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Functional Analysis of Precursors for Serious Problem Behavior and Related Intervention

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Precursor behaviors are innocuous behaviors that reliably precede the occurrence of problem behavior. Intervention efforts applied to precursors might prevent the occurrence of severe problem behavior. We examined the relationship between precursor behavior and problem behavior in three individuals with developmental disabilities. First, a descriptive (correlational) assessment focusing on transitional probabilities, which established that problem behavior typically followed precursor behavior, was conducted. Next, a functional (experimental) analysis was conducted to evaluate the relationship between precursor and problem behavior. Results suggested that these two behaviors served the same function. Finally, in the intervention phase, participants were taught a response that was functionally equivalent to the precursor behavior. Results demonstrated a decrease in the frequency of problem behavior. Collectively, these results suggest that prevention efforts might profitably be focused on precursor behavior. Further implications for the use of functional analysis and functional communication training in prevention are discussed.

Keywords: autism; problem behavior; precursor behavior; functional analysis; functional communication training

Understanding the relationship between problem behavior and earlier occurring precursor behaviors might be useful in helping to design interventions for problem behavior (Harris, 1980; Voeltz & Evans, 1982). Identification of precursor behaviors is important because it can alert caregivers and staff of an increased likelihood that more severe problem behavior is about to occur thereby facilitating efforts at prevention (Albin, O’Brien,
& Horner, 1995). Analyses of various topographies of severe problem behavior (e.g., screaming, aggression, and self-injury) have demonstrated that these behaviors (a) may be members of the same response class and (b) may be hierarchically related such that the behaviors occur in a predictable progression of increasing severity (Lalli, Mace, Wohn, & Livezey, 1995; Richman, Wacker, Asmus, Casey, & Andelman, 1999). Recent investigations of response-class hierarchies have emphasized the relationship between these multiple topographies of problem behavior (Harding et al., 2001; Smith & Churchill, 2002).

Different topographies of problem behavior can be maintained by the same consequences (Harding et al., 2001; Magee & Ellis, 2000; Richman et al., 1999; Smith & Churchill, 2002). For example, Harding et al. (2001) conducted an extinction analysis of different topographies of problem behavior and demonstrated that they were maintained by the same consequences, that is, they were members of the same response class. Their results demonstrated that mild problem behavior (i.e., task refusal and tantrums) typically preceded severe problem behavior (i.e., self-injury, aggression, or property destruction) in a sequence, suggesting that these behaviors formed a response hierarchy. Similarly, Smith and Churchill (2002) conducted a functional analysis of severe problem behavior (i.e., self-injury and aggression) followed by a functional analysis of milder precursor problem behavior (i.e., screaming, grabbing, falling, vocalization, crying, reaching, and foot stomping). Results of their study suggested that the milder precursor behaviors and the more severe problem behaviors that followed were both maintained by the same reinforcers. It is also interesting to note that the authors found the rates of problem behavior decreased when precursor behavior was reinforced.

As noted earlier, the relationship between precursor behavior and problem behavior could provide information useful in the prevention of problem behavior. It has been hypothesized that intervention efforts applied to these behaviors...
earlier, often more innocuous behaviors, might prevent the occurrence of more severe forms of problem behavior (Hagopian, Paclawskyj, & Kuhn, 2005; Harding et al., 2001; Harris, 1980; Richman, 2008). Thus, if during work time a young boy reliably covers his eyes with his hands prior to exhibiting escape-motivated self-injury, our earlier research suggests that it may be possible to prevent problem behavior by implementing a communication-based intervention (Carr & Durand, 1985). For example, the boy might be prompted to ask for a break or assistance (as appropriate) whenever he is observed to cover his eyes.

The previous research, just cited, highlights the possibility that precursor and problem behaviors are sometimes functionally equivalent. Existence of these functional relationships justifies a more detailed and formal analysis of the assessment and intervention implications of such equivalence. Therefore, in the present study, we explored equivalence relationships through descriptive assessment via direct observation that allowed for an analysis of the transitional probabilities existing between classes of precursor behavior, problem behavior, and a residual class of other behavior (i.e., any behavior other than precursor or problem behavior). Assessment implications of these relationships were then formally validated through a functional analysis. Finally, these analytic data were, in turn, used to design a preventive intervention strategy involving functional communication training (FCT) applied to the precursor behaviors themselves. In sum, the two hypotheses of this study were (a) precursor and problem behavior can be demonstrated to be functionally equivalent through a combination of transitional probability analysis and functional analysis and (b) functional communication training, a preventive strategy based on the concept of functional equivalence, can be applied to precursor behaviors to produce a reduction or elimination of problem behavior.

