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ESTABLISHING AND MAINTAINING TREATMENT EFFECTS WITH LESS INTRUSIVE CONSEQUENCES VIA A PAIRING PROCEDURE

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The generality and long-term maintenance of a pairing procedure designed to improve the efficacy of less intrusive procedures were evaluated for the treatment of problem behavior maintained by automatic reinforcement exhibited by 2 individuals with developmental disabilities. Results suggested that a less intrusive procedure could be established as a conditioned punisher by pairing it with an effective punisher contingent on problem behavior. Generalization across multiple therapists was demonstrated for both participants. However, generalization to another setting was not achieved for 1 participant until pairing was conducted in the second setting. Long-term maintenance was observed with 1 participant in the absence of further pairing trials. Maintenance via intermittent pairing trials was successful for the other participant.

DESCRIPTORS: behavior disorders, developmental disabilities, pairing, conditioning, maintenance, punishment

Function-based interventions are highly effective for treating problem behavior in individuals with developmental disabilities. Nevertheless, advances in this technology have not eliminated the need for punishment in some cases (e.g., Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Wacker et al., 1990). For example, time-out, graduated guidance, basket hold, facial screen, and contingent demands have been combined with functional communication training to optimize treatment success. In fact, punishment may be critical to the treatment of some problem behaviors when the precise source of reinforcement cannot be identified or controlled (Vollmer & Iwata, 1993). Still, the use of punishment is controversial and remains the subject of debate. There is general consensus, however, that interventions should be designed to be as least intrusive or restrictive as possible. Another potential disadvantage of punishment described in applied textbooks and literature reviews relates to the durability and generality of its effects and the amount of effort required for caregivers to implement treatment consistently (see Lerman & Vorndran, 2002, for a review). Thus, strategies to improve the efficacy and acceptability of punishment have been evaluated in some studies.

For example, intermittent schedules of punishment permit the infrequent application of punishment, thus decreasing both the intrusiveness of treatment and the amount of effort required by the caregiver. Lerman, Iwata, Shore, and DeLeon (1997) attempted to thin the schedule of punishment from a continuous schedule to an intermittent schedule with 4 participants. Consistent with basic studies on intermittent punishment, Lerman et al. found that intermittent punishment was unsuccessful for 2 participants.

Methods to increase the effectiveness of less intrusive punishment procedures also have been examined in the applied literature. For example, Charlop, Burgio, Iwata, and Ivancic (1988) compared the efficacy of a single punishment procedure (e.g., time-out) to that of a group of punishment procedures (e.g., time-out, verbal reprimand, overcorrection, and loud noise)

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presented singly in random order. Results indicated that varied punishment was more effective in decreasing inappropriate behavior than using the same punisher with each implementation. This study added an important contribution to the applied literature on punishment because less intrusive punishers (e.g., verbal reprimands) were interspersed among more intrusive procedures (e.g., overcorrection), and problem behavior remained low.

Another potential way to decrease the intrusiveness of punishment is to establish and use conditioned aversive stimuli. Conditioning requires the systematic pairing of stimuli that are neutral or ineffective as punishers with stimuli that function as effective punishers. Once conditioned, these stimuli can function as punishers when delivered contingent on behavior in the absence of the primary, or unconditioned, punisher. Conditioned punishment might be beneficial for use in clinical settings because relatively less intrusive procedures that are easy to deliver (e.g., verbal reprimands, a brief tone) could be established as effective punishers.

Conditioned punishment has been studied primarily in the basic laboratory using classical conditioning methods. Basic researchers have established various stimuli as conditioned punishers, including tones (Davidson, 1970), lights (Hake & Azrin, 1965), and low-voltage shock (Crowell, 1974). In most studies, the conditioned stimulus was established by presenting it prior to an unavoidable aversive stimulus independent of responding. The conditioned stimulus then was either removed at the onset of the aversive event (Hake & Azrin, 1965; Mowrer & Solomon, 1954) or remained present while the aversive stimulus was delivered periodically independent of responding (Orme-Johnson & Yarczower, 1974). Such a method would not be appropriate for clinical use because ethical standards preclude exposing individuals to aversive stimuli on a noncontingent basis. An alternative, response-dependent, method for establishing conditioned punishers involves pairing a neutral stimulus with a punisher delivered contingent on a targeted response (such as severe self-injury). Although more clinically acceptable than a classical conditioning procedure, response-dependent methods may limit opportunities to condition a stimulus, especially if the unconditioned punisher is highly effective (i.e., a substantial decrease in the target behavior would necessarily restrict the frequency of the pairing trials).

Another challenge to the clinical use of conditioned punishers is that they will become less effective over time if they are no longer paired with the unconditioned punisher (Azrin & Holz, 1966). To address this problem, Hake and Azrin (1965) developed a procedure in which the conditioned effect may be maintained indefinitely. Using pigeons as subjects, Hake and Azrin conducted intermittent pairings of a conditioned stimulus (a clicking tone and a change in color of a response key) and an unconditioned punisher (electric shock) throughout the study, a strategy that permitted the experimenters to study other aspects of conditioning without encountering extinction.

Despite the potential use of conditioned punishers, only a handful of applied studies have evaluated conditioned punishment, and none have addressed potential problems with long-term maintenance. For example, Lovaas and Simmons (1969) paired the word "no" (a neutral stimulus) with shock for 1 participant who engaged in severe self-injury. Results suggested that, when used alone, "no" had acquired the suppressive properties of shock. However, the effects of the conditioned punisher were evaluated across fewer than 20 5-min sessions. Dorsey, Iwata, Ong, and McSween (1980) also demonstrated that the word "no" could acquire suppressive properties after pairing it with water mist for 2 individuals. In

addition, the suppressive effects of the verbal reprimand generalized to a second setting that had never been associated with the water mist as well as to other therapists who had never delivered the water mist. The conditioned effect was shown to be maintained across about 15 20-min sessions in each of two settings for the 2 participants. Dixon, Helsel, Rojahn, Cipollone, and Lubetsky (1989) paired a visual screen with aromatic ammonia and later showed that the visual screen alone was effective in reducing aggression across 17 1-hr sessions. However, potentially confounding medication evaluations for a seizure disorder took place during the analysis, preventing clear evaluation of the conditioned effect.

