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FUNCTIONAL ANALYSES AND TREATMENT OF PRECURSOR BEHAVIOR

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Functional analysis has been demonstrated to be an effective method to identify environmental variables that maintain problem behavior. However, there are cases when conducting functional analyses of severe problem behavior may be contraindicated. The current study applied functional analysis procedures to a class of behavior that preceded severe problem behavior (precursor behavior) and evaluated treatments based on the outcomes of the functional analyses of precursor behavior. Responding for all participants was differentiated during the functional analyses, and individualized treatments eliminated precursor behavior. These results suggest that functional analysis of precursor behavior may offer an alternative, indirect method to assess the operant function of severe problem behavior.

DESCRIPTORS: functional analysis, functional communication training, precursor behavior, response class, severe problem behavior

Experimental functional analysis of behavior disorders involves the direct manipulation of antecedents and consequences hypothesized to occasion and maintain problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). Effects of these manipulations are evaluated in highly controlled conditions in which problem behavior is evoked and, presumably, reinforced; thus, functional analyses are likely to produce temporary increases in problem behavior in one or more conditions. In fact, elevated measures in one or more experimental conditions are taken as evidence of the operant functions of problem behavior.

There are reasonable concerns associated with assessment procedures that systematically evoke and provide potentially reinforcing consequences for severe problem behavior. For example, the relative benefits of conducting experimental analyses of severe problem behavior such as aggression or inappropriate sexual behavior (e.g., grabbing staff's or peers' genitalia) must be weighed against the immediate effects of evoking such behavior and the more lasting effects of reinforcing it. In addition, schools, day programs, parents, and other consumers of behavioral services may not permit severe problem behavior to be reinforced during assessment.

In light of these concerns, a number of strategies have been designed to reduce the possible risks associated with conducting experimental functional analyses of problem behavior. One strategy has been to limit the length of the assessment (e.g., Derby et al., 1992; Kahng & Iwata, 1999; Vollmer, Marcus, Ringdahl, & Roane, 1995). However, brief assessments do not identify maintaining variables consistently; as a result, extended analyses requiring a longer assessment period may be necessary (Vollmer et al.). Another strategy has been to use protective equipment during functional analyses (e.g., Le & Smith, 2002). However, research has demonstrated that the addition of such equipment can alter the results of a functional analysis (Borrero, Vollmer, Wright, Lerman, & Kelley, 2002). Moreover, it may be difficult or impossible to add protective equipment for some behavior (e.g., inappropriate sexual behavior).

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Another strategy for reducing risk associated with an experimental functional analysis is to infer the variables that maintain severe problem behavior indirectly by conducting a functional analysis of precursor behavior (Smith & Churchill, 2002). Precursor behavior is any response that tends to occur immediately prior to severe problem behavior. For example, an individual may yell or threaten to engage in aggression before engaging in aggression.

Although topographies of precursor behavior differ from severe problem behavior, precursor and severe problem behavior may be related functionally if they produce the same consequence (Grow, Kelley, Roane, & Shillingsburg, 2008). When different topographies are sensitive to the same consequences, they may be said to be members of a common response class (Skinner, 1969). Thus, functional analysis of precursor behavior is based on the notion that contingencies applied to a member of a response class have similar effects on other responses in that class (Harding et al., 2001; Lalli, Mace, Wohn, & Livezey, 1995; Parrish, Cataldo, Kolko, Neef, & Egel, 1986; Sprague & Horner, 1992). This strategy presumes that precursor behavior and severe problem behavior are members of the same functional class and that it should be possible to reduce or eliminate severe problem behavior using treatments corresponding to results of functional analyses of precursor behavior.

Smith and Churchill (2002) compared results of functional analyses of severe problem behavior with functional analyses of precursor behavior. Results demonstrated that functional analyses of precursor behavior identified the same maintaining contingencies as those identified during functional analyses of severe problem behavior. Treatments based on the results of a precursor analysis were not evaluated.