**Method**

**Participants and Setting**

Three individuals attending a day school for individuals with developmental disabilities participated. Timmy was a 6-year-old boy diagnosed with autism, whose cognitive functioning fell within the severe range of mental retardation, as measured by the Slosson Intelligence Test (IQ = 32). He communicated using a symbol system (the picture exchange communication system [PECS]). The second participant, Sally, was a 7-year-old girl. Sally’s overall level of adaptive functioning, as measured by the Vineland Adaptive Behavior Scale-Classroom Edition (VABS-CE), was estimated to be
in the mild range of mental retardation (adaptive behavior composite = 64). In addition, Sally was described as having characteristics of autism. She communicated primarily with one word utterances. Jake was an 18-year-old man diagnosed with autism. His functioning level was estimated to be in the severe to profound range of mental retardation, based on the results on the Cattell Infant Intelligence Test (IQ < 30). He communicated primarily through sign language and picture symbols. Jake occasionally uttered single words but typically required prompting to initiate any communication. Jake was taking Risperdal (6 mg/day), Luvox (750 mg/day), and Depakote (750 mg/day) throughout the course of the study. All participants had a history of displaying severe problem behavior. Sessions were conducted at the school in a 4 m × 4 m tutoring room equipped with a one-way mirror (Timmy and Sally) or in the living area of a community residence (Jake).

Response Definitions

On the basis of reports from the teaching staff, who knew each individual for 3 to 6 months, precursor behaviors and problem behaviors were identified. Timmy’s precursor behavior consisted of hand posturing, defined as positioning his hands such that his thumbs were pointed toward him, his index fingers were pointed up, and the remainder of his fingers were folded. His problem behavior was self-injury, defined as biting his hand, hitting his chin with his wrist, hitting his head, banging his head, throwing his body backward into a chair, or hitting his hands on furniture or other hard objects. Sally’s precursor behavior was a vocalization defined as a high-pitched squeal, grunt, or whine. Her problem behavior was aggression, consisting of biting, scratching, or hitting others, and self-injury, defined as biting her wrist. Jake’s precursor behavior consisted of abrupt, jerky body movements involving his head, arms, legs, or shoulders. Specifically, Jake’s precursor behavior included rapidly turning his head past one shoulder, bending his arm at the elbow and rapidly pulling his arm back past his body, bending one leg with the other held straight, and abruptly moving one shoulder forward or backward. Jake’s problem behavior was self-injury consisting of hand-biting. His self-injury was so severe he had several raised calluses on each of his hands.

Procedure

Overview. The protocol consisted of four components: First, participants were identified. Second, a descriptive (correlational) analysis was conducted to examine the relationship (transitional probability) between precursor behavior and problem behavior in the context of a typical daily activity. In
the third component, the relationship between precursor behavior and problem behavior was investigated experimentally using functional analysis methodology. Finally, in the intervention component, each participant was taught a functionally equivalent communicative response relevant to the precursor behavior to reduce the occurrence of the problem behavior.

Component 1: Participant identification through interview. The purpose of this component was to identify participants and to determine a primary motivation for problem behavior. Initially, interviews were conducted with classroom staff and supervisors. Classroom staff were asked to identify children who exhibited behavioral cues that indicated problem behavior was likely to occur (e.g., “Does Timmy have warning signs that problem behavior is likely to occur? What are they?”). These interviews provided preliminary information about individuals who typically displayed precursor behavior as well as problem behavior.

Following the initial interview, classroom staff were interviewed again using the Functional Analysis Interview Form (O’Neill et al., 1997; O’Neill, Horner, Albin, Storey, & Sprague, 1990) to identify a primary motivation for each problem behavior. Because the intervention phase of this study consisted of teaching a functionally equivalent communicative response, a key inclusion criterion was that a child’s problem behavior had to be socially mediated. Through these interviews, we selected participants (described earlier) who regularly displayed precursor behavior and exhibited socially mediated problem behavior. Based on the interview, the teachers nominated escape as the primary motivation for problem behavior for each participant.

Component 2: Descriptive analysis. The purpose of this component was to carry out direct observations to document the relationship between precursor behavior and problem behavior for each participant. Four 20-min observations were videotaped in the school setting in situations identified during the functional analysis interview as leading to problem behavior. For Sally and Timmy, these observations took place in their classrooms during time periods when they were working on goals from their individualized educational programs (IEPs). For both children, these tasks included gross motor imitation, receptive object and/or picture identification and matching. Jake was observed working on gross motor activities (e.g., washing tables, exercise) with staff members during an agency program he attended after school. Data were collected on the occurrence of precursor behavior and problem behavior. Transitional probabilities (described later) were calculated on the basis of these observations (Bakeman & Gottman, 1986).
Component 3: Analog analysis of precursor behavior. The purpose of this component was to experimentally demonstrate the relationship between precursor behavior and problem behavior. Each individual participated in an experimental manipulation of relevant trigger stimuli. Only demand sessions were conducted during this phase on the basis of teacher report from the functional analysis interview (O’Neill et al., 1990, 1997). Analysis of escape behavior followed the procedure outlined by several investigators (Fisher, Piazza, Bowman, Hagopian, & Langdon, 1994; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). One to four sessions were run per day, typically 3 to 5 days per week. The total number of sessions conducted was 15, 22, and 16 for Timmy, Sally, and Jake, respectively. Most sessions were conducted by either the first author or a trained research assistant. However, for each participant two sessions (probe sessions) were conducted by a member of the school staff who was blind to the hypotheses of the study but who had been trained in conducting demand sessions. During the precursor analysis, the naive experimenter (member of the school staff) conducted sessions 7 and 13 for Timmy, 14 and 22 for Sally, and 9 and 13 for Jake.

