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BRIEF PRACTICE

A Clinical Demonstration of Correlational and Experimental Analyses of Precursor Behavior

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Abstract

Individuals with intellectual and developmental disabilities are at an increased risk for engaging in severe problem behavior, which is often preceded by less intense precursor behaviors. These precursor behaviors may be a viable option as target behaviors for functional analyses in situations where evoking severe problem behavior is not ideal. We identified precursor behaviors through a correlational analysis and confirmed their membership in the same response class as more severe problem behavior through an experimental analysis.

Keywords Conditional probabilities · Functional analysis · Precursor behavior · Severe problem behavior

Behavior analysts treat severe problem behavior (SPB) most effectively by designing and implementing treatments based on the results of a functional analysis (FA; Iwata, Dorsey, Slifer, Bauman, & Richman, 1994). FA procedures allow for the systematic manipulation of variables potentially evoking and maintaining SPB. However, in some cases, SPB may be too intense to conduct an FA. These intense forms of SPB are often preceded by less severe behaviors (e.g., crying or whining), commonly referred to as "precursor behavior(s)" or "precursors" (cf. Fritz, Iwata, Hammond, & Bloom, 2013). One way to alleviate or minimize risks involved with FAs of intense SPB may be to identify and use precursors as a proxy for SPB.

Fritz et al. (2013) identified precursors through both correlational (i.e., conditional probabilities) and experimental (i.e., an FA on both the precursor and SPB) analyses. Results showed correlational analyses are a reliable method for pinpointing precursors, and confirmed agreement of response class membership for both precursor and target behaviors through an FA of precursors. Moreover, they demonstrated that precursor assessments can effectively serve as the basis for intervention. Therefore, the purpose of the current investigation was to replicate and extend Fritz et al.'s procedures by (a) completing a retrospective analysis of precursors to provide a framework for assessing and treating and (b) determining when precursors and SPBs will not co-occur, or occur at all, by including a noncontingent reinforcement condition. The latter purpose further explicates response class membership between SPB and precursors in our experimental analyses of precursors.

Research Highlights
- Precursor behaviors can serve as potential alternatives to more severe problem behaviors as target behaviors in functional analyses.
- Conditional probability analyses are an effective method for identifying precursors.
- Intervening when precursor behaviors occur may avoid evoking more severe problem behavior.
- Precursor behaviors may serve as a means for designing function-based treatments.

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Method

Participant, Setting, and Materials

Theo was an 8-year-old male admitted to an inpatient hospital unit for the assessment and treatment of SPB, including self-injurious behavior (SIB) and disruptive behavior (DIS). He

had several previous hospitalizations for his SPB. Theo's diagnoses included autism spectrum disorder; moderate intellectual disability; disruptive, impulse-control, and conduct disorders; stereotypic movement disorder with SIB; and attention-deficit/hyperactivity disorder. He communicated in short statements (one to three words) and was compliant with one- to two-step instructions.

All sessions were conducted in a 4.4 m × 4.8 m padded therapy room. The room included two chairs, a table, other relevant materials for the specific conditions, and a one-way observation window. Sessions were conducted by trained therapists under the supervision of a behavior analyst.

Data Collection and Response Definitions

Using the computer software program BDataPro (Bullock, Fisher, & Hagopian, 2017), data were collected on SPBs and precursors. Frequency data were collected and converted to rate (responses per minute; RPM). SPB included SIB (hand to head, hand to body, self-biting, and hitting body off a surface) and DIS (hitting or kicking surfaces, swiping objects, ripping/breaking/tearing objects, knocking over furniture, and banging on surfaces with an open or closed fist from a distance of 6 in or greater). Defined and measured precursors included (a) screaming, (b) whining, (c) hand flapping, and (d) hand-mouthing (hereafter, mouthing).

Interobserver Agreement (IOA)

Staff members received extensive training in data collection and were considered reliable after completing three consecutive sessions with at least 80% agreement with the lead therapist. IOA was calculated using the mean-count-per-interval method. Each session was divided into 10-s intervals, the smaller number of responses was divided by the larger number of responses scored, and then multiplied by 100. A second staff member collected data simultaneously, but independently, for 60% of the FA, 100% of the correlational analysis of precursors, and 65% of the experimental analysis of precursor sessions. During the FA, agreement for the frequency of SPB was 98.77% (range, 89.17%–100%). During the experimental analysis of precursors, agreement for the frequency of SPB was 99.31% (range, 89.17%–100%) and 97.43% (range, 92.43%–100%) across precursors.

