the precursor FA was not effective in reducing rates of his target problem behavior.

Precursors were found to be members of the same response class as the target problem behavior for 7 of the 8 subjects. The 8th subject's (Leigh's) precursors were maintained by 1 of 2 sources of reinforcement that also maintained her target problem behavior. In addition, the

precursor FA eliminated instances of the target problem behavior for 3 subjects (Curtis, Adam, and Donald), and resulted in low rates of the target problem behavior for 4 subjects (Renee, Gerald, Donald, and Leigh), but did not reduce rates of the target problem behavior for 1 subject (Kevin). A within-session analysis of Kevin's data revealed that during demand sessions, Kevin engaged in the target behavior before precursors prior to reinforcement delivery in 100%, 57%, and 33% of cases, respectively. It is possible that a recent history of reinforcement for the target behavior during the precursor assessment might have shifted response allocation toward the target behavior, which extinguished over subsequent demand sessions. Therefore, although the precursor assessment results indicated that some responses predicted the occurrence of the target behavior, Kevin engaged in high rates of all behaviors, and his response allocation seemed to shift depending on which topographies contacted the reinforcement contingency. In fact, during the last 5 min of the third demand session of the precursor FA, Kevin simply said "No" and received escape without engaging in other response topographies.

It is interesting to note that subjects did not engage in all of their selected precursors during the precursor FA, except Renee, for whom only 1 precursor was identified. Therefore, the function of each subject's precursors was determined based on a subset of responses selected as precursors in Study 1. Proportions of observed precursors during the precursor FA for each subject are shown in Figure 3-3. The function of Curtis' precursors was determined based solely on occurrences of blocking the therapist. Gerald engaged in only 2 of 4 precursors (grimacing and head movements). Adam engaged in 4 of 5 precursors (saying "No", turning away, slouching, pushing materials away), and Donald engaged in only 2 of 6 precursors (negative vocalizations and reaching for objects). Leigh engaged in 3 of 6 precursors (hand circles, chin down, and stomping/shuffling her feet) during the precursor FA. Guy engaged in 6 of 8

precursors (biting objects, pushing materials away, cursing, body swinging, throwing objects, and stomping), and Kevin engaged in 6 of 12 precursors (saying "No," grunting, arm waving, table knocking, fidgeting with pants, and placing his hands on his knees).

The function of unobserved precursors remains unknown. It is possible that either (a) the precursor assessment simply yielded a high number of false alarms or (b) these behaviors are members of the same response class as the target problem behavior but were not observed because other precursors contacted the reinforcement contingency and maintained. Some precursors emerged in the same condition as the target behavior during the target FA for 4 subjects (Donald, Leigh, Guy, and Kevin). For example, Donald engaged in snarling during the tangible condition of target FA, which could have emerged as a function of extinction for more frequently occurring precursors. Three of Leigh's precursors (covering her eyes, resting her head, and moving her hands in circles) occurred at higher rates only in the tangible condition during the target FA. Guy began to flop on the floor during the demand condition of the target FA, and Kevin began to drop to/scoot on the floor during the demand condition of the target FA. Therefore, this provides some evidence that those precursor topographies might be maintained by the same source of reinforcement as the target behavior and emerged as a function of extinction of other precursors. Additional analyses would be required, however, to verify this possibility, which was beyond the scope of the present study.

Further Comparison of Caregiver Report and Precursor Data: The comparison of precursors reported by caregivers and those identified by the precursor assessment conducted in Study 1 indicated that caregivers only reported 10 of 90 precursors identified by the precursor assessment (approximately 12%). Given that many precursors identified by the precursor assessment were not observed during the functional analyses in Study 2, it seemed possible that

caregivers might have identified precursors that were not observed during the precursor assessment but that were observed in the functional analyses. Therefore, precursors reported by caregivers and those observed during the functional analyses were compared for subjects in Study 2 to determine the extent to which caregivers reported precursors that emerged in the same condition(s) as the target behavior during the functional analyses. Results showed that caregivers reported 7 of 31 precursors that were observed during the functional analysis (approximately 23%). These results suggest that caregivers were only slightly more accurate in reporting precursors than was concluded during the comparison conducted in Study 1.

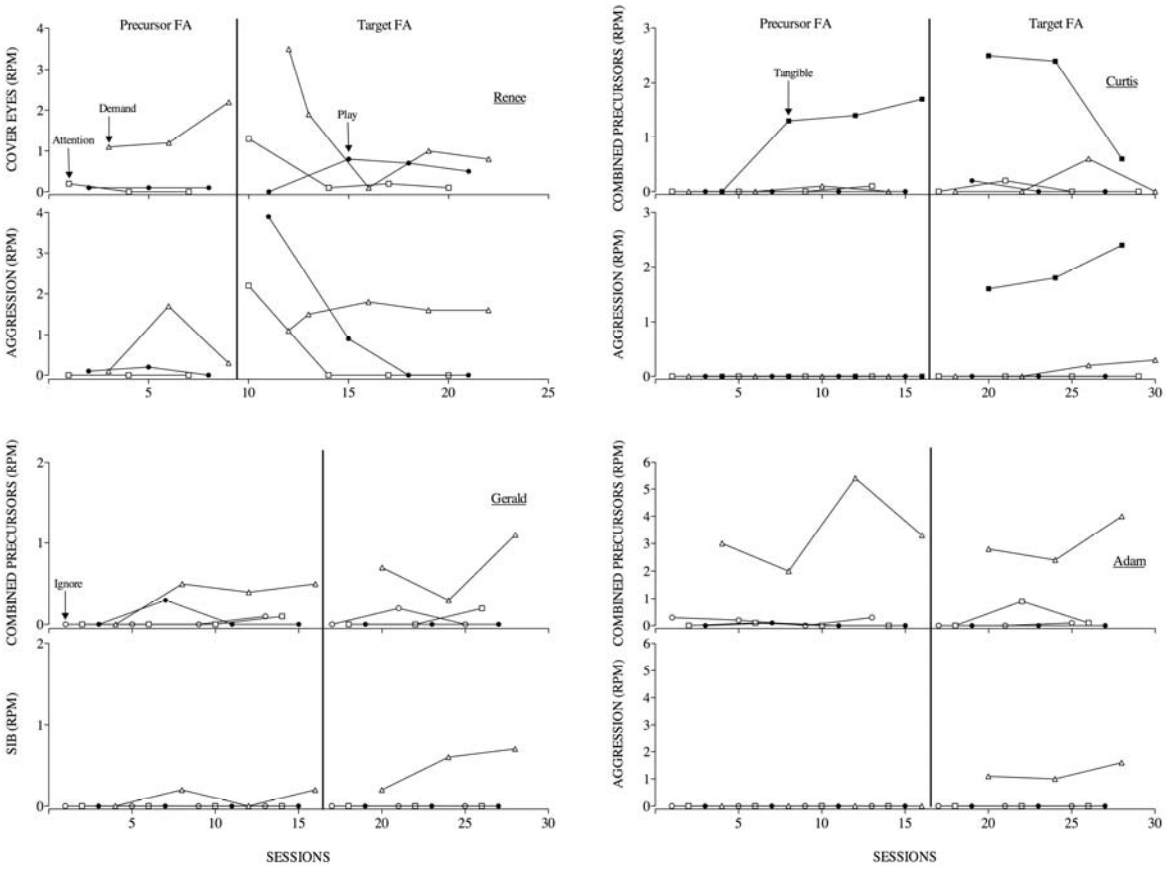

Figure 3-1. Results of the independent functional analyses for Renee, Curtis, Gerald, and Adam in Study 2. The top and bottom graphs for each subject show rates of the precursors and target behaviors, respectively. The left panel of each set of graphs shows results of the precursor FA; the right panel of each set of graphs shows results of the target FA.