Sally and Timmy participated in demand sessions that simulated their classroom environments. Tasks were selected from their individualized educational programs. These tasks were similar to those used in component 2. Ten-minute sessions were conducted in a room equipped with a table, chairs, and developmentally appropriate academic tasks. The experimenter instructed the child to be seated and issued a demand approximately once every 30 s using the prompting procedure typically used by classroom staff. For Timmy, sequential verbal, gestural, and physical prompts were used. For Sally, a no-no prompt was used, with the experimenter providing brief feedback (i.e., saying “no”) if Sally responded incorrectly to a demand. After an incorrect response to the second prompt, the experimenter said, “no” a second time and physically guided Sally to respond correctly (e.g., guided her to point to the picture of a car). In both cases, the experimenter terminated the task for 30 s in response to a target behavior. After 30 s had elapsed, the experimenter presented another demand.

Jake participated in demand sessions involving exercise (a nonpreferred gross motor activity), specifically, walking on a treadmill. Five-minute sessions were conducted in the living area of a community residence. At the start of each session, the experimenter told Jake, “It’s time to walk on the treadmill.” Sequential verbal, gestural, and physical prompts were used to elicit compliance. If Jake exhibited a target behavior he was given a 30-s break. At the end of 30 s, the experimenter again asked Jake to walk on the treadmill.
Two experimental conditions were compared during the precursor analysis (see top half of Table 1). In phase A, task termination occurred following the display of either precursor or problem behavior. In phase B, task termination occurred for the display of problem behavior only; precursor behavior was followed by the continuation of demands. In summary, the consequence (reinforcer) for problem behavior (i.e., 30-s escape) was the same in both phase A and phase B. However, precursor behavior was reinforced (i.e., 30-s escape) only in phase A. Because problem behavior was reinforced across phases, any change in the frequency of problem behavior observed across phases could be attributed solely to the change in contingency for precursor behavior.

**Component 4: Communication-based intervention.** The purpose of this component was to reduce occurrence of problem behavior by teaching each participant a communicative response that was functionally equivalent to precursor behavior and problem behavior. An appropriate communicative response was chosen in consultation with each participant’s speech therapist. Timmy used a PECS break symbol taken from *The Picture Communication Symbols Combination Book* (Mayer-Johnson Company, 1994). Sally used a PECS break symbol and would occasionally request a break verbally as well. For easy access, the PECS symbol was placed in front of the participant on the table during all intervention sessions. For Jake, the communicative response was touching a card with a picture of a “stop” sign. The stop sign was placed in front of Jake while he was on the treadmill, and the

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experimenter carried it to where Jake positioned himself during breaks (e.g., a couch).

Analog demand sessions were conducted as described in component 3. The number of sessions conducted per day ranged from 1 to 6, typically 3 to 5 days per week. The total number of sessions conducted was 14, 15, and 12 for Timmy, Sally, and Jake, respectively. Sessions were conducted by either the first author or a trained research assistant. For Sally and Jake, probe sessions were conducted by an experimenter who had no knowledge of the hypotheses of the study and was trained by the first author in conducting an intervention session. The naive experimenter conducted sessions 10 and 11 during Sally’s intervention, and sessions 3 and 4 during Jake’s intervention. However, due to unavailability of staff, it was not possible to conduct intervention sessions with Timmy, using another naive experimenter.

Two conditions were compared during the intervention phase (see the bottom half of Table 1): communication acquisition (phase B) and baseline control (phase A). Demands were presented every 30 s. In phase B, participants were prompted to ask for a break (communicate) on the occurrence of precursor behavior. If the participant asked for a break, communication was reinforced with a brief 30-s escape from the task. The experimenter also terminated the task for 30 s if the participant displayed problem behavior (i.e., problem behavior was negatively reinforced). In the baseline comparison phase (i.e., phase A), the child was not prompted to communicate on the occurrence of precursor behavior and the experimenter continued to issue demands. If the participant independently requested a break, the experimenter said, “That’s nice asking for a break, but you need to keep working” and continued to present demands. The experimenter reinforced problem behavior with 30-s task termination. In summary, in phase B, precursor behavior was used as a signal to prompt communication, and the task was terminated for the display of either communication or problem behavior. In phase A, the task was terminated for the display of problem behavior only.

**Experimental Design**

An ABAB reversal design was used during the precursor analysis (component 3). In phase A, both precursor behavior and problem behavior were reinforced with a 30-s break. In phase B, only problem behavior was reinforced. A BAB reversal design was used during intervention (component 4). In phase B, the participant was prompted to communicate when precursor behavior occurred. Both communication and problem behavior were reinforced. In phase A, only problem behavior was reinforced.
Data Analysis and Reliability

Data were collected on the frequency of both precursor behavior and problem behavior during the descriptive analysis, precursor functional analysis, and intervention components (i.e., components 2, 3, and 4, respectively) using the portable computer system software program (Repp, Karsh, Van Acker, Felce, & Harman, 1989). Data were also collected on frequency of communicative responses during intervention.