Finally, Salvy, Mulick, Butter, Bartlett, and Linscheid (2004) demonstrated long-term treatment maintenance (up to 1 year) of a verbal reprimand combined with movement toward a device that delivered contingent shock (the Self-Injurious Behavior Inhibiting System) for a preschooler with developmental disabilities who engaged in severe head banging. However, multiple limitations of the study precluded direct evaluation of the role of conditioning in treatment maintenance. First, the effectiveness of the verbal reprimand prior to pairing with contingent shock was never evaluated. Second, the majority of the data beyond the initial six-session treatment evaluation were reported solely by the individual's mother with no reliability or procedural integrity data. Finally, additional treatment components taught to the parent (extinction and differential reinforcement) may have been responsible for the long-term reduction of self-injury.

Although three of the four studies discussed above indicated that neutral stimuli can be successfully established as conditioned punishers, the efficacy of the conditioned punisher was examined only briefly in all but one study (Salvy et al., 2004). None of the studies addressed the issue of the eventual extinction of the conditioning effect or evaluated possible methods to circumvent such problems. In addition, only one study (Dorsey et al., 1980) examined the generality of the conditioned stimuli. If conditioned punishers are found to be useful, challenges related to treatment durability and generality will need to be addressed.

The purposes of this study were first to evaluate a pairing procedure to improve the efficacy of a less intrusive intervention in the treatment of problem behavior maintained by automatic reinforcement. Next, the generality of conditioning across settings and therapists and long-term maintenance were evaluated. The problem of treatment maintenance was addressed with 1 participant by using a strategy similar to that used by Hake and Azrin (1965). In particular, the durability of the conditioned effect was assessed and used as the basis to develop a schedule of pairings between the conditioned aversive stimulus and the punisher, an approach suggested by Lerman and Vorndran (2002). The effectiveness of treatment under intermittent pairing then was evaluated.

GENERAL METHOD

Participants and Settings

Susan was a 34-year-old woman who had been diagnosed with severe mental retardation, cerebral palsy, legal blindness, and a seizure disorder. Susan could walk independently but sometimes required assistance to maintain her balance. She could follow simple one-step instructions, but she did not have any expressive communication skills. Susan had been referred for the assessment and treatment of hyperventilation that sometimes resulted in loss of consciousness, injuries from related falls, and petit mal seizures. Results of previous medical evaluations eliminated any potential physiological causes for the hyperventilation. Susan resided in a group home for women with developmental disabilities. At the time of this study, she was receiving skills training at her group home 5 days per week. Sessions were conducted in two rooms in the group home (the

living area and her bedroom). The living room contained chairs, tables, a television, and necessary session materials. The bedroom contained two beds, a recliner, a television, and the necessary session materials. Four to five sessions were conducted per day, 3 to 5 days per week.

Brian was a 10-year-old boy who had been diagnosed with severe mental retardation and cerebral palsy. He ambulated with the assistance of a wheelchair. He had functional use of only one hand and communicated with gestures and a few one-word utterances (e.g., "toys," "juice," "bye"). Brian had been referred for assessment and treatment of chronic hand mouthing that resulted in tissue damage to his hand. He attended a self-contained classroom for individuals with developmental disabilities. Sessions were conducted in two rooms adjacent to Brian's classroom (a large and a small therapy room). The rooms contained desks, chairs, tables, and the necessary session materials. Four to five sessions were conducted per day, 3 to 5 days per week.

Response Measurement and Reliability

For Susan, hyperventilation was defined as rapid, shallow breaths that occurred within 1 s to 2 s of each other. For Brian, hand mouthing was defined as insertion of any part of his hand past the plane of the lips or contact between his tongue and any part of his hand or arm. Data on problem behavior were collected using partial-interval recording and expressed as percentage of 10-s intervals. Observers were graduate and undergraduate students who previously met a training criterion.

A second observer simultaneously but independently collected data on problem behavior during 30% (Susan) and 45% (Brian) of sessions. Interobserver agreement percentages were calculated by dividing the session into consecutive 10-s intervals. Agreements were defined as 10-s intervals in which both observers scored or did not score the behavior. Disagreements were defined as 10-s intervals in which only one observer scored the behavior. The agreement coefficients then were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Mean interobserver agreement was 98% (range, 68% to 100%) for Susan and 97% (range, 80% to 100%) for Brian.

Functional Analysis and Results

A functional analysis similar to that described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) was conducted with both participants to assess the variables that maintained their problem behavior. Attention, tangible, demand, toy play, and no-interaction conditions were implemented in a multielement design.

The top panel of Figure 1 depicts the results of Susan's functional analysis. Results showed undifferentiated levels of hyperventilation across conditions. Thus, a series of no-interaction sessions was conducted to determine if the behavior would be maintained in the absence of social consequences (e.g., Vollmer, Marcus, Ringdahl, & Roane, 1995). Hyperventilation remained variable and persisted over a long period, suggesting that it was maintained by automatic reinforcement. Results of Brian's functional analysis are depicted in the bottom panel of Figure 1. Hand mouthing was observed in all conditions. However, levels of hand mouthing were consistently higher in the no-interaction condition than in the other conditions. These results suggested that Brian's hand mouthing was maintained by automatic reinforcement.

Experimental Design

The effects of treatment and pairing on problem behavior were evaluated with each participant using a reversal design. A multiple baseline across settings design was used to test for the generality of conditioning. The sequence and content of conditions varied somewhat for Susan and Brian. Thus, the procedure and results for each participant will be described separately.