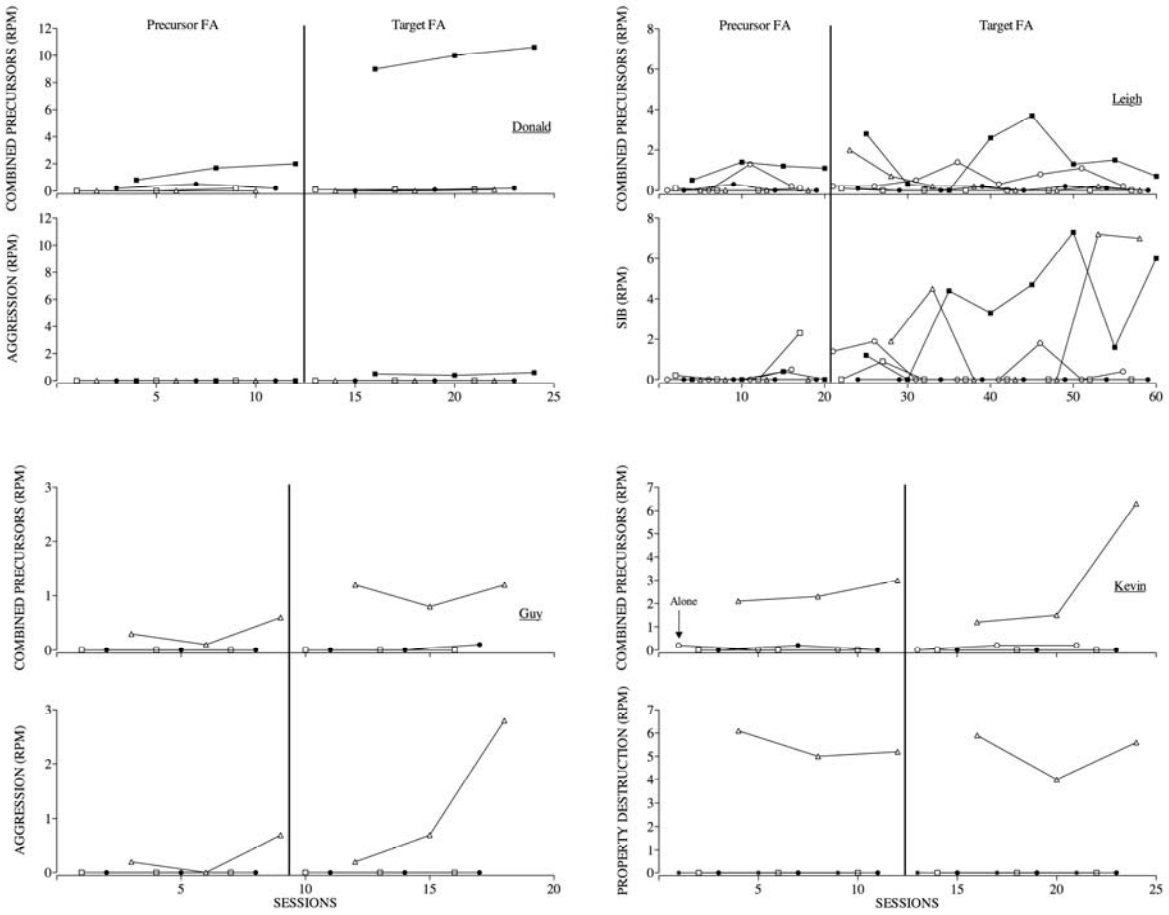

Figure 3-2. Results of the independent functional analyses for Donald, Leigh, Guy, and Kevin

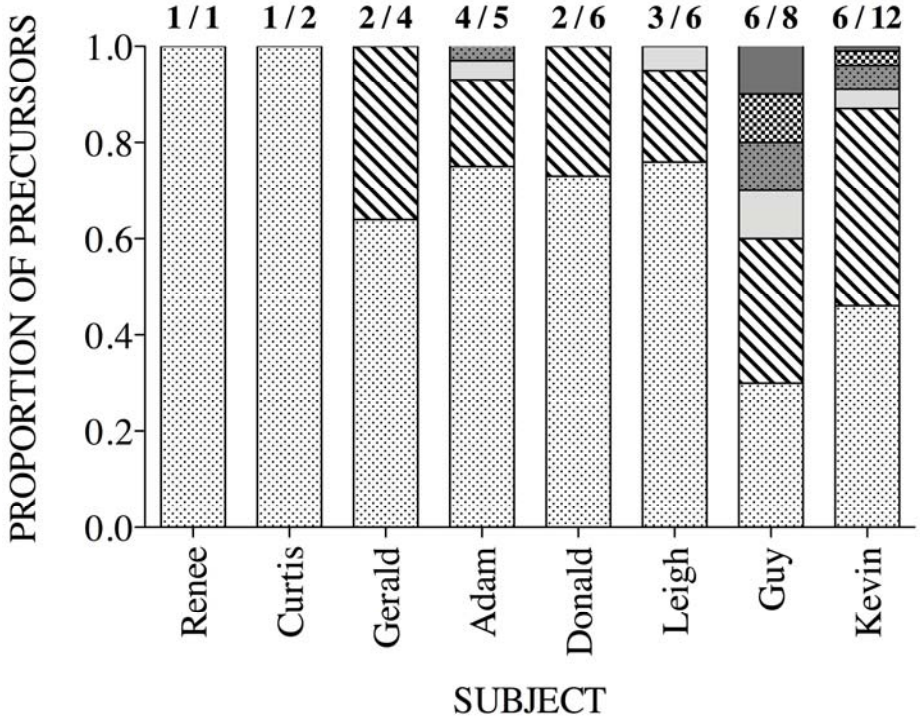

Figure 3-3. Proportional distribution of precursor responses observed during the precursor FA (each section of a bar graph represents a different precursor) for subjects in Study 2. Numbers above each bar show the number of precursors observed out of the total number of selected precursors for each subject.

CHAPTER 4
STUDY 3: PRECURSOR ASSESSMENT AS THE BASIS FOR INTERVENTION

Given that the precursor assessment was effective in identifying precursors for all subjects (Study 1) and that these behaviors typically were members of the same response class as the severe problem behavior (Study 2), the combination of precursor assessment and precursor FA seemed to be a promising basis for making conclusions about the function of severe problem behavior while minimizing risk. This information presumably could then be used to design an effective reinforcement-based intervention to specifically demonstrate reductions in precursors while maintaining low rates of severe problem behavior.

Very few studies, however, have shown that an intervention aimed at reducing less severe behaviors can maintain low rates of more severe behaviors. Results of a study by Shukla and Albin (1996), however, showed that one individual engaged in mild and severe problem behaviors during demand situations. During treatment, the participant was prompted to sign "break" following an instance of mild problem behavior, which was effective in reducing rates of all problem behaviors and increasing rates of communication. The procedure maintained a close temporal contiguity between the mild behavior and reinforcer delivery, however, which could result in adventitious reinforcement of mild behaviors for some individuals. In addition, extinction was not programmed for the severe problem behavior, which might not be effective in reducing rates of severe problem behaviors for others.

Only one published study to date has designed an intervention based upon the results of a precursor FA. Najadowski et al. (2008) conducted a precursor FA for 3 subjects and observed that all subjects' precursors were maintained by positive reinforcement (access to attention or preferred items). Severe problem behavior was never observed during the assessment. The intervention was similar to that used by Shukla and Albin (1996) and consisted of differential

reinforcement of alternative behavior (appropriate requests) and extinction for both precursors and severe problem behavior. These procedures resulted in a reduction in precursors, an increase in appropriate requests, and zero instances of severe problem behavior (except during one session for one subject during a reversal to baseline). Therefore, although these results are very promising with respect to reducing risks posed by severe problem behaviors, the severe problem behavior either never occurred throughout assessment or treatment (2 subjects) or occurred in one session only (1 subject), thus limiting the conclusions that can be drawn with respect to the function of the severe problem behavior. In addition, subjects were prompted to engage in appropriate requests following instances of precursors, which could prove problematic for some individuals (as described above).

Another promising approach to decreasing problem behaviors, while strengthening appropriate forms of communication, is a combination of noncontingent reinforcement (NCR) and differential reinforcement of alternative behavior (DRA) procedures. Marcus and Vollmer (1996) evaluated this treatment for 2 individuals and found that the initial, continuous NCR schedule eliminated problem behaviors; however, appropriate communication (alternative behavior) only emerged as the NCR schedule was thinned. Because dense NCR schedules of reinforcement were implemented only briefly for both subjects, it was unclear if appropriate communication might have emerged eventually under the dense NCR schedule. Therefore, Goh, Iwata, and DeLeon (2000) evaluated the NCR plus DRA intervention and provided subjects with extended exposure to the dense NCR schedule with DRA in place. They found that appropriate communication did not emerge under the dense NCR schedule and only emerged when the NCR schedule was thinned. Rates of problem behavior generally remained low in both studies under the combined NCR plus DRA intervention. These results suggest an alternative treatment

strategy in which NCR might be used initially to suppress problem behaviors, and DRA could be added to treatment during NCR schedule thinning to produce increases in appropriate, alternative behaviors.