Transitional probabilities were calculated on the basis of data obtained from the classroom observation during the descriptive analysis (Bakeman & Gottman, 1986) to characterize the relationship between precursor and problem behavior for each individual. Each 20-min observation session was divided into a series of 30-s observation intervals, as described below. Five transitional probabilities were calculated: (a) the probability that a precursor behavior was directly followed by a problem behavior, (b) the probability that a precursor behavior was directly followed by a second precursor behavior, (c) the probability that precursor behavior was directly followed by other behavior (i.e., neither a second precursor behavior nor problem behavior occurred during the 30-s interval that followed a precursor behavior), (d) the probability that a problem behavior was directly followed by another problem behavior, and (e) the probability that a problem behavior occurred in spite of the fact that neither a precursor behavior nor a problem behavior occurred during the preceding observation interval. A new 30-s observation interval began with each occurrence of precursor behavior (for probabilities a, b, and c) or problem behavior (for probabilities d and e).

Reliability data on precursor behavior, problem behavior, and communication were collected by a second trained observer who had no knowledge of the hypotheses of the study. Agreement was calculated by dividing number of agreements by the number of agreements and disagreements multiplied by 100. For Timmy, reliability data were collected in 25% of the descriptive analysis sessions and 31% of the precursor analysis and intervention sessions. The mean interobserver agreement across conditions was 85.3% for precursor behavior (range = 75%-100%), 94.9% for problem behavior (range = 83%-100%), and 96.8% for communication (range = 87%-100%). For Sally, reliability data were collected in 25% of the descriptive analysis sessions and 32% of the precursor analysis and intervention sessions. Mean interobserver agreement was 86.2% for precursor behavior (range = 79%-100%), 95.3% for problem behavior (range = 78%-100%), and 98.7% for communication (range = 94%-100%). For Jake, reliability data were collected in 25% of the descriptive analysis sessions and 32% of
the precursor analysis and intervention sessions. Mean interobserver agreement across conditions was 98.6% for precursor behavior (range = 86%-100%), 96% for problem behavior (range = 80%-100%), and 100% for communication.

Results

Component 1: Participant Identification Through Interview

Results of the functional analysis interview form provided an in-depth description of each participant’s problem behavior and identified a primary motivation for problem behavior.

Timmy. Timmy’s teacher reported that his problem behavior consisted primarily of self-injury, including head hitting and head banging. Timmy reportedly would bang his head against the floor, the wall, his own feet, or any other available object. He typically exhibited between 3 and 7 episodes of self-injury per day with bursts of up to 20 min in length. The intensity of Timmy’s self-injury was reported to be high, which was of special concern to his teacher because Timmy actively avoided banging his head on soft surfaces, such as mats or pillows, targeting hard surfaces such as floors and tables. His teacher reported that Timmy’s hands typically “tensed up and contorted” near his face (precursor behavior) before he was about to hit or bang his head. In addition, Timmy’s teacher reported that his problem behavior was most likely to occur during morning work hours and least likely to occur during lunch. This pattern suggested that the primary motivation for Timmy’s problem behavior was escape from demands.

Sally. Sally’s teacher reported that Sally’s problem behavior consisted primarily of biting herself and others. These behaviors were reported to be of high intensity, occurring many times per day, and often resulting in bodily harm. Sally also exhibited a vocalization, described by her teacher as a scream or loud, high-pitched verbalization. One of the supervisors of Sally’s classroom reported that this vocalization (precursor behavior) often preceded the occurrence of problem behavior. Sally’s teacher further reported that Sally’s problem behavior was most likely to occur during instruction and least likely to occur while Sally was playing. This pattern suggested that the primary motivation for Sally’s problem behavior was escape from demands.
Jake. The program manager at Jake’s after-school program reported that Jake’s primary problem behavior was biting his hand. Jake’s self-injury was reported to be very intense, occurring in episodes ranging from a few seconds to 30 min approximately 3 times per day during the after-school program. His program manager reported that Jake typically exhibited jerky body movements (precursor behavior) prior to the display of self-injury. Furthermore, Jake reportedly was most likely to exhibit problem behavior in response to demands, particularly when the demands were novel, difficult, or involved high amounts of physical exertion (e.g., washing tables, exercise, etc.), and was least likely to exhibit problem behavior during routine activities requiring minimal exertion (e.g., looking at a book). This pattern suggested that the primary motivation for Jake’s problem behavior was escape from demands.

Component 2: Descriptive Analysis

As noted, each participant was observed during demand situations in a school setting for four, 20-min naturalistic observations. Table 2 shows the transitional probabilities that were calculated on the basis of these observations. Results for each participant are discussed next.