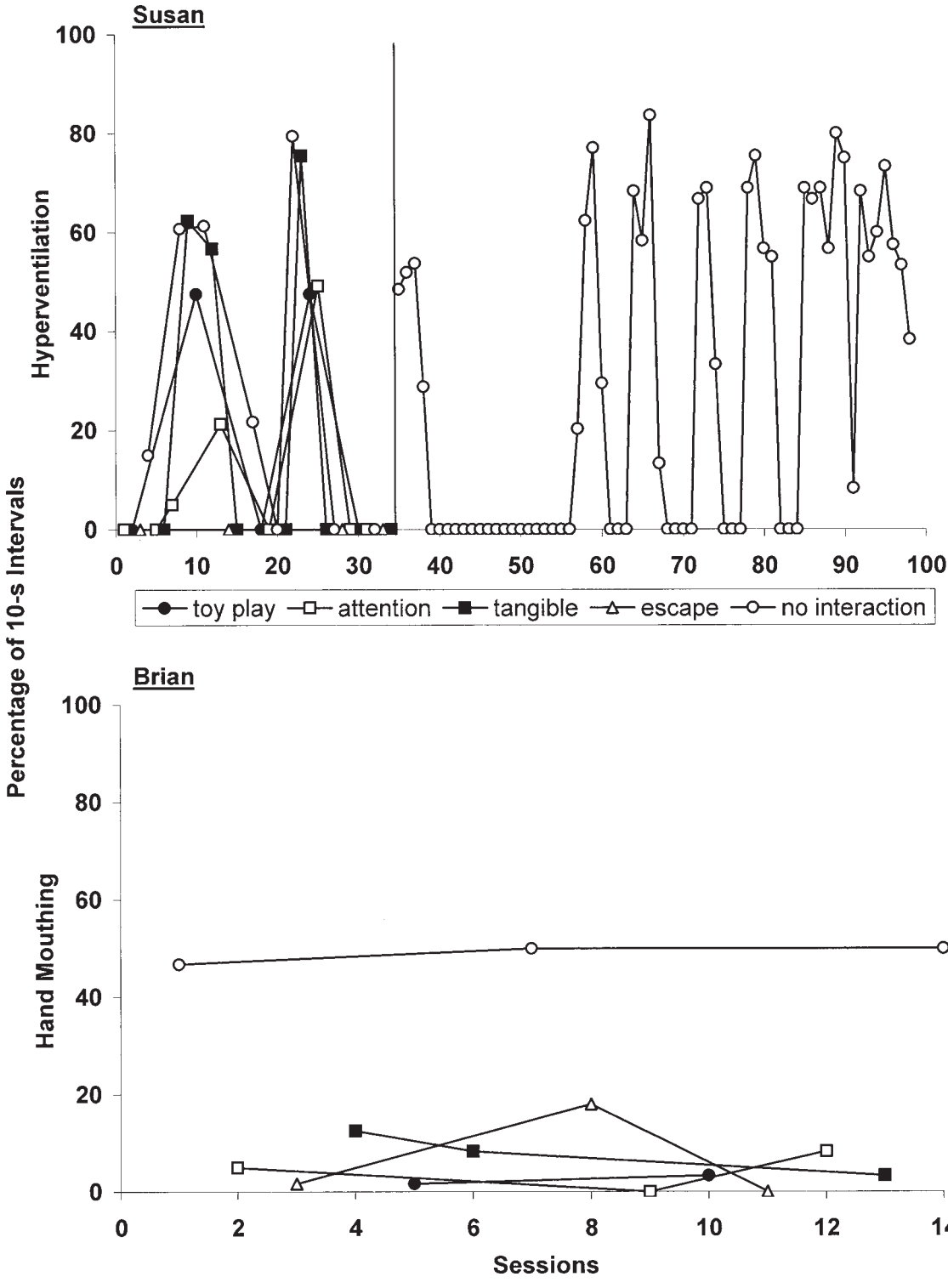

Figure 1. Percentage of 10-s intervals with problem behavior during functional analysis sessions for Susan and Brian.

Susan

Prior to this study, a variety of less restrictive interventions for hyperventilation had been implemented by Susan's group-home staff without success. These treatments have been shown to be effective in reducing behavior maintained by automatic reinforcement. For example, staff provided Susan with frequent access to a variety of preferred sensory items, including visual and auditory stimuli, to compete with the reinforcement obtained via hyperventilation (Piazza et al., 1998). Other interventions included redirection to preferred leisure materials and verbal reprimands (Hagopian & Adelinis, 2001; Richman, Lindauer, Crosland, McKerchar, & Morse, 2001). At the time of the study, Susan's current behavior plan specified that staff should provide her with frequent access to preferred leisure items and respond to hyperventilation by calling her name, rubbing her back, and redirecting her attention to leisure items. Her habilitation plan also indicated that staff should provide her with frequent opportunities to ambulate independently to discourage inactivity and provide exercise. Nonetheless, the current and previous treatments did not reduce hyperventilation to clinically acceptable levels.

Procedure

A paired-choice preference assessment was conducted prior to the treatment evaluation (Fisher et al., 1992). Preferred items identified included a television, keys, a small mirror, a handheld water toy, and other shiny items. Continuous access to these items was available in all conditions described below except during implementation of the walking procedure when the items were removed from Susan's hands for safety; however, the television remained on at all times. The following conditions were conducted in both settings, designated Setting 1 (bedroom) and Setting 2 (living area), unless otherwise stated. All sessions were 10 min long.

Baseline. Susan had access to preferred items described above, no programmed consequences were provided for hyperventilation, and no one interacted with her.

Less intrusive procedure (LIP) alone (before pairing). The therapist called Susan's name and gently nudged her shoulder for 10 s contingent on hyperventilation. The purpose of this condition was to evaluate the effects of the LIP (a procedure similar to that specified in her residential behavior plan) on hyperventilation prior to the pairing procedure.