A review of 26 studies using NCR (9 studies) and/or DRA (18 studies) interventions was conducted to determine the relative effectiveness of each intervention in quickly suppressing problem behaviors. Studies were included in the analysis if: (a) NCR was delivered continuously throughout sessions, (b) DRA was implemented using an FR-1 schedule of reinforcement, (c) functional reinforcers were used during NCR or DRA, (d) no other treatment components were included (e.g., response blocking, timeout, etc.), and (e) extinction was programmed for problem behavior. Results revealed that continuous schedules of NCR were more effective than DRA in eliminating problem behaviors during the first session of treatment compared to DRA. More specifically, NCR resulted in zero instances of problem behavior during the first session in 67.57% of cases, whereas DRA resulted in zero instances of problem behavior during the first session in only 35.94% of cases. Additionally, NCR was more effective than DRA in reducing overall rates of problem behaviors during treatment: The mean reduction in problem behavior under NCR was 91.76%, whereas the mean reduction under DRA was 81.16%. One noted disadvantage of NCR is that the procedure does not specifically teach the individual an appropriate means of obtaining reinforcers (Carr et al., 2000; Vollmer, Iwata, Zarcone, Smith & Mazaleski, 1993); however, the results of this review suggest that dense schedules of NCR might prove advantageous for suppressing severe problem behaviors before teaching an appropriate form of communication.

The purpose of this Study 3 was to determine whether an effective treatment could be designed based on the results of precursor assessments alone while (a) obtaining indirect

evidence regarding the function of severe problem behavior (i.e., the target behavior) and (b) maintaining low rates of the target behavior throughout assessment and treatment. In general, treatment consisted of a sequence beginning with continuous NCR, in which the reinforcer was identified from a precursor FA. Subsequently, the NCR schedule was thinned, and DRA was introduced for an alternative behavior that served the same function as the precursor behaviors.

Method

Subjects and Setting

Because the intervention strategy consisted of sequential introduction of social reinforcers (noncontingent followed by contingent), only individuals whose precursor FA suggested that the behaviors were maintained by social reinforcement were included in this study. Two individuals from Study 1 (Amanda and Sammy) who engaged in severe problem behavior, who had not participated in Study 2, and who were not participating in other projects participated in Study 3. Three other individuals exhibited problem behavior (precursors and/or the target behavior) that appeared to be maintained by automatic reinforcement and, thus, were not included. All sessions were conducted in a classroom at a special education school.

Response Measurement and Reliability

Amanda's target behavior was SIB and was defined as hitting her face or head with her hand or fist. Her precursors included reaching for the therapist, a hand posture (i.e., placing her elbow on the table with her wrist bent), and stretching (i.e., leaning back in her chair with her arms stretched above her head). The response selected to be strengthened as an appropriate, alternative form of communication for reinforcement (i.e., mand) was signing "food," which was already in her repertoire and was shown to be predictive of SIB during the precursor assessment (Study 1).

Sammy's target behavior was aggression and was defined as hitting, kicking, biting, head butting, or throwing objects that hit others. His precursors included tugging on the experimenter's shirt, mouth movements (i.e., opening and closing his mouth without making noise), climbing on furniture, running across the room, throwing or pushing furniture, and angry vocalizations (i.e., growling or guttural sounds). The responses selected to be strengthened as appropriate, alternative forms of communication for reinforcement (i.e., mands) were signing "break" (during treatment for behavior maintained by negative reinforcement) or signing "play" (during treatment for behavior maintained by positive reinforcement).

Data were collected and interobserver agreement was calculated as previously described for the precursor assessment (described in Study 1) and precursor FA (Study 2). In addition, the same data collection methods and interobserver agreement measures were used in treatment conditions as in the precursor FA, and interobserver agreement was assessed during at least 25% of sessions in each condition of the precursor FA and in each condition of treatment for both subjects.

During the precursor FA, mean interobserver agreement scores for Amanda were 99.5% for precursors (range, 92% to 100%) and 99.2% for SIB (range, 93.6% to 100%). Mean agreement scores for Sammy were 98.9% for precursors (range, 88.1% to 100%) and 98.2% for aggression (range, 90.3% to 100%). During treatment, mean interobserver agreement scores for Amanda were 98% for precursors (range, 80% to 100%), 98.4% for SIB (range, 92.5% to 100%), and 99.1% for mands (range, 79.9% to 100%). During treatment for Sammy's behaviors maintained by negative reinforcement, mean interobserver agreement scores were 98.2% for precursors (range, 75% to 100%), 97.4% for aggression (range, 81.3% to 100%), and 96.6% for mands (range, 85% to 100%). During treatment for Sammy's behaviors maintained by positive

reinforcement, mean interobserver agreement scores for Sammy were 99.4% for precursors (range, 95% to 100%), 100% for aggression, and 98.3% for mands (range, 93.3% to 100%).

Procedures

Precursors identified in Study 1 for each subject were included in a precursor FA in which consequences were provided following precursors only (i.e., no consequences were provided following the target behavior). Conditions of the FA were the same as described in Study 2 and consisted of attention, demand, play, and tangible. An ignore condition also was included for Amanda to rule out the possibility that SIB was maintained by automatic reinforcement.

Treatment was based upon the results of the precursor FA only (i.e., the function of the target behavior was inferred from response patterns during this assessment) and generally consisted of baseline, continuous NCR, and NCR schedule thinning plus DRA. All sessions were 10 min in duration.

Baseline

Baseline was identical to the condition of the precursor FA in which the highest rates of precursors were observed. These were the tangible (Amanda and Sammy) and demand (Sammy) conditions. Consequences were delivered following precursors only (i.e., a small piece of food for Amanda, 30-s escape from academic tasks for Sammy in the first treatment, or 30-s access to toys for Sammy in the second treatment). No consequences were delivered following the target behavior or appropriate communication.

Continuous NCR

The reinforcer shown to maintain precursors during the precursor FA was delivered freely and noncontingently throughout each session. No consequences were delivered following precursors, the target behavior, or appropriate communication in this condition. During treatment for behaviors maintained by positive reinforcement, subjects had continuous access to highly

preferred food (Amanda) or leisure items (Sammy). During treatment for behaviors maintained by negative reinforcement, no demands were placed on Sammy throughout session.

NCR Schedule Thinning Plus DRA

Once low, stable rates of precursors and the target behavior were observed under continuous NCR, the NCR schedule was thinned by removing one 10-s interval of NCR per min using procedures similar to those described by Goh et al. When precursors were observed at rates less than 80% of baseline rates and rates of the target behavior were low, schedule thinning progressed by removing another 10-s interval of NCR per min. At the start of this condition, DRA was implemented during intervals in which NCR was not provided by physically prompting the participant to engage in appropriate communication. The prompts then were systematically delayed (i.e., the therapist waited a few additional seconds before prompting appropriate communication) to allow the subject to engage in appropriate communication independently. Prompts were removed when the subject began to exhibit independent appropriate communication consistently. Contingent upon appropriate communication (independent or prompted) the therapist delivered the reinforcer. No consequences were delivered following the target behavior. Additional treatment components were implemented as needed and are described in the results section for each subject.

Results and Discussion

Results of the precursor FA showed that Amanda's precursors were maintained by positive reinforcement in the form of access to preferred food items (Figure 4-1). Amanda also engaged in SIB at increasing rates in the tangible condition, even though no consequences were provided for this behavior. These results suggested that her target problem behavior was likely maintained by the same source of reinforcement as precursors.

During treatment (Figure 4-2), Amanda engaged in moderate rates of precursors during baseline (mean, 3.1 rpm). She also engaged in moderate rates of SIB (mean, 1.1 rpm) and low rates of mands (mean, 0.2 rpm), even though no consequences were provided for these behaviors. When continuous NCR was implemented, Amanda did not exhibit any precursor behaviors, and rates of SIB and mands were low (means, 0.1 and 0.3 rpm, respectively). During NCR schedule thinning plus DRA, Amanda engaged in variable and increasing rates of precursors (mean, 1.1 rpm), SIB (mean, 0.2 rpm), and independent mands (mean, 1.6 rpm). It appeared that a response hierarchy was developing in which Amanda engaged in precursors (and sometimes SIB) followed shortly by independent mands. Therefore, it seemed possible that precursors and SIB might have been adventitiously reinforced as a result of the close temporal contiguity between those behaviors and the delivery of reinforcement for mands. Other factors might have accounted for the development of this particular response hierarchy, including the presumably low effort necessary to engage in precursors (primarily reaching toward the therapist), a recent history of reinforcement for precursors during baseline, and possibly a recent history of reinforcement for SIB outside of the experimental setting. Therefore, response blocking was added to the treatment to disrupt the development of a response hierarchy, and blocked responses were scored and included in the session rate. This intervention resulted in decreasing rates of precursors (mean, 0.7 rpm), near-zero rates of SIB (mean, 0.03 rpm), and increased rates of independent mands (mean, 3.3 rpm). Next, a reversal to baseline was conducted and resulted in increased rates of precursors (mean, 3.0 rpm), low rates of SIB (mean, 0.3 rpm), and variable rates of mands (mean, 2.0 rpm). A return to NCR thinning plus DRA and response blocking resulted in decreasing rates of precursors (mean, 0.4 rpm), zero rates of SIB, and high rates of independent mands (mean, 4.0 rpm). By the end of this phase, Amanda was

engaging primarily in independent mands, which seemed to preclude the need for NCR and response blocking. Therefore, DRA alone was evaluated and resulted in low rates of precursors (mean, 0.1 rpm), low rates of SIB (mean, 0.2 rpm), and similar rates of independent mands as in the preceding phase (mean, 4.1 rpm).