Timmy. In the classroom setting, Timmy tended to have high rates of self-injury during work periods. His self-injury occurred in bursts, typically preceded by a precursor behavior. Thus, it was not unusual for Timmy to hand posture (precursor) and then bang his head 10 times. Results of these classroom observations are summarized in the top section of Table 2. As shown in the first column, when Timmy exhibited a precursor behavior during observation, the likelihood (mean) that the next behavior occurring within 30 s was a problem behavior was .72 (range = .65 to .78). The second column shows that given the occurrence of a precursor behavior, the likelihood that the next behavior within 30 s was a second precursor was .20 (range = .13 to .23). Data in the third column (precursor to other behavior) indicate that the likelihood that neither a second precursor behavior nor a problem behavior would follow a precursor behavior within 30 s was .08 (range = .03 to .12). The fourth column shows that the likelihood that a problem behavior would be immediately followed by a second problem behavior within 30 s was .73 (range = .54 to .83). Finally, data in the fifth column show that the likelihood that a problem behavior would occur with neither a problem behavior nor a precursor behavior occurring in the preceding 30 s interval was .02 (range = .00 to .04).
Sally. Results of the classroom observations for Sally are summarized in the middle section of Table 2. As shown in the first column, when Sally exhibited a precursor behavior during observation, the likelihood that the next behavior occurring within 30 s was problem behavior was .63 (range = .54 to .75). The second column shows that given the occurrence of a precursor behavior, the likelihood that the next behavior within 30 s was a second precursor was .25 (range = .18 to .32). Data in the third column (precursor to other) indicate that the likelihood that neither a second precursor behavior nor a problem behavior would follow a precursor behavior within 30 s was .12 (range = .07 to .16). The fourth column shows that the likelihood that a problem behavior would be immediately followed by a second problem behavior within 30 s was .35 (range = .25 to .45). Finally, data in the fifth column show that the likelihood that a problem behavior would occur with neither a problem behavior nor a precursor behavior occurring in the preceding 30-s interval was only .02 (range = .00 to .04).

Jake. Results of Jake’s descriptive analysis are displayed in the bottom section of Table 2. As shown in the first column, when Jake exhibited a
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precursor behavior during observation, the probability that problem behavior followed within 30 s was .52 (range = .33 to .71). The second column shows that given the occurrence of a precursor behavior, the likelihood that the next behavior within 30 s was a second precursor was .22 (range = .14 to .35). Data in the third column (precursor to other) indicate that the likelihood that neither a second precursor behavior nor a problem behavior would follow a precursor behavior within 30 s was .26 (range = .09 to .50). The fourth column shows that the likelihood that a problem behavior would be immediately followed by a second problem behavior within 30 s was .40 (range = .19 to .50). Finally, data in the fifth column show that the likelihood that a problem behavior would occur with neither a problem behavior nor a precursor behavior occurring in the preceding 30-s interval was only .08 (range = .00 to .15).

Component 3: Analog Analysis of Precursor Behavior

In phase A of the analog analysis, participants received a 30-s break for the occurrence of either precursor behavior or problem behavior. In phase B of the analysis, participants received a 30-s break for the occurrence of problem behavior only. Recall that sessions for Timmy and Sally were 10 min in duration. Sessions for Jake were 5 min in duration.

Timmy. The top section of Figure 1 depicts results of Timmy’s precursor analysis. Overall, frequency of Timmy’s problem behavior was low during phase A (median = 1.0, range = 0 to 2) and increased sharply during Phase B (median = 16.5, range = 14 to 24). His display of precursor behavior was relatively constant across phases A (median = 12.0, range = 10 to 17) and B (median = 14.0, range = 7 to 20).

Sally. The middle section of Figure 1 depicts the results of Sally’s precursor analysis. As was the case with Timmy, the frequency of Sally’s problem behavior was low during phase A (median = 4.0, range = 1 to 8) and increased sharply during phase B (median = 11.0, range = 4 to 16). Her display of precursor behavior was higher during phase B (median = 15.0, range = 12 to 34) than during phase A (median = 8.0, range = 4 to 26).

Jake. The bottom section of Figure 1 depicts the results of Jake’s precursor analysis. As was the case with Timmy and Sally, the frequency of Jake’s problem behavior was low during phase A (median = 0, range = 0 to 1) and increased sharply during phase B (median = 7.0, range = 2 to 11). His display of precursor behavior was relatively constant across phases A (median = 4.0, range = 1 to 8) and B (median = 6.5, range = 3 to 10).
The triangles connected by dotted lines represent precursor behavior. The squares connected by solid lines represent problem behavior. Asterisks indicate sessions conducted by the naive experimenter.
Component 4: Communication-Based Intervention

In phase B of intervention (communication acquisition), participants received a 30-s break contingent on the display of either problem behavior or communication. Each time the participant exhibited precursor behavior, he or she was prompted to communicate. In phase A (baseline), participants received a 30-s break contingent on the display of problem behavior only. The experimenter continued presenting demands (i.e., no 30-s break was given) for the display of either communication or problem behavior. Sessions for Timmy and Sally were 10 min in duration. Sessions for Jake were 5 min in duration.