Walking. The reductive effects of contingent walking were evaluated in Setting 1 only. This procedure was selected as the least restrictive procedure that was likely to be effective based on anecdotal evidence that walking was aversive to Susan (e.g., she was frequently noncompliant with requests to walk). Contingent on each occurrence of hyperventilation, the therapist stood in front of Susan, held her under both arms, and gently guided her to stand. After Susan was standing, the therapist continued to assist her with maintaining her balance while she walked for 20 s (approximately four to five steps away from the chair and back).

LIP plus walking (pairing). Contingent on each occurrence of hyperventilation, the therapist implemented the LIP immediately followed by the walking procedure. These sessions were conducted in Setting 1 only. The purpose was to establish the LIP as a conditioned punisher via pairings with the walking procedure.

LIP alone (postpairing). Procedures were identical to those used to evaluate the effects of the LIP prior to the pairing sessions. Initially, these sessions were scheduled to occur after 35 pairings or 25 sessions, whichever came first. Although this criterion was selected based on previous applied research (e.g., Dorsey et al., 1980), it had to be altered for Susan. Only five pairings occurred during the first 25 sessions because contingent walking suppressed hyperventilation to near-zero levels. Therefore, 15 pairings (across 44 sessions) were conducted

before testing for conditioning. Sessions initially were conducted in Setting 1 to determine if an adequate number of pairings had been implemented to establish conditioning before introducing the LIP in Setting 2. The criterion for adequate pairing was an 80% reduction in hyperventilation from the baseline mean. The LIP was introduced in Setting 2 when hyperventilation remained below this criterion for nine consecutive sessions in Setting 1. This phase continued until the conditioning effect broke down in either Setting 1 or Setting 2. A breakdown in conditioning was defined as an increase in hyperventilation above 80% of the baseline mean for one session in either setting (i.e., 33% of 10-s intervals, calculated from baseline sessions in Setting 1).

The purpose of this phase was threefold. First, results would show whether the previously ineffective LIP would suppress behavior in the same setting in which the pairings occurred. Second, the generality of the conditioned effect would be tested by introducing the LIP into the second setting. Third, these data would be used to determine how long the conditioned effect would be maintained without additional pairings.

Novel therapists were introduced into Setting 2 when Susan's behavior did not meet the criterion for a breakdown after 53 sessions across the two settings. Novel therapists consisted of trained graduate and undergraduate students who had never previously implemented the walking procedure with Susan.

LIP plus walking (re-pairing). Pairing procedures identical to those used previously were implemented when Susan's behavior met the criterion for a breakdown in conditioning in Setting 2 with the second novel therapist. Re-pairing sessions were conducted by that therapist in Setting 2, while the original therapist continued to implement the LIP alone in Setting 1. Re-pairing continued until a minimum of five pairings was implemented and hyperventilation had not occurred for 5 min since the last pairing. The purpose of this condition was to determine whether the punishing effect of the LIP could be reestablished via continued pairings with contingent walking.

Staff training. Two primary caregivers were taught how to implement the pairing procedure via written and verbal instructions, modeling, practice, and feedback. Initially, the caregivers were told to implement the pairing procedure (LIP plus walking) until the level of hyperventilation was within the range of that obtained during the treatment evaluation with the experimenter (i.e., consistently below 5% of intervals). Caregivers were told to monitor the levels of hyperventilation throughout the day via the data-collection sheets provided by the group home. Data sheets consisted of scatterplot and antecedent-behavior-consequence-type forms. When data collected by staff indicated that hyperventilation had decreased to low levels after 1 month, the caregivers were instructed to discontinue the walking procedure. Caregivers also were told to conduct re-pairing sessions whenever hyperventilation occurred five or more times within 5 min and to continue these pairings until at least five pairings occurred and 5 min elapsed without hyperventilation. This arbitrary schedule was designed to prevent a potential breakdown in conditioning.

Follow-up. Follow-up sessions were conducted in various areas of Susan's group home (e.g., kitchen, backyard, living area). Preferred leisure items similar to those used in treatment sessions were available in most follow-up sessions; however, caregivers were not explicitly instructed to follow the procedure. Sessions were conducted by the same two caregivers at 2, 2.5, and 7 months following training. Three to four sessions were conducted at each visit, and visits were made at different times of the day (e.g., morning and late afternoon).

Results

Results for Susan are depicted in Figure 2. The top panel shows the effects of the LIP