Results of the precursor FA showed that Sammy's precursors (Figure 4-3) were maintained by both positive reinforcement (access to preferred leisure items) and negative reinforcement (escape from demands). In addition, Sammy engaged in increasing rates of aggression in the demand condition, and he only engaged in aggression during the first session of the tangible condition. These results suggested that the identified function of precursors likely matched the function of his target problem behavior.

Two treatments were evaluated for Sammy: the first treatment targeted problem behaviors maintained by negative reinforcement (Figure 4-4), and the second treatment targeted problem behaviors maintained by positive reinforcement (Figure 4-5). During treatment for problem behaviors maintained by negative reinforcement, Sammy engaged in moderate rates of precursors during baseline (mean, 3.1 rpm), low rates of aggression (mean, 0.4 rpm), and low rates of independent mands (mean, 0.1 rpm). When continuous NCR was implemented, Sammy engaged in low rates of precursors (mean, 0.3 rpm), near-zero rates of aggression (mean, 0.03 rpm), and zero independent mands. During NCR schedule thinning plus DRA, he engaged in variable rates of precursors (mean, 1.6 rpm), variable, increasing rates of aggression (mean, 0.8 rpm), and increasing rates of independent mands (mean, 1.2 rpm). Like Amanda, it seemed that Sammy was exhibiting a response hierarchy in which he engaged in precursors as the experimenter approached to deliver a demand and, when escape was not provided for the precursors, he engaged in an independent mand (or sometimes aggression). Therefore, a type of

change-over delay was added to treatment in which independent mands were prevented immediately following a precursor behavior, and Sammy was physically guided to complete the demand issued by the experimenter. When he had not engaged in a precursor behavior for 5 s, Sammy was permitted to mand for escape and a 30-s break was provided at that time. This resulted in an initial burst in precursors, which decreased over subsequent sessions (mean, 1.7 rpm), decreasing rates of aggression (mean, 0.5 rpm), and steady rates of independent mands (mean, 1.6 rpm). A reversal to baseline then was conducted, and rates of precursors increased (mean, 2.2 rpm), rates of aggression were near zero (mean, 0.1 rpm), and low rates of mands were observed (mean, 0.5 rpm). NCR thinning plus DRA with the change-over delay again was implemented and resulted in decreasing rates of precursors (mean, 0.7 rpm), low rates of aggression (mean, 0.3 rpm), and increased rates of mands (mean, 1.5 rpm). By the end of the condition, NCR seemed unnecessary and, thus, was removed in the final phase. DRA plus the change-over delay alone resulted in decreasing rates of precursors to near zero (mean, 0.5 rpm), near-zero rates of aggression (mean, 0.3 rpm), and steady rates of independent mands (mean, 1.6 rpm).

During treatment for problem behaviors maintained by positive reinforcement (access to preferred leisure items), Sammy engaged in moderate rates of precursors during baseline (mean, 2.1 rpm), near-zero rates of aggression (mean, 0.03 rpm), and zero independent mands. During continuous NCR, Sammy engaged in near-zero rates of precursors (mean, 0.2 rpm) and zero instances of aggression and mands. When NCR schedule thinning plus DRA was implemented, Sammy engaged in decreasing rates of precursors (mean, 0.3 rpm), near-zero rates of aggression (mean, 0.01 rpm), and increasing rates of independent mands (mean, 1.3 rpm). A return to baseline resulted in increasing rates of precursors (mean, 1.6 rpm), near-zero rates of aggression

(mean, 0.03 rpm), and decreasing rates of mands (mean, 0.6 rpm). When NCR schedule thinning plus DRA was again implemented, precursors decreased (mean, 0.8 rpm), aggression occurred at higher rates during the first session but remained at zero for all subsequent sessions (mean, 0.2 rpm), and moderate rates of mands were observed (mean, 1.4 rpm). The NCR component was removed in the final phase, and Sammy engaged in decreasing rates of precursors (mean, 0.3 rpm), zero rates of aggression, and increasing rates of mands (mean, 1.5 rpm).

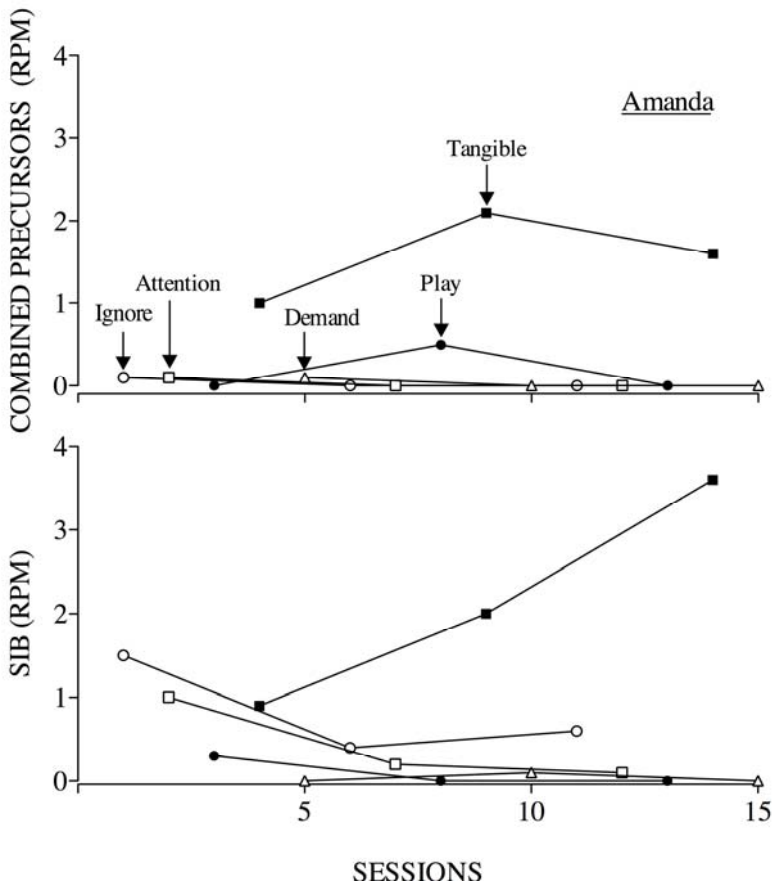

Figure 4-1. Results of the precursor FA for Amanda in Study 3.