Study 1: FA

Procedures During Theo's admission, a functional behavioral assessment, which included an FA, was conducted. Results of the Functional Analysis Screening Tool (Iwata, DeLeon, & Roscoe, 2013), along with parental interviews and direct observations of Theo, indicated his SPB was likely maintained by attention and access to tangibles, thus behavior was not evaluated for an automatic function. A standard FA was conducted utilizing a fixed order of conditions, initially in a multielement design (i.e., attention, toy play, and escape).

All sessions were 10 min in duration. During the attention condition, Theo and the therapist were present in the room. The therapist only provided brief attention contingent on an instance of a target behavior. In the toy play condition, the participant had continuous access to moderately and highly preferred toys identified via a free operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998). No demands were given; brief social attention was delivered every 30 s. During the demand condition, the therapist presented academic and vocational demands using a three-step graduated-guidance prompting procedure. Contingent on a target behavior, the therapist removed all academic stimuli and provided Theo a 30-s break.

Following the multielement FA, a second phase was initiated utilizing a pairwise design, in a 2:1 test to control format, to evaluate if SPBs were also maintained by access to tangibles (the same items identified as most preferred based on a free operant preference assessment). During the test condition, Theo had 2-min presession access to highly preferred toys, and then the session was initiated. The therapist removed the preferred toys and said, "It's my turn to play." Contingent on a target behavior, the therapist returned the preferred toys for 30 s. During the control condition, the participant had continuous access to the same highly preferred toys. Additionally, brief social attention was delivered every 30 s to ameliorate SPB that may have been attention maintained.

Results Figure 1 depicts the FA results. During the multielement FA, Theo engaged in zero rates of SPB during the demand condition and variable rates of SPB during the attention condition (M = 0.80 RPM) compared to the toy play condition (M = 0.03 RPM). During the pairwise FA, high and differential responding was observed between the tangible test (M = 2.00 RPM) and the control (M = 0.15 RPM) conditions. Thus, results indicated that Theo's SPBs were maintained by attention from adults and access to tangible items.

Study 2: Correlational Analysis of Precursors

Direct observation and parental interviews indicated that Theo engaged in precursors (as mentioned previously, screaming, whining, hand flapping, and mouthing) prior to exhibiting SPB. In order for a precursor to be identified, it must have both a temporal relation (the behavior frequently precedes SPB) and a functional relation to SPB (Fritz et al., 2013). Thus, the purpose of Study 2 was to identify antecedent behaviors that had a temporal relation to SPB through correlational analysis, and therefore would be considered precursors. We used all available video-recorded sessions to investigate potential precursors to SPB via a lag-sequential analysis to