The current study attempted to replicate and extend procedures used by Smith and Churchill (2002) by conducting functional analyses of precursor behavior and by testing whether treatments based on the results of the analysis of precursor behavior would eliminate precursor behavior while maintaining low or zero levels of severe problem behavior.

METHOD

Participants and Settings

Three individuals had been referred for assessment and treatment of severe problem behavior. All participants were able to follow simple instructions and communicated using speech. Brent was an 8-year-old boy who had been diagnosed with an emotional handicap and traumatic brain injury. Pete was a 5-year-old boy who exhibited developmental delays. Brent and Pete had been referred for aggression towards teachers (Brent) and peers (Brent and Pete) at school. Tom was a 45-year-old man who had been diagnosed with mental retardation. He had been referred for engaging in masturbation and grabbing or attempting to grab the genitalia of staff and peers at his day program.

Sessions were conducted 3 to 5 days per week in a classroom for children with behavior problems (Brent), a treatment room attached to the kindergarten (Pete), and either a treatment room or in the natural environment at the day program (Tom). All settings resembled a classroom, with academic materials, tables, chairs, and leisure items available (depending on the condition).

Response Measurement and Interobserver Agreement

The dependent variables were occurrences of severe problem behavior, precursor behavior, and an alternative mand (during treatment). Occurrences of vocal precursor behavior (e.g., whining, crying) were scored if they were separated by 3 s or more from a previous occurrence. We identified precursors to severe problem behavior by asking participants' caregivers to identify responses that were likely to be observed immediately prior to the occurrence of severe problem behavior and by observing each

participant to confirm that the precursors identified by caregivers not only preceded severe problem behavior but also occurred in close temporal proximity to it.

Aggression (Brent and Pete) was defined as hitting (contact between a participant's hand and another person's body), kicking (contact between a participant's foot and another person's body), biting (contact between a participant's teeth and another person's body), scratching (contact between a participant's fingernail and another person's skin), throwing objects at others, and attempts to make contact that were dodged or blocked by others. *Masturbation* (Tom) was defined as contact between a participant's hand and his genitals (either on top of or underneath clothing). *Inappropriate grabbing* (Tom) was defined as contact or attempted contact between the participant's hand and another person's genitalia. Brent's precursor behaviors were whining, crying, complaining (e.g., "I don't like this," or "Why do I have to do this?"), and threatening to hurt himself or others (e.g., "I am going to kill myself," or "I am going to hit you."). Pete's precursor behaviors were whining, crying, statements of toy possession (e.g., "That's my toy!" or "Why does he get that toy?"), and reaching or grabbing for toys possessed by others. Tom's precursor behavior was uttering sexual statements about a person's genitalia.

During functional communication training (FCT), Brent's alternative mand was requesting a teacher's attention by raising an attention card above his head. Pete's alternative mand was asking for toys appropriately (e.g., "May I have that, please?"). Tom's alternative mand was pressing a button on a necklace to page staff to provide him with attention. Manding was scored (for Tom only) as independent if it occurred without vocal instruction from an experimenter and as prompted if the experimenter vocally instructed him to press the button.

Data were recorded independently by trained observers on Palm Pilots and were calculated as responses per minute. Interobserver agreement was collected during 39% of functional analysis sessions and 37% of treatment sessions. Agreement was calculated by dividing session time into continuous 10-s intervals and comparing observers' scores on an interval-by-interval basis. The smaller of the two observers' scores was divided by the larger per 10-s interval. The resulting quotients then were summed, divided by the number of observation intervals, and multiplied by 100%. During the functional analyses, mean interobserver agreements for precursor and severe problem behavior, respectively, were 99% (range, 93% to 100%) and 99.7% (range, 97% to 100%). During baseline and treatment sessions, mean agreements for precursor behavior, severe problem behavior, and alternative mands were 97% (range, 85% to 100%), 99.8% (range, 97% to 100%), and 96% (range, 83% to 100%), respectively.