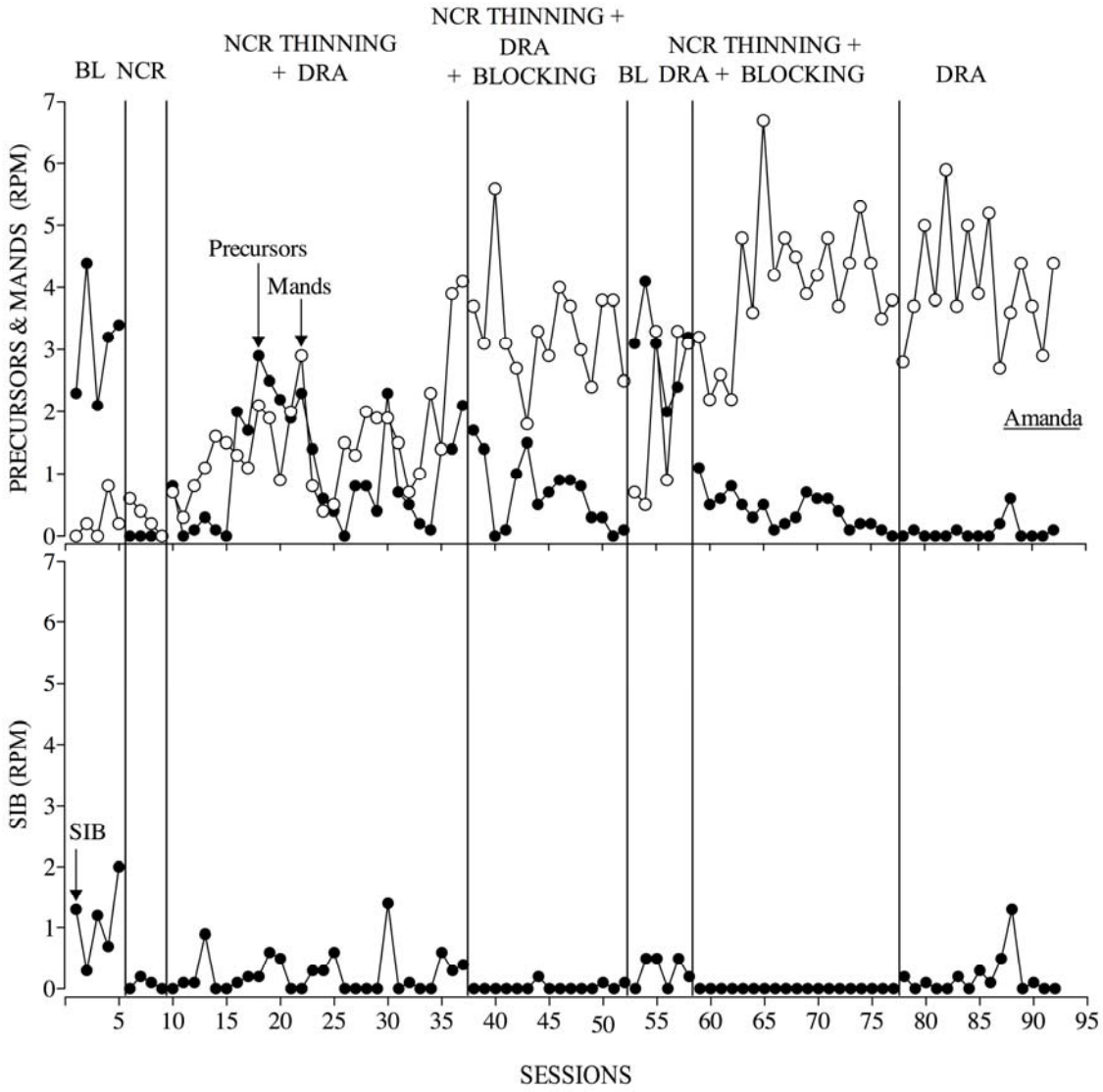

Figure 4-2. Treatment results for Amanda in Study 3.

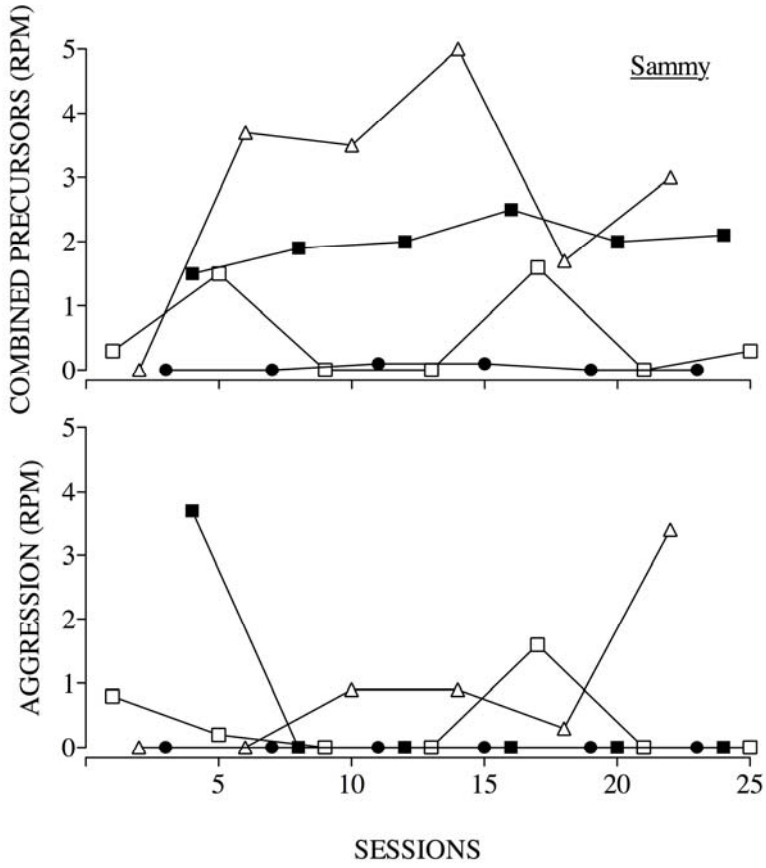

Figure 4-3. Results of the precursor FA for Sammy in Study 3.

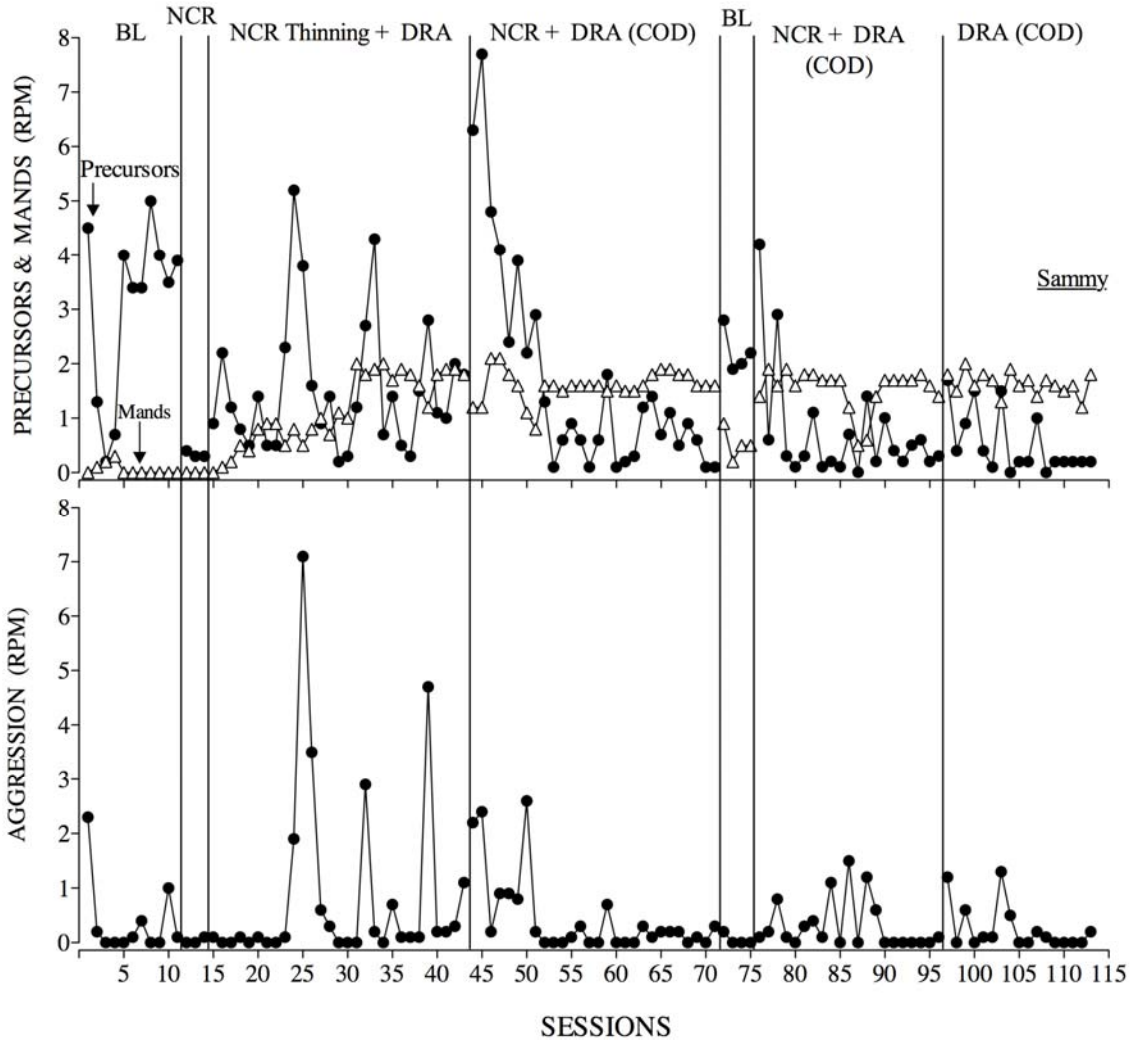

Figure 4-4. Treatment for behavior maintained by negative reinforcement for Sammy.