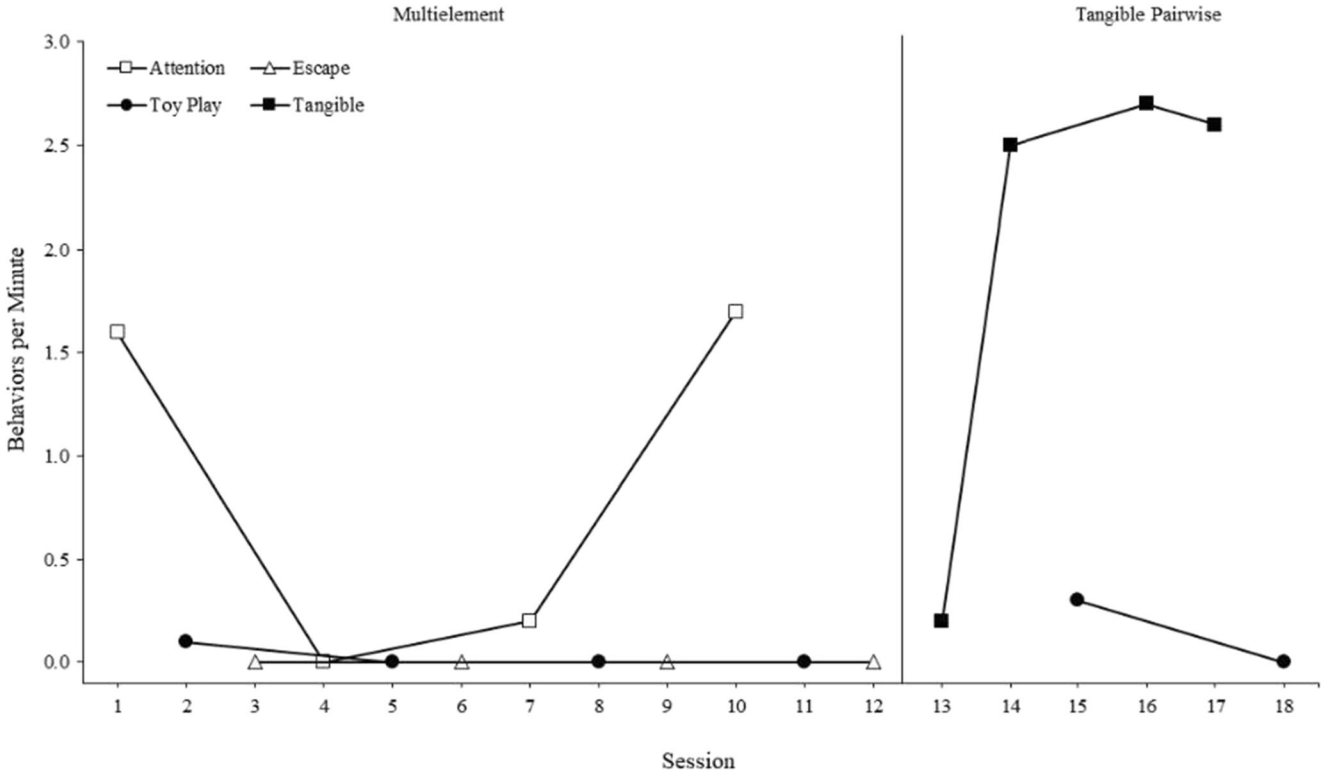

Fig. 1 FA of SIB and DIS

examine behaviors that reliably preceded hand-to-body SIB from the attention (Sessions 4, 7, and 10) and tangible (Sessions 16 and 17) conditions of the FA. Observations and interviews with staff indicated these videotaped sessions were representative of his behavior in the other FA sessions in which the same contingencies were implemented. Hand-to-body SIB was selected as the target behavior because it was the most common and least severe form of SIB.

Lag-sequential analysis An interval-based lag-sequential analysis was conducted using procedures similar to other published correlational analyses (e.g., Camp, Iwata, Hammond, & Bloom, 2009). We examined each antecedent behavior and whether SPB occurred subsequent to the antecedent behavior in the same 10-s interval or the next three 10-s intervals; this interval window was selected based on previous investigations of precursors and observations of Theo. Data were collected on (a) each instance of antecedent behavior across the session, (b) each instance of the SPB, and (c) how often the antecedent behavior preceded the target behavior. We conducted the lag-sequential analysis of antecedent behaviors in both the attention and tangible conditions by determining the conditional and background probability of each antecedent behavior preceding SPB. The conditional probability of each antecedent behavior was calculated by dividing the number of intervals in which the antecedent behavior preceded the target behavior by the number of intervals in which the target behavior occurred. Because a single antecedent could precede a single target behavior multiple times (e.g., whining occurring in several intervals before Theo engaged in hand-to-body SIB), this calculation was restricted to not exceed 1.0. The background probability (unconditional probability) of each antecedent behavior was calculated by dividing the number of intervals in which the antecedent behavior occurred by the number of intervals in the session. Similar to other analyses on precursors (e.g., Fritz et al., 2013), we identified likely precursors as those where the conditional probability of an antecedent event was greater than the background probability.

Results In the attention condition, the conditional probabilities of whining and screaming were 1.0 and .67, respectively (see Fig. 2). The background probabilities were .07 and .02, respectively. These results indicate whining and screaming were highly likely to occur before hand-to-body SIB and were not frequently observed in the absence of hand-to-body SIB. In the tangible condition, the conditional probability of screaming was .21; the background probability was .13. One way to interpret these data is that screaming did not precede hand-to-body SIB in approximately 80% of intervals within the tangible condition. However, screaming was still approximately twice as likely to precede hand-to-body SIB than not in the tangible condition. Together, results suggest a temporal relation exists between screaming and whining in the attention condition; screaming was also likely to precede SPB in the tangible condition. However, for screaming and whining to be considered precursors to SPB, they must also have an equivalent functional relationship.