Functional Analysis

A functional analysis of precursor behavior was conducted with each participant (Iwata et al., 1982/1994). Alone (Tom only), attention, play, demand, and tangible (Pete only) conditions were presented in a multielement design (procedural details are available from the corresponding author). Experimental contingencies were placed on precursor behavior rather than severe problem behavior. All conditions were 5 min in length and presented until variables maintaining precursor behavior were apparent.

During all conditions for Brent, the experimenters, Brent, other students, Brent's teacher, and aides were present; however, only experimenters interacted with him. During all conditions for Pete, the experimenters, Pete, and a confederate student from Pete's classroom were present. The confederate student was present because Pete's aggression was directed towards classmates. Any attempts to harm the confederate student were blocked to keep the student safe. The experimenter was in the room with Tom in all conditions except alone.

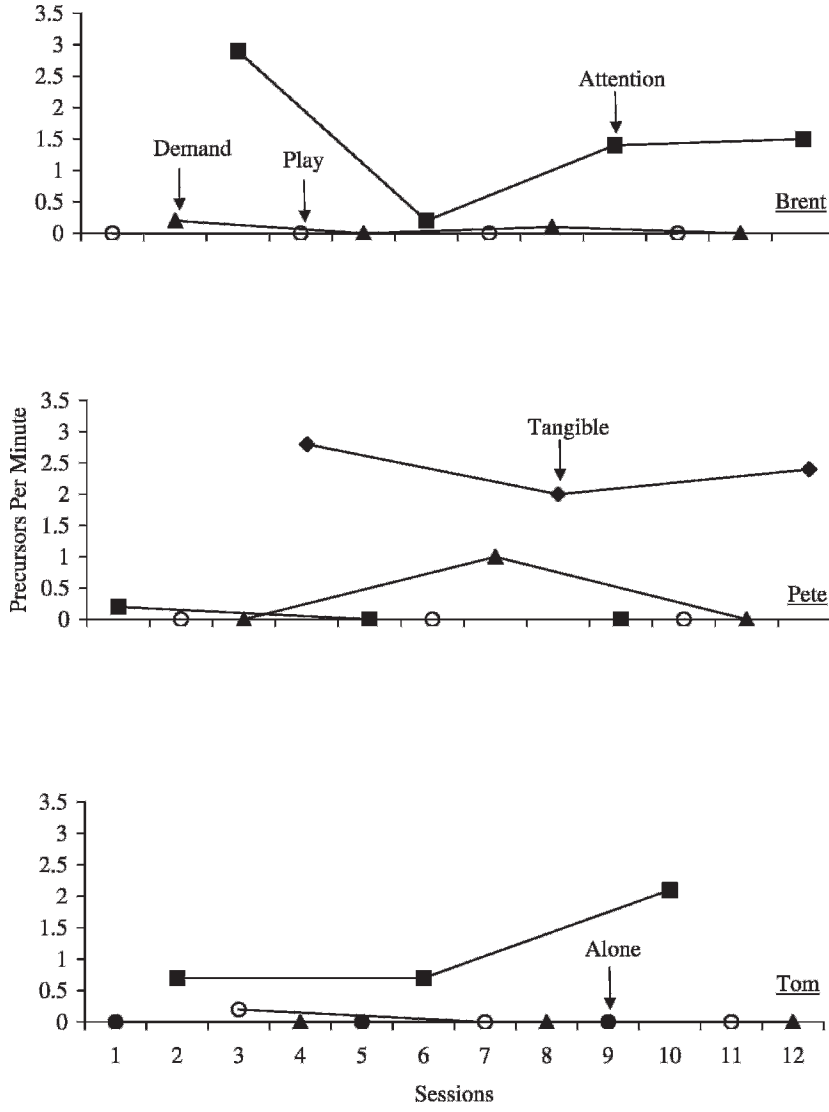

Figure 1. Precursor behaviors per minute during Brent's, Pete's, and Tom's functional analyses.

Results. Results of the functional analyses are depicted in Figure 1. Only precursors per minute are depicted, because none of the participants engaged in severe problem behavior during their functional analyses. All of the participants showed differentiated responding in one condition. Precursor behavior for Brent and Tom was highest during the attention condition ($M = 1.5$ and $M = 1.17$ responses per minute, respectively), indicating an attention function. Precursor behavior for Pete was highest during the tangible condition ($M = 2.4$ responses per minute), indicating a tangible items function.