Timmy. Timmy’s intervention data are presented in the top section of Figure 2. Timmy was taught to use a symbol indicating break. In phase B, Timmy’s display of problem behavior was typically low (median = 3.0, range = 0 to 61) and his display of communication was high (median = 10.0, range = 7 to 14). In phase A, Timmy’s display of problem behavior was high (median = 20.0, range = 19 to 21) and his display of communication was low (median = 0, range = 0 to 0). Thus, when both communication and problem behavior were reinforced (phase B), problem behavior was low and communication was high. When only problem behavior was reinforced (phase A), problem behavior was high and communication was low. Timmy displayed high rates of precursor behavior in both phase A (median = 21.0, range = 15 to 21) and phase B (median = 20.0, range = 12 to 29).

Sally. Sally’s intervention data are presented in the middle section of Figure 2. Sally was taught to use a symbol to indicate her need for a break; she often communicated this need verbally (e.g., she said, “break”) as well. As was the case with Timmy, Sally’s display of problem behavior during phase B was low (median = 2.0, range = 0 to 9) and her display of communication was high (median = 15.0, range = 8 to 18). In phase A, Sally’s display of problem behavior was high (median = 12.0, range = 10 to 17) and her display of communication was low (median = 2.0, range = 0 to 5). Thus, when both communication and problem behavior were reinforced (phase B), problem behavior was low and communication was high. When only problem behavior was reinforced (phase A), problem behavior was high and communication was low. Sally displayed precursor behavior at a higher frequency in phase A (median = 7.0, range = 2 to 11) than in phase B (median = 3.5, range = 0 to 14), although her display of precursor behavior was quite variable across phases.
Figure 2
Frequency of Precursor Behavior, Problem Behavior, and Communication During the Communication-Based Intervention for Each Participant

Communication frequency includes prompted and unprompted responses. The triangles connected by dotted lines represent precursor behavior. The squares connected by solid lines represent problem behavior. The circles connected by dotted lines represent communication. Asterisks indicate sessions conducted by the naïve experimenter.
**Jake.** Jake’s intervention data are presented in the bottom section of Figure 2. Jake was taught to touch a “stop” sign to request a break. As was the case with Timmy and Sally, Jake’s display of problem behavior during phase B was low (median = 0, range = 0 to 0) and his display of communication was comparably higher (median = 4.0, range = 3 to 9). In phase A, Jake’s display of problem behavior was high (median = 7.5, range = 3 to 25) and his display of communication was low (median = 0, range = 0 to 1). Thus, when both communication and problem behavior were reinforced (phase B), problem behavior was low and communication was high. When only problem behavior was reinforced (phase A), problem behavior was high and communication was low. As was the case with Sally, Jake’s precursor behaviors occurred at a higher frequency during phase A (median = 6.5, range = 5 to 9) than during phase B (median = 2.0, range = 1 to 4).

**Discussion**

Two hypotheses were examined in the present study. First, it was predicted that precursor behavior and problem behavior would serve the same function. Second, a communication-based intervention, applied contingent on the precursor behavior, was predicted to reduce the occurrence of problem behavior. Problem behavior changed in a lawful, orderly manner during both the analysis and intervention phases of this study, confirming both hypotheses. These findings suggest that it is possible to reduce or prevent occurrence of problem behavior by intervening at the precursor level. This strategy is a departure from most previous research that has emphasized the importance of the analysis and intervention of problem behavior per se.

**Testing the Hypotheses**

During the precursor analysis (component 3), participants received a brief (i.e., 30-s) break contingent on the display of problem behavior. In phase A, participants were able to obtain a break contingent on precursor behavior as well as problem behavior. When the 30-s break was contingent on the display of either precursor behavior or problem behavior, precursor behavior was high and problem behavior was low. When participants received a break contingent on problem behavior only (phase B), the frequency of problem behavior increased dramatically. Thus, when participants were able to access equivalent reinforcement through precursor behavior or problem behavior, they typically exhibited precursor behavior
instead of problem behavior. The participants likely did not progress to the display of problem behavior because precursor behavior itself was reinforced thereby making the display of problem behavior unnecessary. These results suggest that precursor behavior and problem behavior were maintained by the same consequences; namely, negative reinforcement through escape from demands, thus confirming the hypothesis that both behaviors served the same function.

In phase B of the communication-based intervention (component 4), precursor behaviors were used as a signal for the adult to teach a communicative response. When both problem behavior and communication (prompted only in response to the display of precursor behavior) produced the same consequence (i.e., a 30-s escape from demands), participants typically chose to communicate. The result was a decrease in the level of problem behavior thus confirming the second hypothesis of this study. These results further suggest that the communicative response also served the same function as precursor and problem behavior (i.e., to obtain a break) and indicates that precursor behavior was maintained by the same class of reinforcers (i.e., negative reinforcement).