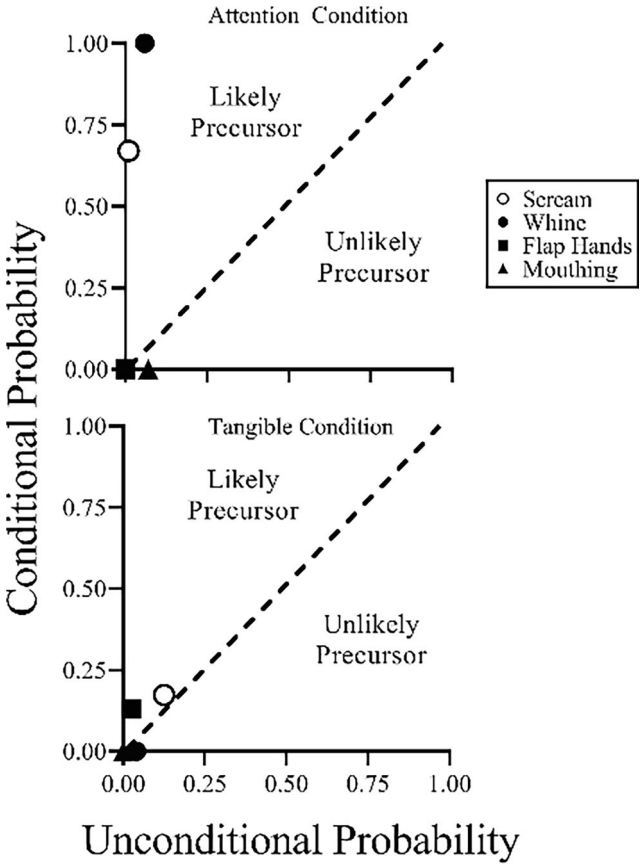

Fig. 2 Conditional and unconditional probabilities of antecedent behaviors in the attention and tangible conditions

Study 3: Experimental Analysis of Precursors

The purpose of Study 3 was to demonstrate that precursors and SPB occurred within the same functional response class. Sessions were 10 min in duration, and a reversal design was utilized.

Test 1 (contingent reinforcement for SPB) The participant had 2-min pre-access to highly preferred toys and attention from the therapist; after this, the 2-min session was initiated. The therapist removed the toys and stated, "It's my turn to play, and my attention is unavailable." Contingent on SPB, the therapist returned the preferred toys for 30 s, delivered attention, and said, "Fine, you can have your toys, and I can play with you." All precursors were ignored.

Test 2 (contingent reinforcement for precursor behavior) Procedures were identical to Test 1 except toys and attention were delivered upon instances of precursors, and all SPBs were ignored.

Noncontingent reinforcement (NCR) Procedures were identical to the toy play condition in the FA. The participant had continuous access to highly preferred toys and attention from the therapist upon request or every 30 s; no demands were given. If SPB had occurred during NCR, the therapist would have delivered additional attention and stated, "Theo, why would you do that? You have all your toys and my attention," and re-presenting the toys to control for SPB that may have occurred to access social consequences.

Results Data for the experimental analysis are presented in Fig. 3. During the Test 1 phase, rates of SPB (M = 1.60 RPM) were very similar to those of precursors (M = 1.45 RPM). During the Test 2 phase, when consequences were provided for precursors only, rates of precursors remained elevated (M = 2.67 RPM), whereas rates of SPB (M = 0.03 RPM) decreased greatly. During the reversal back to Test 1, rates of SPB again increased (M = 2.30 RPM) and were highly correlated with the occurrence of precursors (M = 1.60 RPM). Similar to the first Test 2 phase, rates of precursors in the second Test 2 phase were high and differentiated (M = 3.27 RPM) compared to zero rates of SPB. During the NCR phases, there were zero occurrences of precursors or SPB.

Discussion

We successfully identified and confirmed response class membership of precursors through correlational and experimental analyses. Congruent with previous findings, results of the current investigation support identifying and using precursors as alternatives to more intense SPB as targets in FAs (e.g., Borlase, Vladescu, Kisamore, Reeve, & Fetzer, 2017; Borrero & Borrero, 2008). We have also extended prior research (i.e., Fritz et al., 2013) in two distinct ways. First, we included NCR in our experimental analysis to provide a more convincing demonstration of response class membership, as it demonstrates when the behaviors will co-occur and, importantly, when the behaviors will not co-occur, or not occur at all. Second, we identified a set of precursors (i.e., whining and screaming) related to multiple functions (i.e., access to attention and to tangibles) and multiple SPBs (SIB and DIS); Fritz et al. demonstrated the opposite—multiple precursors for one function. Although we identified precursors post hoc, these results suggest that identifying precursors is still important. That is, identifying a shared precursor can lead to greater treatment efficiency by targeting the one precursor, or set of precursors, rather than separate SPBs. Procedures described herein could serve as a model for how to conduct precursor analyses. In short, practitioners could (a) conduct an FA targeting SPB, (b) run correlational analyses (using the methods described in this paper and others; e.g., Camp et al., 2009), and (c) then use those identified precursors as the targeted behavior for intervention. It is important to note that not all nominated *potential* precursors were confirmed as such (e.g., mouthing). Thus, correlational analyses ought to be