Treatment

Individualized interventions involving FCT were designed based on the variables identified to maintain precursor behavior during each functional analysis. Effects of treatments on precursor and severe problem behavior were evaluated using reversal designs. Baseline and treatment

sessions were 5 min in length for Pete and 10 min in length for Brent and Tom. Sessions for Tom eventually were extended to 30 min. We also reviewed archived records kept by the school (for Brent) or asked staff to complete a questionnaire regarding the occurrence of severe problem behavior for Pete and Tom.

During baseline and the reversal, Brent's teachers were instructed to interact with him as they usually did by giving Brent attention in the form of either a verbal reprimand or redirection contingent on either precursor or severe problem behavior. During FCT, Brent was provided with a card that read TA (for teacher's attention). At the start of each session, he was instructed to raise the card above his head if he wanted to talk to the teacher. The teacher provided Brent with 5 to 10 s of attention (e.g., "Good TA, what do you need?") when he raised the card. The teacher prompted Brent to use his card by saying, "Remember to use your TA card if you need something," when Brent engaged in precursor behavior. Because administrators of Brent's school expressed the importance of not allowing severe problem behaviors to occur, an agreement was made that were severe problem behavior to occur, teachers could take whatever action they deemed necessary.

During baseline and the reversal, Pete and a confederate student played together with toys (e.g., blocks). The experimenter gave Pete 2 min of access to a toy of his choice immediately prior to sessions. An experimenter took the toy away from Pete and gave it to the confederate student while saying, "It's [confederate's] turn," at the start of sessions. If Pete attempted to engage in aggression towards an experimenter or the confederate student, it was blocked by an experimenter. If he engaged in precursor behavior, the experimenter said, "Okay, you can have it" and provided 30-s access to the toy. The experimenter took the toy away again and repeated the steps at the end of the 30-s interval.

FCT procedures were identical to baseline except that the confederate peer delivered the toy to Pete for 30 s if Pete manded for the toy appropriately (i.e., "May I have that, please?"). In addition, the experimenter prompted Pete to mand if he engaged in precursor behavior. Reinforcement of the mand was thinned using a graduated multiple-schedule arrangement in which periods of reinforcement and extinction were alternated and signaled by a card held up by an experimenter (Hanley, Iwata, & Thompson, 2001), initially in 30-s and then in 1-min intervals. The toy was provided for appropriate manding when the card had Pete's name on it but not when the card had the confederate peer's name on it.

At the start of baseline and reversal sessions, the experimenter provided Tom with a necklace with a button that paged the experimenter when pressed. The experimenter informed Tom that she had work to do but that he could color or do a puzzle. The experimenter provided Tom with attention in the form concern (e.g., "Tom, please don't say that.") contingent on precursor behavior and ignored pages and instances of severe problem behavior.

During FCT, Tom continued to wear the necklace and was provided with coloring materials and puzzles while the experimenter appeared to be busy. Occurrences of precursor and severe problem behavior were ignored, and at the start of the session, the experimenter prompted Tom to press the button on his necklace if he wanted to talk. Subsequently, the experimenter prompted Tom initially to page him or her every 3 s, which increased contingent on three consecutive prompted pages during which no precursor behavior occurred (Worsdell, Iwata, Hanley, Thompson, & Kahng, 2000). The interval was increased within and between sessions from 3 s to 10 min (details available from the corresponding author) when Tom met this criterion. We increased session length from 10 to 30 min in the treatment room when Tom reached the 3-min prompting interval. Eventually, we also conducted 30-min sessions in the natural environment where other clients and staff were present.