**Conceptual Issues: Mechanisms Underlying the Relationship Between Precursor Behavior and Problem Behavior**

In all phases of both the precursor analysis and intervention, problem behavior was reinforced. Yet, when given the opportunity to engage in alternative behaviors for equivalent reinforcement (i.e., precursor behavior in component 3 and communicative behavior in component 4), participants chose to engage in the alternative behaviors. There are several mechanisms that merit consideration, relevant to explaining the relationship between precursor behavior and problem behavior.

*Response chaining and superstitious reinforcement.* It is possible that precursor behavior and problem behavior formed a response chain that was maintained by superstitious reinforcement. A response chain is defined as a series of responses in which each response acts as a discriminative stimulus for subsequent response links in the chain (Reynolds, 1968). In the present instance, it is possible that precursor behavior may have functioned as a discriminative stimulus that evoked problem behavior. In the applied literature, researchers have suggested that the evidence for a response chain is a consistent relationship between behaviors such that the occurrence of a
behavior early in the chain (e.g., precursor behavior) predicts the occurrence of other behaviors (e.g., problem behavior) in an orderly sequence (Evans, Meyer, Kurkjian, & Kishi, 1988). This description is consistent with the results of the present study.

In the precursor analysis (component 3), precursor behavior was reinforced in phase A, and participants received reinforcement without having to display problem behavior. However, when a participant’s precursor behavior was not reinforced (i.e., during phase B), precursor behavior remained constant or increased. These results might suggest that in phase A, the behavior chain was terminated at an early stage (i.e., once the precursor behavior was displayed). This outcome may have occurred because the response chain was interrupted. Previous research has shown that it is possible to alter a sequence of behavior by interrupting a chain (Catania, 1968; Kuhn, Lerman, Vorndran, & Addison, 2006). In the present instance, intervening at a precursor level prevented a progression to problem behavior because precursor behavior was reinforced (i.e., with a 30-s break), making problem behavior unnecessary as a means for getting a break. Furthermore, during the break period, various discriminative stimuli for nonproblem behavior may have become more salient. For example, presence of a pencil may have functioned as a discriminative stimulus for the nonproblem behavior of scribbling with the pencil. This new behavior (e.g., scribbling with the pencil) was not discriminative for problem behavior. Hence, the precursor/problem behavior sequence (chain) was broken.

During the communication-based intervention, interrupting the response chain at the precursor level (i.e., by prompting communication) during phase B was found to be an effective means for reducing the occurrence of problem behavior. It is possible that intervening at a precursor level prevented a progression to problem behavior due to the presence of a precursor that caused the adult to prompt a communicative request. The new response (communicative request) thus interrupted the precursor/problem behavior sequence (chain) because the communicative response was not a discriminative stimulus for problem behavior the way precursor behavior was. This conceptualization is consistent with suggestions that it is considerably easier to intervene on earlier behaviors in a chain and prevent an escalation in behavior (Evans et al., 1988). Thus, evidence from both the analysis and intervention components of the present study suggested that precursor behavior and problem behavior may have formed a response chain.

“Superstitious” reinforcement (Skinner, 1948) offers a second explanation for the way in which the relationship between precursor behavior and problem behavior originated and was maintained. The traditional behavioral
model emphasizes a discriminative stimulus-response-reinforcement paradigm (Reynolds, 1968). According to this model, responses are controlled largely by their consequences. Thus, behaviors that have been reinforced are likely to occur, whereas those that have not been reinforced extinguish over time. Anecdotal observations suggested that precursor behavior was not consistently reinforced by staff in the classroom setting but problem behavior was often reinforced. Nonetheless, results of the descriptive analysis in the present study suggested that precursor behavior and problem behavior typically occurred in a fixed sequence. Data from the precursor analysis suggested that when only problem behavior was reinforced (i.e., in phase B), precursor behavior nonetheless continued to occur. This outcome may have been due to superstitious reinforcement in which a response was accidentally maintained by the reinforcement produced by a subsequent response (Catania, 1968). In this instance, it was possible that precursor behavior, though not directly reinforced in the classroom, continued to occur due to its association with subsequent reinforcement of problem behavior.

Collectively, these explanations suggest three possibilities. First, precursor behavior and problem behavior may have formed a response chain. Second, precursor behavior and problem behavior may have been linked through superstitious reinforcement. Finally, it is possible that precursor behavior and problem behavior formed a superstitious chain, in which precursor behavior acted as a discriminative stimulus for problem behavior, and the precursor behavior–problem behavior sequence was maintained by superstitious reinforcement.