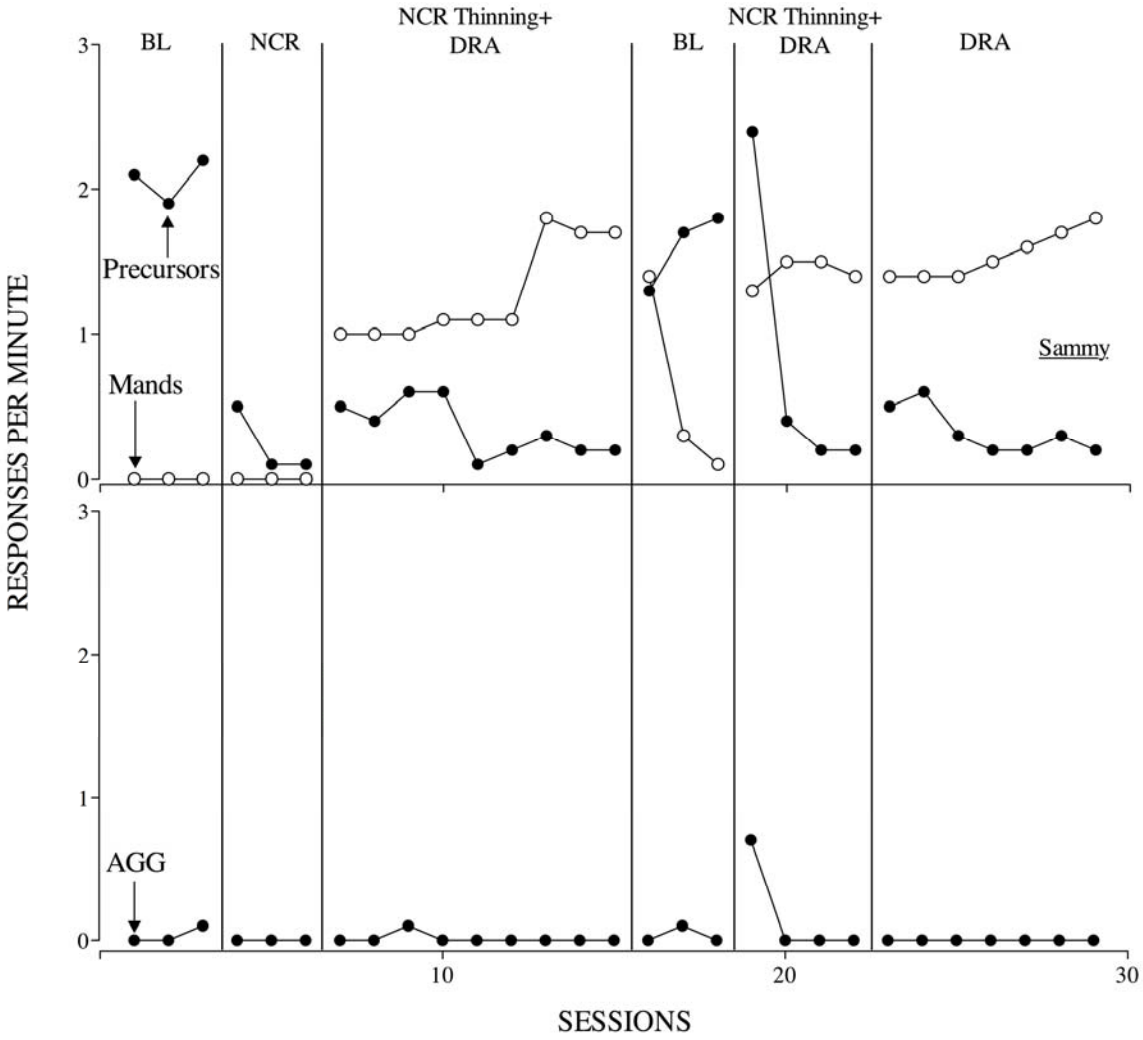

Figure 4-5. Treatment for behavior maintained by positive reinforcement for Sammy.

CHAPTER 5
DISCUSSION

The present studies examined the relation between precursor and problem behavior in three stages: empirical identification and selection of precursor responses (Study 1), response-class analysis of precursor and problem behavior (Study 2), and evaluation of treatment based on the functional analysis of precursor behavior (Study 3). Taken together, results indicated that precursor behaviors are both common and readily identifiable, that they often are members of the same class as problem behavior, and that they may be used as the basis for developing effective interventions.

Study 1 evaluated an objective yet brief method for identifying precursors to problem behavior, and results of the assessment indicated that all 16 subjects engaged in at least one precursor response. In addition, the assessment required very few instances (10 or fewer) of the severe problem behavior to identify precursors; thus, the trial-based precursor assessment seems to be a viable method of assessing severe problem behavior while minimizing the risks posed by dangerous topographies. The fact that problem behavior often is preceded by precursors suggests that problem behavior may simply be the terminal response in a hierarchy that begins with mildly annoying, disruptive behaviors (e.g., negative vocalizations, pushing materials away, etc.) or appropriate behaviors that are not reinforced (e.g., saying “No” or signing “food”). If so, it is surprising that caregivers rarely were able to identify precursors. In fact, caregivers for only 6 subjects were able to report potential precursors, and the reported precursors matched the behaviors identified by the precursor assessment in approximately 12% of cases. When the precursors reported by caregivers were compared to those actually observed during the functional analyses for subjects in Study 2, correspondence only increased to 23% of cases. It is possible that caregivers are not as attentive when problem behaviors are not occurring and miss

the occurrence of precursors. These behaviors still might become members of the same response class as problem behavior if precursors are followed quickly by problem behavior. Therefore, these behaviors might become members of the same response class as a result of the close temporal contiguity between the precursors and problem behavior (Catania, 1971). Correspondence between caregiver report and results of the precursor assessment might have been higher, however, if caregivers had been given access to the precursor checklist during the interview. The presence of example response topographies might have prompted caregivers to report potential precursors in cases in which none were reported or additional response topographies that were not reported independently.

There are, however, some limitations of using a trial-based method to identify precursor behaviors. First, the procedure may not be practical for very low-rate problem behavior, because the duration of trials may be too brief to evoke the target problem behavior. Wallace and Iwata (1999) compared results from functional analysis sessions based on 5-, 10-, and 15-min durations and found that some individuals did not engage in the target problem behavior until session conditions had been in effect longer than 5 min. Therefore, the 5-min trials of the precursor assessment might not prove to be a useful assessment method for some individuals' problem behavior. In fact, precursor assessments could not be completed for 3 potential subjects because their problem behavior was seen rarely; they subsequently were assessed during functional analyses with extended session durations. This methodology also might not be useful for very high-rate problem behavior, because short inter-response times for the target behavior would reduce the likelihood of observing other behaviors that could be identified as precursors. This problem was encountered with Amy and required the inclusion of play trials to provided periods of time in which the target behavior was not observed in order to calculate some probabilities

calculations (e.g., the probability of the target behavior given the absence of the precursor and the probability of the precursor given the absence of the target behavior).

Results of Study 2 verified that responses selected from the precursor assessment were members of the same response class as the target problem behavior for 7 of 8 subjects (precursor and target behaviors matched for one of two functions for the 8th subject). In addition, the precursor FAs eliminated the occurrence of the severe problem behavior for 3 subjects and reduced rates of the severe behavior for 4 other subjects. Taken together, these findings are significant in validating a combined precursor assessment and precursor functional analysis as a viable method for identifying contingencies that maintain severe problem behavior.

Because not all precursors actually were observed for each subject during the precursor FA, it is unclear whether the unobserved precursors were members of the same response class as the target behavior. One possibility is that subjects simply allocated responding toward topographies that initially contacted the reinforcement contingency, whereas the other precursors extinguished but were members of the same response class as the target behavior. Indirect evidence of this can be seen in cases in which previously unobserved precursors emerged in the same condition as the target problem behavior during the target FA. Previous research has demonstrated this type of finding (e.g., Magee & Ellis, 2000; Richman, Wacker, Asmus, Casey, & Andelman, 1999), in which placing the most frequently observed response topographies on extinction resulted in increased rates of other topographies of problem behavior, and similar effects have been shown with respect to increases in adaptive behaviors (Grow, Kelley, Roane, & Shillingsburg, 2008). More specifically, Grow et al. showed that appropriate but infrequent forms of communication might emerge when problem behaviors are placed on extinction, although the extinction bursts observed using this method of alternative response selection might

preclude its use with severe problem behavior. Given the results of these studies, it is possible that the selective extinction of observed precursors might have clarified the results of the current study; however, because the function of observed precursors matched the function of the target behavior in almost all cases, additional analyses seemed unnecessary given the purpose of this study.