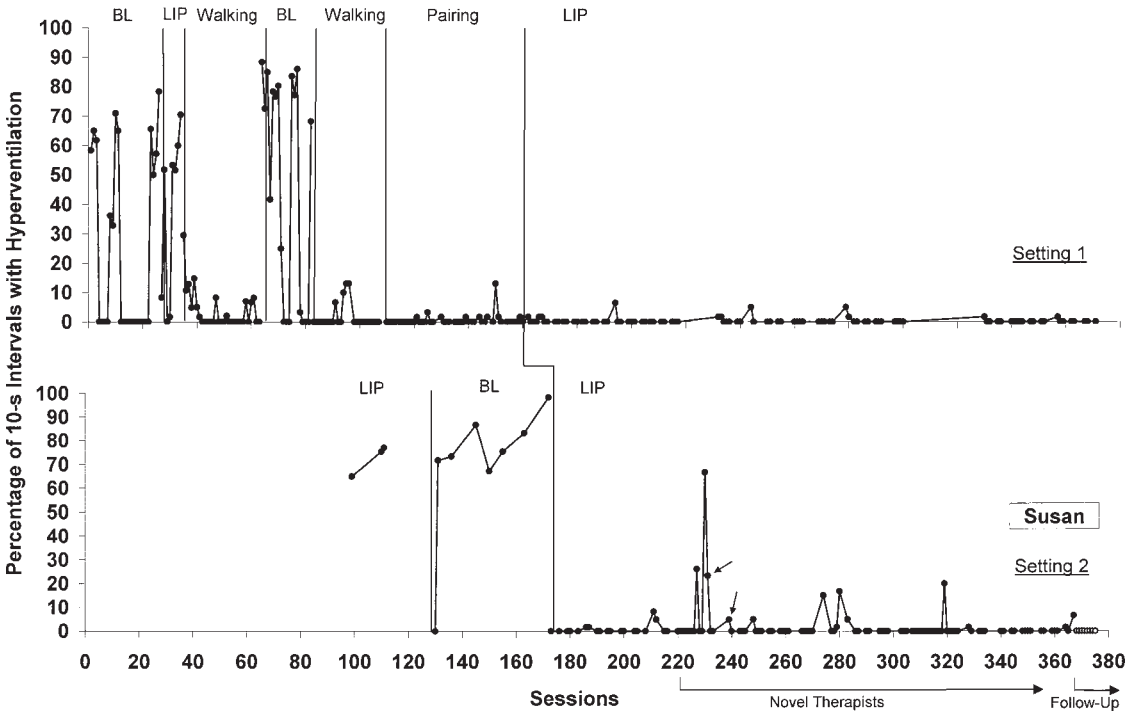

Figure 2. Percentage of 10-s intervals with hyperventilation in Setting 1 (top) and Setting 2 (bottom) for Susan. The arrows in the bottom panel indicate the sessions during which re-pairing was implemented.

alone and walking on hyperventilation prior to pairing in Setting 1. Across the initial baseline (enriched environment) and LIP alone (prepairing) conditions in Setting 1, levels of hyperventilation were variable. Hyperventilation decreased to near zero during contingent walking and then increased to high levels again during a return to baseline. The walking procedure then was reinstated to further evaluate its suppressive effects due to the high degree of variability in hyperventilation during baseline. Concurrent with the second walking phase in Setting 1, the effects of the LIP alone was probed in Setting 2 (second panel). Levels of hyperventilation were similar to those observed during the same condition in Setting 1.

During the pairing phase in Setting 1, hyperventilation continued to remain low. Only 15 opportunities to pair the LIP with walking occurred across 44 sessions. The effect of the LIP alone (postpairing) was then evaluated in Setting 1, and hyperventilation remained low for the remainder of the study. In fact, Susan's hyperventilation never met the criterion for re-pairing in Setting 1. While these conditions were implemented in Setting 1, baseline sessions were conducted periodically in Setting 2, followed by sessions with the LIP alone (postpairing in Setting 1). Hyperventilation decreased substantially in Setting 2 when the LIP was introduced and remained low in both settings for almost 200 sessions conducted across 3 months. With the exception of five sessions (Sessions 231, 232, 275, 281, and 319), hyperventilation occurred in less than 5% of 10-s intervals (nearly a 90% reduction from baseline mean) during sessions conducted by four novel therapists in Setting 2. Re-pairing procedures were implemented (during Sessions 231 and 239) after an increase in hyperventilation was observed with the second novel

therapist. The final eight sessions shown in the bottom panel were conducted by Susan's caregivers. No hyperventilation was observed during any of the follow-up visits.

Brian

A variety of function-based interventions was evaluated with Brian prior to this study. First, we attempted to manipulate the establishing operation for hand mouthing by providing noncontingent access to items that were appropriate to mouth (e.g., textured teether, mini massager). Next, we evaluated differential reinforcement procedures (i.e., differential reinforcement of alternative behavior, differential reinforcement of other behavior) using highly preferred items as reinforcers. Although research findings support the efficacy of these interventions for behavior maintained by automatic reinforcement (see Vollmer, 1994, for a discussion), none were found to be sufficient for reducing Brian's hand mouthing to clinically acceptable levels. Sensory extinction procedures (e.g., placing gloves on his hands) were not evaluated because the hypothesized source of reinforcement was oral stimulation. Thus, various punishment procedures (verbal reprimand, response blocking, hands down, facial screen) were selected and evaluated during brief probe sessions, as described by Thompson, Iwata, Conners, and Roscoe (1999), to identify the least intrusive procedure that was effective (data are available from the first author).

Procedure

A paired-stimulus preference assessment was conducted prior to the study (Fisher et al., 1992). Preferred items identified included a musical toy, a mini massager, a tambourine with beads inside, and bongos. Brian had access to all items during every condition described below. The following conditions were conducted in both settings, designated Setting 1 (large therapy room) and Setting 2 (small therapy room). Sessions were 10 min long except when punishment was implemented because Brian was physically prevented from engaging in hand mouthing during the facial screen/hands down (FS/HD) procedure. In those sessions, the punishment intervals were removed from total session time, and the session was extended for each punisher application, so that a total of 10 min of potential opportunity to hand mouth was available in each session.

Baseline. Brian had access to preferred items described above, there were no programmed consequences for hand mouthing, and no one interacted with him.

FS/HD. The therapist implemented a 30-s FS/HD contingent on each occurrence of hand mouthing. A sleep mask was placed over Brian's eyes, and his hands were held in his lap. Toys were removed from his hands prior to implementing the procedure. This condition was initially implemented in Setting 1 only and later was implemented in Setting 2 when generalization was not observed.

LIP (before pairing). The therapist called Brian's name repeatedly and gently nudged his shoulder for 10 s contingent on hand mouthing. The purpose of this condition was to evaluate the effects of the LIP on hand mouthing prior to the pairing procedure.

LIP plus FS/HD (pairing). Contingent on each occurrence of hand mouthing, the therapist implemented the 10-s LIP followed immediately by the 30-s FS/HD, as described above. The purpose was to establish the LIP as a punishing stimulus via pairings with the contingent FS/HD.