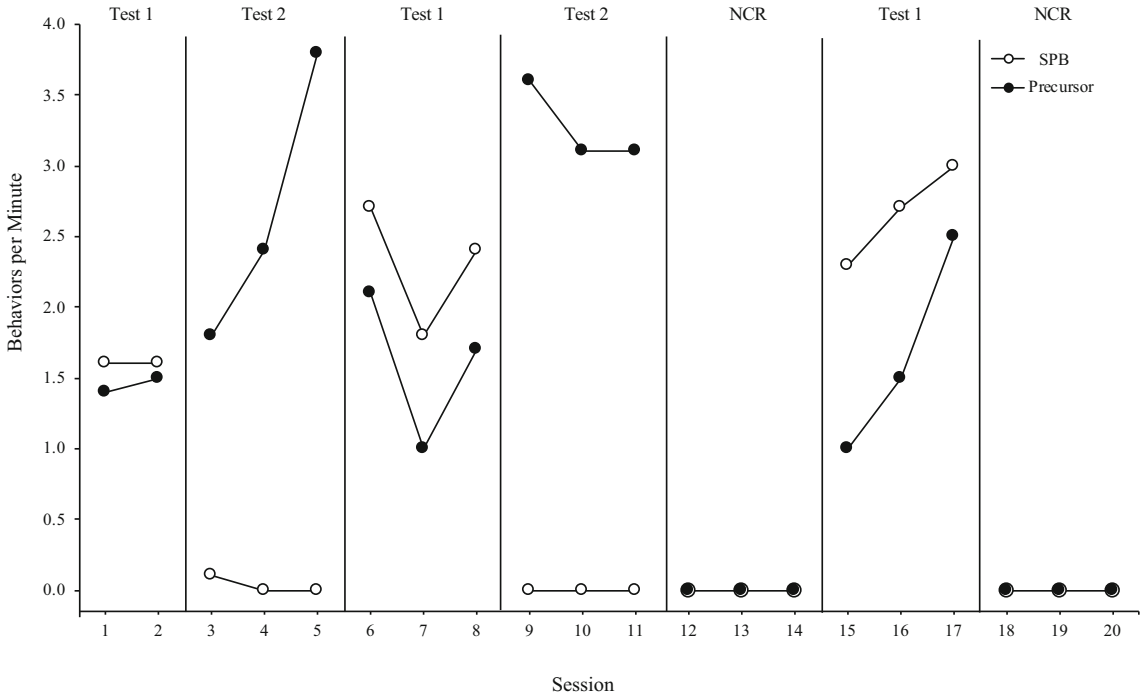

Fig. 3 Experimental analysis of precursors

conducted to quantify the actual likelihood that observed antecedent behaviors are truly precursors.

In this study, we have provided a practitioner-friendly model for identifying precursors, as well as highlighted the importance of identifying precursors post hoc. A noted limitation of the current investigation (and subsequent use of these procedures) is the additional effort involved in conducting correlational analyses and calculating conditional probabilities. Another limitation is that we did not focus on identifying precursors for all topographies of SPB. However, our approach of focusing on precursors for the most frequently occurring and least problematic form of SIB was viable and resourceful, as demonstrated through our analyses that when these precursors were reinforced, SPB decreased. The potential benefits of decreasing the likelihood of more intense SPB may potentially increase caregiver acceptability of procedures due to the caregiver not having to observe more intense SPB over an extended period of time. Additionally, because logical injury risk is attenuated if the likelihood of SPB is reduced, precursor analyses may be more useful in settings where resources are limited (e.g., nursing or medical staff are not readily available). Future researchers should investigate the correspondence between descriptive analyses and experimental analyses of precursors (cf. Borrero & Borrero, 2008).

Implications for Practice

- Precursors can be empirically identified via correlational analyses and calculation of conditional probabilities.
- FAs can be conducted on precursors to potentially avoid evoking intense SPB.
- Subsequent treatments can be designed to target the precursor or include proactive components upon the emission of a precursor to potentially circumvent SPB.
- Post hoc precursor identification can lead to more efficient treatment of multiple SPBs.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in the study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from the participant's parents/legal guardian prior to the study.

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