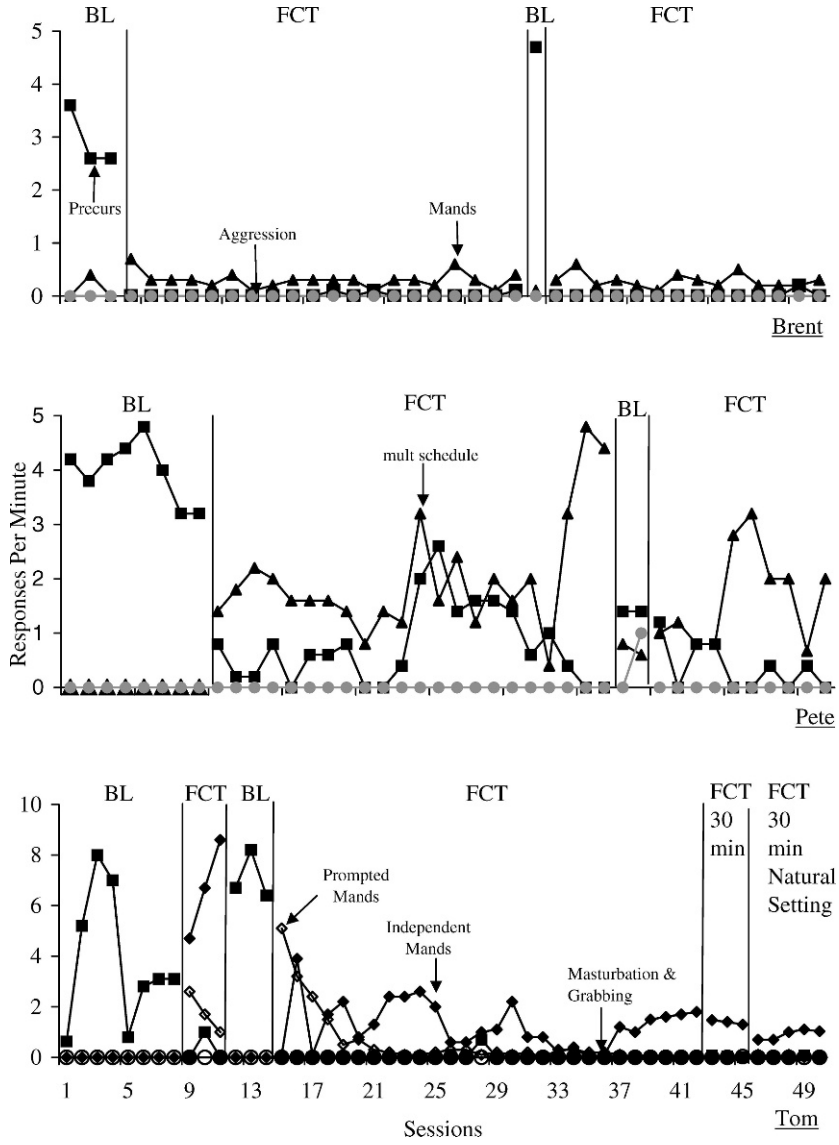

Figure 2. Responses per minute for precursor behavior, severe problem behavior (aggression for Brent and Pete and masturbation and grabbing for Tom), alternative mands (Brent and Pete), and prompted and independent alternative mands (Tom) during baseline (BL), FCT, and extended 30-min sessions (Tom) for Brent, Pete, and Tom.

Results. Figure 2 depicts the effects of treatment on precursor behavior, severe problem behavior, and alternative mands for Brent, Pete, and Tom. Precursor behavior occurred at high levels (*M*s = 2.93 and 4.7 responses per minute) and use of the attention card occurred at low levels (*M*s = 0.13 and 0.1 responses per minute) for Brent during baseline and reversal, respectively. Precursor behavior decreased to low levels (*M*s = 0.02 and 0.01 responses per minute) and use of the card increased (*M*s = 0.3 and 0.29 responses per minute) during FCT phases. Brent never engaged in aggression throughout baseline or FCT sessions.

Precursor behavior occurred at high levels (*M*s = 3.98 and 1.4 responses per minute) for Pete during baseline and the reversal. Aggression and appropriate manding never occurred

during baseline, and aggression increased (M = 0.5 responses per minute) and appropriate manding decreased (M = 0.7 responses per minute) during the reversal. Precursor behavior decreased to lower levels (Ms = 0.77 and 0.36 responses per minute), aggression never occurred, and appropriate manding increased (Ms = 1.99 and 1.65 responses per minute) during FCT phases.