LIP alone (postpairing). These procedures were identical to those conducted in the first LIP-alone condition. Initially, these sessions were scheduled to occur after 35 pairings or 25 sessions, whichever came first. Due to variable levels of hand mouthing in baseline and the first LIP-alone conditions, pairings were continued beyond the criterion to determine whether hand mouthing would remain low. A total of 92 pairings and 24 sessions preceded the first LIP-alone (postpairing) session. When the criterion for conditioning was met (seven consecutive

sessions below 80% of baseline mean), the LIP alone was introduced in Setting 2 and continued in Setting 1. This condition continued until the conditioning effect broke down in either Setting 1 or Setting 2. A breakdown in conditioning was defined as an increase in hand mouthing above 80% of the baseline mean for one session in either setting (i.e., 17% of 10-s intervals, calculated from baseline sessions in Setting 1, second phase only, and Setting 2, excluding the last three sessions, which were conducted after the evaluation of the LIP alone was initiated in Setting 1).

LIP plus FS/HD (re-pairing). Re-pairing procedures were identical to the pairing procedures used previously. Sessions were initiated when a breakdown in conditioning occurred (as defined above) and periodically for other reasons (see further discussion below). Re-pairing sessions were conducted in the setting in which the breakdown was observed while the current condition continued in the other setting. Re-pairing continued until a minimum of five pairings was implemented and hand mouthing had not occurred for 5 min since the last pairing. The purpose of this condition was to determine whether the punishing effect of the LIP could be reestablished via continued pairings with FS/HD.

Maintenance (intermittent pairing Schedules A and B). An intermittent pairing schedule was developed based on the average number of times that the LIP alone (postpairing) was implemented before responding met the criterion for a breakdown in conditioning. The initial pairing schedule, designated Schedule A, was a variable-ratio (VR) 10 schedule (range, 8 to 12 presentations of LIP alone) and was developed by averaging the number of LIP presentations that occurred prior to the sessions when a breakdown occurred in Setting 1. During the maintenance phase, the schedule did not reset at the end of each session. That is, the schedule carried over across sessions and settings. For example, if a pairing was scheduled to occur on the 12th presentation of the LIP and the LIP was delivered five times during a session in Setting 1, the pairing occurred on the seventh presentation of the LIP in the next session (in Setting 1 or 2). Later, separate pairing schedules were used in each setting because the initial schedule based on breakdown data from Setting 1 was ineffective in Setting 2. The intermittent pairing schedule for Setting 1 was identical to the previous schedule, whereas a denser schedule (VR 5; range, 3 to 7), designated Schedule B, was used in Setting 2 based on breakdown data obtained only in that setting. The new schedules did not reset at the end of each session. That is, different schedules were used concurrently in the two settings, and each schedule carried over across sessions within that setting.

Results

Brian's results are depicted in Figure 3. The top panel shows the effects of FS/HD alone, the LIP alone (before and after pairing), and pairing in Setting 1. Across baseline (enriched environment) and initial LIP alone (before pairing) sessions in Setting 1, levels of hand mouthing were higher and more variable than levels of hand mouthing during the FS/HD and pairing phases. The LIP (postpairing) was shown to be as effective as the pairing condition. While these conditions were implemented in Setting 1, sessions with the LIP alone (before pairings in Setting 1) and baseline were conducted periodically in Setting 2 (second panel). Levels of hand mouthing were comparable to those observed in Setting 1 under the same conditions. After this initial evaluation of conditioning, re-pairing sessions were conducted in Setting 1 when (a) a lack of generalization was observed in Setting 2 (Session 103; see further discussion below) and (b) two breakdowns in conditioning occurred in Setting 1 (Sessions 146 and 159).

Beginning with Session 100, the LIP alone (postpairing in Setting 1) was implemented in Setting 2 to test for generality of conditioning. Hand mouthing did not meet the criterion for

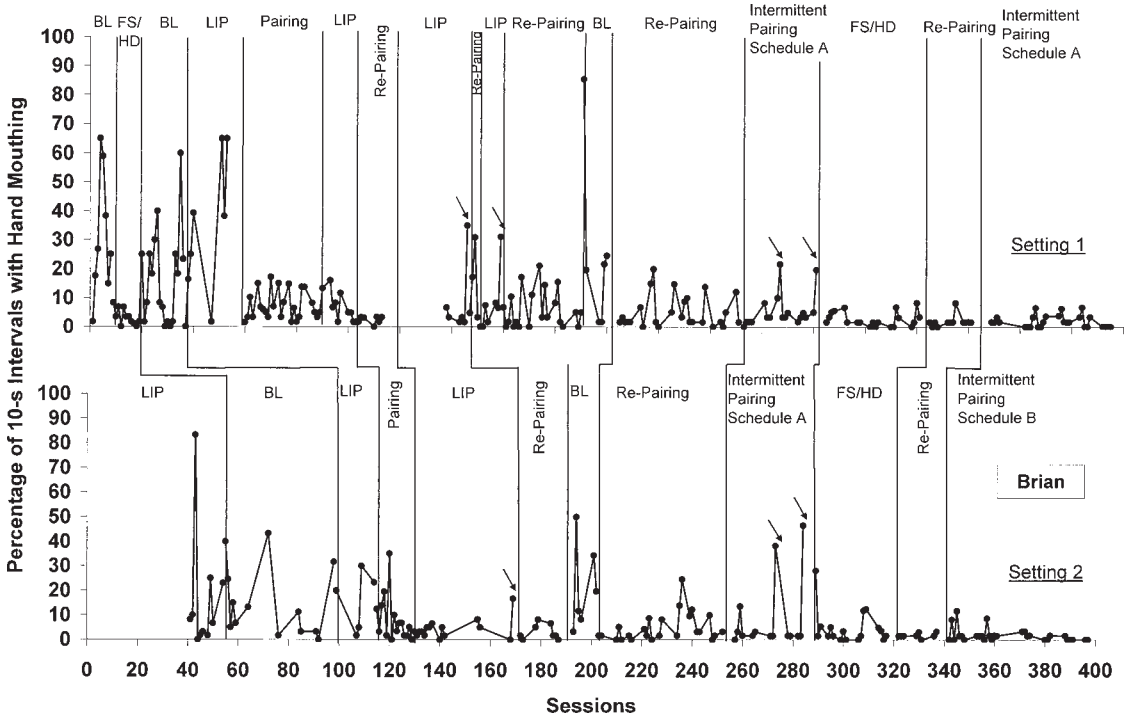

Figure 3. Percentage of 10-s intervals with hand mouthing in Setting 1 (top) and Setting 2 (bottom) for Brian. Arrows indicate sessions during which levels of hand mouthing exceeded the criteria for treatment breakdown.