Another potentially influential variable in determining subjects' response allocation toward particular precursor topographies is the relative response effort required to emit some topographies compared to others. In fact, many of the identified precursors did not appear to require much effort (e.g., negative vocalizations), which incidentally seem to be identified as precursors frequently in previous research (Borrero & Borrero, 2008; Lalli et al., 1995; Najadowski et al., 2008; Smith & Churchill, 2002). No specific procedures were used to determine the relative effort required for precursors or the target problem behavior in this study, however, although previous research has shown that effort can influence response allocation toward adaptive and problem behaviors. For example, Horner and Day (1991) compared the effects of teaching a high-effort (full sentence signs) versus low-effort (single-word sign) functional, alternative responses for one individual whose problem behavior was maintained by negative reinforcement. They found that the individual engaged in low rates of problem behavior and high rates of communication only when the alternative response required less effort. Therefore, subjects in the current study could have engaged in the less effortful behaviors, which maintained following reinforcement during the precursor FA, thus precluding the occurrence of other precursors.

An alternative explanation for unobserved response topographies during the precursor FA is that the current methodology simply yields a high rate of false alarms when identifying

precursors. The criterion for including a potential precursor in the probability analyses was simply its occurrence within a trial, and interpretations of the probability analysis results were based on relative (rather than absolute) values of conditional and unconditional probabilities for each potential precursor. This method was used because it seemed to be a simple, conservative method for identifying responses that preceded and were correlated with the target behavior, but it might have resulted in the selection of precursors that did not occur frequently before the target behavior (false alarms). Additionally, the termination criterion for the precursor assessment was 10 trials in which the target problem behavior was observed; therefore, a high rate of false alarms might have resulted as a function of the brevity of the assessment. No attempt was made to standardize the number of 5-min trials in which the target behavior was not observed for most subjects (except for Amy, who engaged in property destruction during the first 10 trials of the assessment); however, the total duration of trials *without* the target problem behavior was nearly equal to the total duration of trials *with* the target behavior for all subjects in the current study. Future research might evaluate different precursor selection or assessment-termination criteria in an attempt to clarify these results. For example, one might (a) examine relative frequencies of precursors in trials with and without the target behavior, (b) select responses that tend to occur closer in time before the target behavior, or (c) apply different interpretative rules to analyze the probability data. More specifically, future research might examine more stringent selection criteria by selecting only responses with high probabilities of the target given the precursor and vice versa (e.g., a probability of 0.6 or higher). Another option would be to conduct more trials in which the target problem behavior is unlikely to occur to, resulting in a larger sample of behavior for determining the probability of observing potential precursors in the absence of the target problem behavior.

It also is important to note that only half of the relation between precursors and the target behavior was examined in the current study by determining the function of responses that were predictive of the target behavior. It remains unknown whether responses that were not predictive of the target behavior were maintained by a different source of reinforcement. It is possible that any behavior that contacted the reinforcement contingencies might maintain and be effective in predicting the function of the target problem behavior, even though these behaviors might not necessarily be observed in typical settings. Renee's data most closely approximate this possibility in that only 1 precursor to aggression was selected, and it did not appear to strongly predict the occurrence of the target behavior. Results of independent FAs, however, showed that both behaviors were members of the same response class. It seems unlikely that responses that are not predictive of the target behavior would occur under similar conditions as the target behavior, contact the reinforcement contingency, and maintain, however, given that antecedent conditions (EOs) were specifically arranged during the precursor assessment to evoke the target problem behavior. Presumably, other responses that are sensitive to that source of reinforcement also would be observed, and behaviors maintained by a different source of reinforcement would be less likely to be observed. In this way, responses that are likely members of the same response class as the target problem behavior would probably be identified during the precursor assessment. Future research might compare the results of functional analyses of behaviors that do not predict the target problem behavior to the results of a functional analysis of the target behavior to determine the extent to which these non-predictive behaviors are maintained by the same or different sources of reinforcement.

Finally, it is highly unlikely that a precursor FA would be effective in reducing instances of the target problem behavior if it were maintained by automatic reinforcement because

arranging social consequences for precursors would not be expected to affect the rate of the target behavior. This would not, however, necessarily preclude the development of an effective treatment for behavior maintained by automatic reinforcement based upon the results of precursor assessments. For example, Hagopian et al. (2005) were able to design treatment following an assessment of precursors by blocking stereotypy (hand flapping) that predicted the occurrence of SIB (eye poking) for one individual. This subject's SIB was maintained by automatic reinforcement, and blocking the precursor (stereotypy) was shown to be more effective in reducing both stereotypy and SIB than blocking SIB alone. Therefore, these results suggest that precursor analyses per se may have some clinical utility regardless of the function of problem behavior and even if rates of the target problem behavior do not decrease during assessment.

Results of Study 3 showed that effective reinforcement-based interventions can be designed based on the results of precursor analyses only. Although severe problem behavior was not eliminated during the precursor FA or baseline, lower rates of the target behavior were observed relative to rates of precursors. Therefore, if reinforcement contingencies had been placed on the target behavior (i.e., no reinforcement for precursors) during the FA and baseline, it is probable that higher rates of the target behavior would have been exhibited by both subjects.

The effects of continuous NCR replicated the results of previous studies (Goh et al., 2000; Marcus & Vollmer, 1996) in that nearly all responding (precursor and target behavior) was suppressed under these conditions, and subjects did not emit the appropriate alternative response (mand). As the DRA component was introduced while the NCR schedule was systematically thinned, both subjects acquired the mand; however, these procedures were not effective in reducing precursors while maintaining low rates of the target behavior in 2 of 3 cases. The

addition of a response blocking component (Amanda) or a change-over delay (Sammy, treatment for behavior maintained by negative reinforcement) was effective in reducing rates of precursors and target behaviors, while mands maintained under the DRA contingency. When low rates of precursors and target behaviors were attained, the additional treatment components (NCR and blocking for Amanda and NCR for Sammy) were removed and similar effects on all behaviors were observed. (The change-over delay component remained in Sammy's final treatment package due to the severity of his aggression, although it was rarely implemented during the final sessions of the evaluation.) Therefore, both subjects allocated responding toward mands under conditions that would typically be encountered in their classrooms (i.e., Amanda could sign to receive food and Sammy could sign to receive a break from work). It is also interesting to note that no additional treatment components were necessary to reduce Sammy's precursors and maintain low rates of the target behavior during the second intervention evaluation. In fact, the second evaluation was completed in approximately ¼ of the number of sessions required to complete the first evaluation.

As in Study 2, not all precursors identified via the trial-based precursor assessment actually were observed during the precursor FA in Study 3. For example, the function of Amanda's precursors was determined primarily by the occurrence of reaching toward the therapist (i.e., hand postures and stretching were observed rarely). The positive reinforcement function of Sammy's precursors was determined solely by the occurrence of angry vocalizations, and the negative reinforcement function was determined by the occurrence of climbing, angry vocalizations, mouth movements, and moving furniture. Two of Sammy's precursors (running across the room and tugging on the therapist's shirt) were never observed. As previously discussed, it is possible that modifications to the methods of data analysis and/or precursor

selection criteria might lead to better predictions with respect to which response topographies are likely members of the same response class as the target behavior and, thus, would be exhibited during the precursor FA.

It also seems possible that improvements in the precursor assessment methodology might have resulted in greater initial behavioral reductions under NCR schedule thinning plus DRA. For example, if responses other than the selected precursors also predicted the occurrence of severe problem behavior, their inclusion in treatment could have prevented the occurrence of the target behavior. This is because the greater the number of responses that occur before severe problem behavior and contact the reinforcement contingency, the less likely severe problem behavior would be emitted. Anecdotally, it did not appear that either subject exhibited other "precursor" behaviors that were not identified via the precursor assessment. In fact, the precursor exhibited most frequently by Amanda during treatment was reaching toward the therapist, and the precursor exhibited most frequently by Sammy was angry vocalizations.

An alternative explanation for the initial poor treatment effects with NCR schedule thinning plus DRA is that some of the precursors selected for inclusion during treatment actually were members of a different response class than the target behavior. For example, some response topographies that were selected as precursors via the precursor assessment actually were not observed during the precursor FA; therefore, the function of these "precursors" was unknown. Given that the responses were selected suggests that they occurred at sufficient rates in general to be detected, and it could have been mere coincidence that the responses occurred in trials in which the target behavior also was observed. If this were true, these response topographies could have been exhibited during treatment and detected simply as a function of extended observation periods. Anecdotally, Sammy engaged in some precursor topographies in the absence of the

establishing operation (i.e., when demands were not presented or when preferred items were not removed), which suggests that these behaviors might have been maintained by a different source of reinforcement. Alternatively, features of the environment might have been discriminative for the presentation of demands or removal of preferred items, thus evoking some of the precursors in the momentary absence of the establishing operation. These possibilities remain speculative as additional analyses of selected precursors were beyond the scope of the present study.