Precursor behavior for Tom occurred at high levels (Ms = 3.83 and 7.1 responses per minute), and he never used the pager during baseline and the reversal. Precursor behavior occurred at zero or low levels (Ms = 0 and 0.03 responses per minute), and prompted (Ms = 1.77 and 0.6 responses per minute) and unprompted (Ms = 6.67 and 1.29 responses per minute) paging increased during FCT phases. Precursor behavior remained low (Ms = 0.03 and 0.01 responses per minute), prompted paging was low (Ms = 0.01 and 0.05 responses per minute), and independent paging remained high (Ms = 1.39 and 0.91 responses per minute) during extended FCT sessions in the treatment room and in the natural environment. Tom never engaged in masturbation or inappropriate grabbing throughout baseline or FCT sessions.

Pre- and Posttreatment Measures of Severe Problem Behavior

Data collected by Brent's teachers and aides revealed that mean number of instances of aggression per day was 1.75 during the 4 days prior to the treatment evaluation and zero during the 4 days following the treatment evaluation. Data from a questionnaire indicated that Pete engaged in aggression a few times per week during the month prior to intervention and not at all during the last 4 days of school. Data from a questionnaire indicated that Tom engaged in masturbation a few times per week and grabbing at least once per week during the month prior to intervention, and he engaged in masturbation once and grabbing or attempting to grab either never (one respondent) or once (second respondent) during the month following the treatment evaluation.

DISCUSSION

All participants in this study responded with differentiation to particular reinforcement contingencies during functional analyses of precursor behavior. Thus, clear operant functions were identified and used to design individualized treatments. Overall, these treatments were found to eliminate precursor behavior and possibly prevented occurrences of severe problem behavior.

Although the mechanisms responsible for the nonoccurrence of severe problem behavior remain unclear, some potentially influential variables can be identified. For example, potential sources of reinforcement were provided for precursor behavior during test conditions of the functional analyses and during baseline conditions of treatment; therefore, it may have been unnecessary for participants to engage in severe problem behavior to obtain reinforcement. Thus, reinforcement for precursor behavior may have functioned as differential reinforcement of alternative behavior, whereby the precursor behavior was strengthened and severe problem behavior was eliminated (Smith & Churchill, 2002). Furthermore, precursor behavior may have required less effort and inflicted less pain (Lalli et al., 1995), thereby producing a bias in favor of precursor behavior over severe problem behavior.

The current results are consistent with an account that precursor and severe problem behavior are hierarchically occurring members of the same response class. Previous research has shown that reinforcement of an early response in a hierarchy of responses in the same response class may suppress later responses in the hierarchy (Lalli et al., 1995); thus, a reasonable account of the nonoccurrence of severe problem behavior during precursor functional analyses and treatment conditions is that responses that occurred earlier in the response-class hierarchy

produced reinforcement. However, these results are tentative and should be interpreted with caution because experimental analyses of severe problem behavior were not conducted, and there are several alternative accounts for the nonoccurrence of severe problem behavior.

It is possible that the relevant antecedents and consequences were absent during the functional analysis and treatment conditions. Thus, although precursor behavior showed differentiation during functional analysis and treatment conditions, it is possible that precursor behavior was otherwise unrelated to severe problem behavior. Alternatively, it is possible that the precursors and alternative mands competed with severe problem behavior.

Given that we conducted only a preliminary evaluation of the relation between precursor and severe problem behavior in the current study, a number of strategies for future research may be suggested. First, efforts should be made to collect as much data on severe problem behavior as possible prior to and following treatment. Another strategy would be to conduct probe sessions in which reinforcement is temporarily withheld for all behavior, which may occasion the reappearance of behavior in the same response class as precursor behavior. Occurrences of severe problem behavior would suggest a common source of control between severe problem behavior and precursor behavior.