conditioning (less than 80% of baseline mean) in the first session. Despite a reintroduction of pairing sessions in Setting 1 (Sessions 103 to 106 and 110 to 113), additional tests for conditioning effects in Setting 2 (Sessions 107, 108, 109, and 114) further demonstrated a lack of generalization. Hand mouthing was low during two sessions but increased above the criterion in the final two sessions, despite repeated pairings in Setting 1. No further attempts to assess generality were conducted. Instead, pairing sessions were introduced in Setting 2 while sessions were discontinued temporarily in Setting 1. Hand mouthing remained low when the conditioning effect was subsequently tested in Setting 2 and the LIP alone resumed in Setting 1. After a breakdown in conditioning was observed in Setting 2 (Session 169), re-pairing sessions were implemented in that setting and continued in Setting 1.

Baseline and additional pairing sessions were reimplemented in both settings because of the lengthy nature of the previous evaluation and the variability in levels of hand mouthing. First, a return to baseline in both settings showed levels of hand mouthing similar to those in previous baseline conditions. Then, an immediate decrease in hand mouthing was observed with a return to the re-pairing condition in both settings. After 50 pairing sessions across the two settings, the same intermittent pairing schedule was evaluated as a strategy to maintain treatment effects in both settings. Hand mouthing usually remained below the criterion for conditioning in all but two sessions in each setting.

It should be noted that levels of hand mouthing under the re-pairing condition in each setting were highly variable, with levels sometimes equal to those in baseline. This could have occurred because the FS/HD procedure was becoming less effective or because the pairing procedure necessarily inserted a 10-s delay between the onset of the response and the

application of FS/HD. Thus, before continuing our evaluation of the intermittent pairing procedure, FS/HD only was implemented in both settings to determine whether it still functioned as an effective punisher. With the exception of three sessions in Setting 2 (Sessions 289, 308, and 309), levels of hand mouthing decreased and remained low in both settings. These results suggested that FS/HD was still functioning as an effective punisher and that habituation was not a likely explanation for the variability during re-pairing sessions. Re-pairing sessions were implemented in both settings followed by an evaluation of different intermittent pairing schedules in each setting. Hand mouthing remained low across 56 sessions, conducted across 1 month, in both settings.

DISCUSSION

Results indicated that a less intrusive procedure could be established and maintained as a conditioned punisher for 2 participants. Although results of previous studies indicated that neutral stimuli could be established as conditioned punishers (e.g., Dixon et al., 1989; Dorsey et al., 1980; Lovaas & Simmons, 1969; Salvy et al., 2004), only one of the studies investigated the long-term maintenance of conditioned stimuli, and none evaluated methods to circumvent the eventual extinction of the conditioned effect.

For Susan, the LIP alone suppressed hyperventilation after just 15 pairings with the walking procedure and generalized to a second setting not previously associated with the walking procedure. Furthermore, the suppressive effect of the LIP alone was maintained in both settings without additional pairings for 56 sessions. In contrast, for Brian, the conditioned effect did not generalize to Setting 2 following over 100 pairings of the LIP and FS/HD in Setting 1 until pairings were conducted in Setting 2. In addition, after pairing sessions were conducted in Setting 2, the LIP alone suppressed behavior in that setting for only 14 sessions, a less robust maintenance effect than that observed with Susan. These between-participant differences might be attributed to differences in the effectiveness of the more intrusive procedure. Contingent walking suppressed Susan's behavior to a greater degree than did FS/HD for Brian. Brian's behavior also seemed to be more sensitive to the delay that was necessarily inserted between the LIP and FS/HD during pairing. In fact, the efficacy of contingent walking in treating Susan's hyperventilation may have accelerated the conditioning process by making the conditioned stimulus more salient.

Although this study's findings are preliminary, they have important clinical implications. Results indicate that it is possible to improve the efficacy of less intrusive procedures for reducing problem behavior. Given the controversy surrounding the use of punishment for individuals with developmental disabilities and the resistance of some problem behavior to reinforcement- and extinction-based treatments, these findings suggest a promising strategy for the treatment of behavior problems.

Several alternative interpretations of the findings are possible. For Susan, the LIP or the close presence of a therapist may have acquired discriminative rather than aversive properties. Results are consistent with this interpretation because hyperventilation rarely occurred during the LIP-alone (postpairing) condition in Setting 1 and immediately decreased to zero when the LIP alone was introduced in Setting 2. Although the therapist was present during baseline, she was seated closer to Susan during the walking and LIP phases. In fact, because hyperventilation remained so low, the behavior rarely contacted the conditioned stimulus (or discriminative stimulus) in the absence of the punisher and, thus, had little opportunity to undergo extinction. This lack of exposure to the LIP alone might explain why hyperventilation remained suppressed for so long.

For Brian, the lack of generalization into Setting 2 potentially can be explained several ways. First, some unknown contextual stimulus in Setting 1 may have been conditioned with the LIP. If so, the stimulus presented in Setting 2 would have been functionally different than that presented in Setting 1. Another possibility is that the LIP acquired primarily discriminative properties rather than aversive properties. Initially, the LIP was presented in both settings, but FS/HD was presented in only one setting. If the LIP functioned as a discriminative stimulus, it likely would influence behavior only in the setting in which it had been previously correlated with consequences for hand mouthing (Setting 1). The efficacy of the LIP alone after it was paired with FS/HD in Setting 2 supports both interpretations. However, a third interpretation is possible. Hand mouthing may have remained suppressed when FS/HD was withdrawn in both settings because the effects of punishment carried over into the next phase (i.e., were maintained over time), not because a conditioned stimulus was delivered contingent on responding. This potential interpretation was thought to be unlikely when a reversal to baseline following exposure to the pairing procedure showed an immediate return to baseline levels. However, levels of hand mouthing during the re-pairing and intermittent pairing phases subsequent to the reevaluation of FS/HD alone were consistently lower than the previous levels. These data are consistent with the carryover interpretation. Future research might investigate whether a periodic return to the unconditioned punisher alone may be necessary when the conditioned effect shows a decrease in effectiveness.