Response efficiency. Response efficiency has been cited as an important factor in predicting behavior. An efficient response is defined as one that is less effortful, leads to equivalent reinforcement, and has a short delay to reinforcement when compared with a less efficient response (Horner & Day, 1991). In the present study, Timmy’s hand posturing, for example, may have been more efficient than problem behavior if it were (a) less effortful than head banging, (b) produced negative reinforcement (i.e., a 30-s break) more consistently than head banging, and (c) produced the 30-s break immediately following posturing (i.e., short delay of reinforcement) but only after a delay following problem behavior. The procedure used in component 3 may have enhanced the efficiency of precursor behavior. Specifically, in phase A of the analog analysis of precursor behavior, every instance of precursor behavior and problem behavior was immediately reinforced with a 30-s break. The precursor behavior and problem behavior were equally efficient in producing consistent, immediate reinforcement. The most likely
explanation of the ascendancy of precursor behavior over problem behav-
ior was that precursor behavior was less effortful than problem behavior,
and this factor resulted in the high rates of precursor behavior and low rates
of problem behavior seen in phase A. Future studies could profitably assess
the role of efficiency in the relationship between precursor behavior and
problem behavior by directly measuring the three types of efficiency vari-
ables just described.

**Implications for Practice**

*Prevention strategies.* Researchers have suggested that problem behavior
itself may function as a form of communication (Carr & Durand, 1985; Carr
et al., 1994). If this is the case, and precursor behavior can serve the same
function as problem behavior (as the results of the present study suggest),
then precursor behavior may in fact be viewed, functionally, as a primitive
form of communication that can alert others that problem behavior is immi-
nent. In the intervention phase of this study, problem behavior was prevented
by using precursor behavior as a cue to prompt communication. These
results suggest that prevention efforts could meaningfully be targeted at the
precursor behavior to reduce the occurrence of problem behavior. That is,
communication training, when applied to precursor behavior, is a proactive,
antecedent approach for reducing the occurrence of problem behavior. Thus,
the concept of functional equivalence (Carr & Durand, 1985), used to explain
why communicative behavior can replace problem behavior, could be
extended to explain why addressing precursor behavior can have an impact
on problem behavior. Specifically, in the present study, a triple-functional
equivalence was demonstrated; that is, precursor behavior, problem behavior,
and communication were all functionally equivalent.

*Assessment.* Results of the present study have an important implication
for the way in which functional analyses are conducted. Critics of func-
tional analysis procedures often cite ethical concerns in conducting such an
analysis because problem behavior is reinforced during the analysis
(Desrochers, Hile, & Williams-Moseley, 1997; Smith & Churchill, 2002).
Our results suggest a way to avoid this ethical dilemma; namely, that in
some instances, it may be possible to test hypotheses about the function of
problem behavior by manipulating the antecedents and consequences of
precursor behavior. This strategy could provide an alternative to conducting
a functional analysis of problem behavior per se for those individuals who
exhibit precursor behavior. However, if an intervention based on a functional
analysis of precursor behavior did not result in a reduction in problem behavior, then a default functional analysis of problem behavior could always be conducted. The precursor analysis option would be particularly meaningful for those individuals who display high-intensity problem behavior or other problem behaviors that are difficult to deal with directly (Albin et al., 1995; Wahler, 1975).

**Intervention.** The present results also have implications for the way in which communication training is conducted with individuals who display precursor behavior. The current method of teaching communication relies heavily on the use of environmental cues to determine when the individual should be prompted to communicate. For example, an individual who exhibits problem behavior maintained by negative reinforcement associated with the termination of putatively aversive demands may be prompted to communicate following negative feedback on a task (Carr & Durand, 1985). Likewise, an individual who displays problem behavior in situations characterized by low levels of attention may be prompted to communicate in situations when attention is low. By contrast, using precursor behavior as an indication to prompt and teach communication would increase the focus on the individual’s behavior per se rather than relying solely on stimulus properties of the environment (e.g., the presence of demands). Rather than prompting an individual to ask for a break just because he or she is in a demand situation, the individual would be prompted to ask for a break only when he or she displayed precursor behavior, and was therefore indicating that he or she needed a break at that particular moment. Thus, it might be possible to respond to an individual’s momentary sensitivity to the aversiveness of a situation, based on behavior cues, rather than on more general and less predictive stimulus properties of the environment. These behaviors would become crucial in cueing significant others (e.g., parents, teachers) to institute teaching (prevention) efforts.

Given the results of present study, several factors merit further investigation. First, participants in this study exhibited problem behavior maintained exclusively by negative reinforcement. Therefore, subsequent research might profitably examine the relevance of precursor behaviors to problem behavior motivated by positive reinforcement (e.g., social, tangible, and sensory consequences) as well (Durand & Crimmins, 1988). Second, most individuals who exhibit problem behavior, including those in the present study, exhibit such behavior in a variety of different situations. Using precursor behaviors to cue communication would necessarily rely on some situational cues. That is, if an individual exhibits precursor behavior, it may be unclear whether he
or she wants attention, a snack, or a break from work. The use of situational cues would be necessary to determine which type of communicative request would be most appropriate, whereas the use of precursor behaviors could only provide an indication that the individual was indeed trying to communicate. This issue merits further investigation.

In sum, results of the present study suggest that a functional analysis of precursor behavior and training of a functionally equivalent communicative response based on the motivation of that behavior could provide a useful strategy for reducing or preventing the occurrence of serious problem behavior.

References


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