An additional limitation in the current procedures is that we interviewed teachers and staff to identify precursor behaviors, which may have resulted in the identification of responses that were correlated with, but did not reliably precede, severe problem behavior. More formal descriptive procedures to verify that a substantial proportion of severe problem behavior is preceded by the forms of behavior identified as precursors should be investigated. Another limitation is that we conducted only one reversal session with Brent and two reversal sessions with Pete. Finally, it is impossible to determine when independent manding was acquired for Brent and Pete because data were not collected separately on independent and prompted mands.

The current study extends previous research on precursor behavior by implementing an intervention based on the outcomes of a functional analysis of precursor behavior that reduced precursor behavior and was associated with zero levels of severe problem behavior. The data from the current investigation highlight that an especially important area for future research will be the resolution of measurement issues related to inferring the effects of precursor-based procedures on problem behavior.

REFERENCES

Borrero, J. C., Vollmer, T. R., Wright, C. S., Lerman, D. C., & Kelley, M. E. (2002). Further evaluation of the role of protective equipment in the functional analysis of self-injurious behavior. *Journal of Applied Behavior Analysis*, *35*, 69–72.

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northup, J., Cigrand, K., et al. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis*, *25*, 197–209.

Grow, L. L., Kelley, M. E., Roane, H. S., & Shillingsburg, M. A. (2008). Utility of extinction-induced response variability for the selection of mands. *Journal of Applied Behavior Analysis*, *41*, 15–24.

Hanley, G. P., Iwata, B. A., & Thompson, R. H. (2001). Reinforcement schedule thinning following treatment with functional communication training. *Journal of Applied Behavior Analysis*, *34*, 17–38.

Harding, J. W., Wacker, D. P., Berg, W. K., Barretto, A., Winborn, L., & Gardner, A. (2001). Analysis of response class hierarchies with attention-maintained problem behaviors. *Journal of Applied Behavior Analysis*, *34*, 61–64.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, *27*, 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2,* 3–20, 1982)

Kahng, S., & Iwata, B. A. (1999). Correspondence between outcomes of brief and extended functional analyses. *Journal of Applied Behavior Analysis*, *32*, 149–159.

Lalli, J. S., Mace, F. C., Wohn, T., & Livezey, K. (1995). Identification and modification of a response-class hierarchy. *Journal of Applied Behavior Analysis*, *28*, 551–559.

Le, D. D., & Smith, R. G. (2002). Functional analysis of self-injury with and without protective equipment. *Journal of Developmental and Physical Disabilities*, *14*, 277–290.

Neef, N. A., & Iwata, B. A. (1994). Current research in functional analysis methodologies: An introduction. *Journal of Applied Behavior Analysis*, *27*, 211–214.

Parrish, J. M., Cataldo, M. F., Kolko, D. J., Neef, N. A., & Egel, A. L. (1986). Experimental analysis of response covariation among compliant and problem behaviors. *Journal of Applied Behavior Analysis*, *19*, 241–254.

Skinner, B. F. (1969). *Contingencies of reinforcement: A theoretical analysis*. New York: Appleton-Century-Crofts.

Smith, R. G., & Churchill, R. M. (2002). Identification of environmental determinants of behavior disorders through functional analysis of precursor behaviors. *Journal of Applied Behavior Analysis*, *35*, 125–136.

Sprague, J. R., & Horner, R. H. (1992). Covariation within functional response classes: Implications for treatment of severe problem behavior. *Journal of Applied Behavior Analysis*, *25*, 735–745.

Vollmer, T. R., Marcus, B. A., Ringdahl, J. E., & Roane, H. S. (1995). Progressing from brief functional assessments to extended experimental analyses in the evaluation of aberrant behavior. *Journal of Applied Behavior Analysis*, *28*, 561–576.

Worsdell, A. S., Iwata, B. A., Hanley, G. P., Thompson, R. H., & Kahng, S. W. (2000). Effects of continuous and intermittent reinforcement for problem behavior during functional communication training. *Journal of Applied Behavior Analysis*, *33*, 167–179.

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