Future research is needed to examine other variables that are important to the conditioning process, such as the saliency of the neutral stimulus, the type of unconditioned punisher used, the method for establishing conditioning, and the number of pairing trials implemented. Factors that promote successful generalization of conditioned punishers also should be evaluated in future studies. For example, programming common salient stimuli across the two settings, introducing multiple therapists, or pairing the conditioned and unconditioned stimuli intermittently in the training setting may help contribute to generalization. Delineating aversive versus discriminative properties of the conditioned stimuli could be examined by applying the conditioned stimulus to another behavior that has never been associated with the unconditioned punisher. Reduction of this behavior may indicate that the conditioned stimulus has aversive properties.

In this study, maintenance of the conditioned effect was measured by calculating the number of presentations of the conditioned stimulus in the absence of the punisher before levels of the target behavior returned to baseline levels. An intermittent pairing schedule was developed based on these data for Brian. However, such a schedule was never developed for Susan because her problem behavior remained low across the long-term follow-up. Additional research is needed to further explore the use of empirically based schedules of intermittent pairing for the long-term maintenance of conditioned punishers.

REFERENCES

Azrin, N. H., & Holz, W. C. (1966). Punishment. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application* (pp. 380–447). East Norwalk, CT: Appleton-Century-Crofts.

Charlop, M. H., Burgio, L. D., Iwata, B. A., & Ivancic, M. T. (1988). Stimulus variations in enhancing punishment effects. *Journal of Applied Behavior Analysis*, *21*, 89–95.

Crowell, C. R. (1974). Conditioned aversive aspects of electric shock. *Learning and Motivation*, *5*, 209–220.

Davidson, R. S. (1970). Conditioned punishment and conditioned negative reinforcement on a multiple schedule. *Psychonomic Science*, *20*, 163–165.

Dixon, M. J., Helsel, W. J., Rojahn, J., Cipollone, R., & Lubetsky, M. J. (1989). Aversive conditioning of visual screening with aromatic ammonia for treating aggressive and disruptive behavior in a developmentally disabled child. *Behavior Modification*, *13*, 91–107.

Dorsey, M. F., Iwata, B. A., Ong, P., & McSween, T. E. (1980). Treatment of self-injurious behavior using a water mist: Initial response suppression and generalization. *Journal of Applied Behavior Analysis*, *13*, 343–353.

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, *25*, 491–498.

Hagopian, L. P., & Adelinis, J. D. (2001). Response blocking with and without redirection for the treatment of pica. *Journal of Applied Behavior Analysis*, *34*, 527–530.

Hagopian, L. P., Fisher, W., Sullivan, M. T., Acquisto, J., & LeBlanc, L. A. (1998). Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis*, *31*, 211–235.

Hake, D. F., & Azrin, N. H. (1965). Conditioned punishment. *Journal of the Experimental Analysis of Behavior*, *8*, 279–293.

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)

Lerman, D. C., Iwata, B. A., Shore, B. A., & DeLeon, I. G. (1997). Effects of intermittent punishment on self-injurious behavior: An evaluation of schedule thinning. *Journal of Applied Behavior Analysis*, *30*, 187–201.

Lerman, D. C., & Vorndran, C. M. (2002). On the status of knowledge for using punishment: Implications for treating behavior disorders. *Journal of Applied Behavior Analysis*, *35*, 431–464.

Lovaas, O. I., & Simmons, J. Q. (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behavior Analysis*, *2*, 143–157.

Mowrer, O. H., & Solomon, L. N. (1954). Contiguity vs. drive reduction in conditioned fear: The proximity and abruptness of drive-reduction. *American Journal of Psychology*, *67*, 15–25.

Orme-Johnson, D. W., & Yarczower, M. (1974). Conditioned suppression. *Journal of the Experimental Analysis of Behavior*, *21*, 57–74.

Piazza, C. C., Fisher, W. W., Hanley, G. P., LeBlanc, L. A., Worsdell, A. S., Lindauer, S. E., et al. (1998). Treatment of pica through multiple analyses of its reinforcing functions. *Journal of Applied Behavior Analysis*, *31*, 165–189.

Richman, D. M., Lindauer, S. E., Crosland, K. A., McKerchar, T. L., & Morse, P. S. (2001). Functional anlsysis and treatment of breath holding maintained by nonsocial reinforcement. *Journal of Applied Behavior Analysis*, *34*, 531–534.

Salvy, S.-J., Mulick, J. A., Butter, E., Bartlett, R. K., & Linscheid, T. R. (2004). Contingent electric shock (SIBIS) and a conditioned punisher eliminate severe head banging in a preschool child. *Behavioral Interventions*, *19*, 59–72.

Thompson, R. H., Iwata, B. A., Conners, J., & Roscoe, E. M. (1999). Effects of reinforcement for alternative behavior during punishment of self-injury. *Journal of Applied Behavior Analysis*, *32*, 317–328.

Vollmer, T. R. (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. *Journal of Applied Behavior Analysis*, *15*, 187–207.

Vollmer, T. R., & Iwata, B. A. (1993). Implications of a functional analysis technology for the use of restrictive behavioral interventions. *Child and Adolescent Mental Health Care*, *3*, 95–113.

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

Wacker, D. P., Steege, M. W., Northup, J., Sasso, G., Berg, W., Reimers, T., et al. (1990). A component analysis of functional communication training across three topographies of severe behavior problems. *Journal of Applied Behavior Analysis*, *23*, 417–429.

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