In summary, the current series of studies demonstrates a method of analyzing precursor behavior and for progressing from assessment to treatment of severe problem behaviors while minimizing risk posed by those behaviors. Other methods of potentially reducing risk during assessment include the use of protective equipment (Le & Smith, 2002), a different dependent variable such as latency to problem behavior (Thomason, Iwata, Neidert, & Roscoe, in press), and brief session durations (Wallace & Iwata, 1999). The advantage of precursor analyses is that reinforcement contingencies are not placed on severe problem behaviors, thus decreasing the likelihood that severe behaviors would occur at high rates during the assessment and/or continue to occur following the assessment period. In addition, Study 1 provides a new method of empirically identifying precursor behaviors, and results of Study 2 verified that the identified precursors typically are members of the same response class as severe problem behavior. Finally, the sequential introduction of NCR and NCR schedule thinning plus DRA appears to be a viable treatment option for shifting response allocation from problem behavior to appropriate behavior while maintaining low rates of severe problem behavior and reducing risk. The results of Study 3 also indicate that this intervention strategy is appropriate for problem behavior maintained by positive and/or negative reinforcement and that NCR can be gradually thinned such that appropriate behavior maintains under DRA contingencies only.

Table 2-1. Subject characteristics

Name	Age	Classification	Definition of Target Problem Behaviors
Liv	10	Down syndrome	Property destruction (throwing items and knocking over furniture)
Billy	15	Down & Kleinfelter's syndromes	Clothing destruction (ripping, tearing, or unraveling socks)
Chuck	14	Arthrogryposis syndrome	SIB (head hitting)
Kelly	10	Seizure disorder & retinopathy	SIB (self biting)
George	9	Autism	Aggression (hitting, kicking, pinching, and biting)
Amy	3	Down syndrome	Property destruction (throwing objects, tearing materials from walls, and destroying materials)
Renee	15	Angelman's syndrome	Aggression (hair pulling, hitting, and pushing)
Curtis	13	Autism	Aggression (hitting, kicking, biting, and head butting)
Gerald	19	Cerebral palsy, MR (level unspecified)	SIB (hand biting)
Adam	11	Prader-Willi syndrome	Aggression (hitting, kicking, biting, and throwing objects that hit people)
Donald	14	Autism, seizure disorder	Aggression (hitting, kicking, biting, and head butting)
Leigh	13	Trainable mentally handicapped & language impaired	SIB (chin hitting and banging)
Guy	12	Autism	Aggression (hitting, kicking, biting, and head butting)
Kevin	54	Severe MR, seizure disorder	Property destruction (throwing furniture, pounding on walls, and destroying or throwing materials)
Amanda	18	Autism, profound MR	SIB (face and head hitting)
Sammy	6	Deaf, learning disabilities	Aggression (hitting, kicking, biting, head butting, and throwing objects that hit people)

Table 2-2. Precursor checklist

Category	Examples
Vocalizations	Screaming, laughing, cursing, squealing, requests
Facial Expressions	Smiling, grimacing, frowning, surprised
Postures	Slouching, dropping, head down, standing
Locomotion	Walking, running, jumping
Repetitive Motor Movements	Fidgeting, tapping fingers, tapping feet, stomping, hand flapping, head movements, hair twirling, nail picking, clapping
Object Manipulation	Playing with objects, tapping pencil, twirling objects
Other Problem Behaviors	
Self-injurious Behavior	Head banging, head hitting, skin picking, body hitting, self-biting, hair pulling
Aggression	Hitting, kicking, grabbing, head butting, biting, scratching
Property Destruction	Breaking objects, knocking over furniture, banging objects, throwing objects, hitting surfaces, kicking surfaces

Table 2-3. Probability analysis formulas

Probability Type	Formula
Conditional probability of the target behavior (T) given the precursor (P_n)	$p(\mathrm{T} \mid \mathrm{P}_n) = \dfrac{\#\ \text{trials with } \mathrm{P}_n \text{ that also contain T}}{\#\ \text{trials with } \mathrm{P}_n}$
Conditional probability of the target behavior given the absence of the precursor	$p(\mathrm{T} \mid\sim \mathrm{P}_n) = \dfrac{\#\ \text{trials containing T but not } \mathrm{P}_n}{\#\ \text{trials not containing } \mathrm{P}_n}$
Unconditional probability of the target behavior	$p(\mathrm{T}) = \dfrac{\#\ \text{trials containing T}}{\text{total}\ \#\ \text{trials}}$
Conditional probability of the precursor given the target behavior	$p(\mathrm{P}_n \mid \mathrm{T}) = \dfrac{\#\ \text{trials with T that also contain } \mathrm{P}_n}{\#\ \text{trials with T}}$
Conditional probability of the precursor given the absence of the target behavior	$p(\mathrm{P}_n \mid\sim \mathrm{T}) = \dfrac{\#\ \text{trials containing } \mathrm{P}_n \text{ but not T}}{\#\ \text{trials not containing } \mathrm{P}_n}$
Unconditional probability of the precursor	$p(\mathrm{P}_n) = \dfrac{\#\ \text{trials containing } \mathrm{P}_n}{\text{total}\ \#\ \text{trials}}$

Table 2-4. Precursors reported by caregivers vs. assessment-identified precursors. Italicized precursors were behaviors identified by both caregivers and the precursor assessment.

Subject	Caregiver-Reported Precursor(s)	Assessment-Identified Precursor(s)	Precursors Observed in FA
Liv	*Make a cry/screech noise*	*Vocalize positively*, flap hands, mouth objects	N/A
Billy	NONE	Cross legs, pull up pants/touch leg, rub glasses	N/A
Chuck	NONE	Hit surfaces, grab tongue, bounce hands on face	N/A
Kelly	Run away	Whine, mouth fingers, place hands in clothes	N/A
George	*Yell*, *throw items*, tip over chairs	*Yell*, *throw objects*, sign, rub head, swing arms, bang surfaces	N/A
Amy	Laugh	Manipulate objects, make noises, touch face, move around room, move repetitively, hand on foot, say "Mine," put face in object, bend at waist, mouth object	N/A
Renee	NONE	Cover eyes	Cover eyes
Curtis	Whine, repeat phrases, grimace	Scratch leg, block therapist from objects	Block therapist from objects
Gerald	Scream, hit head or ear	Flick lips, grimace, hit others, move head	Grimace, move head
Adam	*Vocalize negatively*, *put head down*, *change entire facial expression*/*make faces at others*, roll eyes, yell, tongue click	*Say "No," slouch*, *grimace*, turn away, put paper in mouth, push materials away	*Say "No," slouch,* turn away, push materials away
Donald	Bruxism	Flap hands, put hand to mouth, snarl, clap hands, vocalize negatively, move to objects	Flap hands, snarl, clap hands, vocalize negatively, move to objects
Leigh	NONE	Cover eyes, rest head, say "Yeah yeah," guide therapist, stomp/shuffle, circle hands	Cover eyes, chin down, stomp/shuffle, circle hands
Guy	*Drop to ground*, *roll on floor*, *curse*, *scream*	*Flop (*includes rolling), *curse*, *vocalize negatively* (includes screaming), swing body, stomp, bite objects, throw objects, push materials away, crumple paper, bite hand, bang head, grimace, shake head "No," hit surfaces, slouch, make requests	*Flop, curse,* swing body, bite objects, throw objects, stomp, push materials away

Table 2-4. Continued

Kevin	*Say "No"*	*Say "No,"* grunt, drop/scoot on floor, wave arms, pull therapist's arm, say "Good boy," hold knees, smile, fidget, stack chairs, hit with head, knock on table	*Say "No,"* grunt, drop/scoot on floor, wave arms, hold knees, fidget, knock on table
Amanda	NONE	Hand posture, reach for therapist, stretch	N/A
Sammy	NONE	Angry vocalizations, run, climb, mouth movements, move furniture, tug on therapist's shirt	N/A

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BIOGRAPHICAL SKETCH

I completed my Bachelor of Science degree at the University of Florida in 2001 then accepted a position on the inpatient Neurobehavioral Unit at the Kennedy Krieger Institute in Baltimore, MD. There I was responsible for the assessment and treatment of severe problem behaviors, such as self-injury, aggression, and property destruction. I returned to the University of Florida in 2003 to pursue a doctoral degree in psychology and specializing in behavior analysis. During my graduate training, I have been involved in research projects on refining behavioral assessment methods, evaluating treatments for problem behaviors, comparing methods of training observers, and evaluating the effects of varying reinforcement parameters on performance. I also served as coordinator of an outpatient clinic for individuals diagnosed with autism, provided behavioral services to students and teachers within a special education setting, and served as teaching assistant and primary instructor for introductory courses in applied behavior analysis. Following graduation, I will join the faculty at the University of Houston – Clear Lake as an assistant professor in applied behavior analysis within the psychology program.