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Clarifying Inconclusive Functional Analysis Results: Assessment and Treatment of Automatically Reinforced Aggression

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Abstract

We conducted a series of studies in which multiple strategies were used to clarify the inconclusive results of one boy's functional analysis of aggression. Specifically, we (a) evaluated individual response topographies to determine the composition of aggregated response rates, (b) conducted a separate functional analysis of aggression after high rates of disruption masked the consequences maintaining aggression during the initial functional analysis, (c) modified the experimental design used during the functional analysis of aggression to improve discrimination and decrease interaction effects between conditions, and (d) evaluated a treatment matched to the reinforcer hypothesized to maintain aggression. An effective yet practical intervention for aggression was developed based on the results of these analyses and from data collected during the matched-treatment evaluation.

Keywords

aggression; automatic reinforcement; competing stimuli; functional analysis; sensory extinction

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The functional analysis (FA) methodology described by Iwata, Dorsey, Slifer, Bauman, and Richman (1994) results in the identification of the consequences maintaining aberrant behavior in 94% of published cases (Beavers, Iwata, & Lerman, 2013). Occasionally, an initial FA does not lead to differentiated results. When this occurs, modifications to the FA can be categorized as an antecedent manipulation, consequent manipulation, design manipulation, or a combination of these (cf. Hagopian, Rooker, Jessel, & DeLeon, 2013). Researchers have successfully identified the consequences maintaining aberrant behavior when initial FA results were inconclusive by (a) evaluating within-session response patterns (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993), (b) modifying the experimental design of the FA (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994; Vollmer, Iwata, Duncan, & Lerman, 1993; Vollmer, Marcus, Ringdahl, & Roane, 1995), (c) conducting separate FAs for each topography of aberrant behavior (Asmus, Franzese, Conroy, & Dozier, 2003), (d) refining the test conditions of the FA (Bowman, Fisher, Thompson, & Piazza, 1997; Call, Wacker, Ringdahl, & Boelter, 2005; Conners et al., 2000; Fisher, Piazza, & Chiang, 1996; Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998; Hagopian, Wilson, & Wilder,

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2001; Richman & Hagopian, 1999; Tarbox, Wallace, Tarbox, Landaburu, & Williams, 2004; Tiger, Hanley, & Bessette, 2006), and (e) implementing an effective function-based treatment (Carter, 2009; Kuhn, DeLeon, Fisher, & Wilke, 1999; Lalli, Livezey, & Kates, 1996; Thompson, Fisher, Piazza, & Kuhn, 1998).

Vollmer, Iwata, Zarcone, et al., (1993) found within-session rates of responding to be suggestive of the consequences maintaining aberrant behavior when data from the first six to eight sessions of an FA were graphed as response rates within consecutive 1-min bins. These data were then compared to the aggregate rates of aberrant behavior observed across sessions of a multielement FA. The authors suggested that within-session response patterns potentially clarified the results of an undifferentiated FA for one individual (Sharon) who had visual impairments; however, see Vollmer, Iwata, Zarcone, et al. for alternate interpretations.

Another approach to clarifying inconclusive FA results is to evaluate responding under test and control conditions using a different experimental design (Iwata, Duncan, et al., 1994; Vollmer, Iwata, Duncan, et al., 1993; Vollmer et al., 1995). Despite the advantages of using a multielement design to demonstrate experimental control over aberrant behavior (e.g., efficiency and the presence of a continuous control condition), the contingencies arranged may fail to evoke discriminated responding within the conditions of the FA. Individuals may also engage in responding that persists during subsequent sessions, yielding interaction effects between FA conditions. When discrimination failure or interaction effects are suspected to contribute to undifferentiated responding, more conclusive FA results can be produced with reversal (Vollmer, Iwata, Duncan, et al., 1993) or pairwise (Iwata, Duncan, et al., 1994) designs. Additionally, Vollmer et al. (1995) as well as Querim et al. (2013) demonstrated that conducting consecutive ignore sessions can suggest whether aberrant behavior is maintained by automatic sources of reinforcement.

Individuals who engage in aberrant behavior often exhibit multiple topographies of aberrant behavior, and behavior analysts are commonly charged with the task of treating each response form. For such individuals, behavior analysts increasingly arrange FA conditions such that all topographies of aberrant behavior are assessed simultaneously (Beavers et al., 2013). However, Beavers et al. noted that doing so may increase the likelihood of finding aberrant behavior to be multiply controlled when each response is in fact maintained by a distinct reinforcer. Asmus et al. (2003) demonstrated that although an initial FA of multiple-response topographies resulted in the identification of only one function (automatic reinforcement), subsequent FAs of each response topography yielded separate functions of each response. Other researchers have noted that this problem is particularly likely if multiple topographies of aberrant behavior are collapsed and presented as a single aggregated measure of response rate (Derby et al., 1994). To prevent both problems (i.e., the false-positive identification of multiple control and the false-positive identification of a single function), Derby et al. showed the importance of graphing each response separately, and Asmus et al. demonstrated the benefit of conducting separate FAs of each response.

The conditions included within an FA can also be modified to better identify the consequences maintaining aberrant behavior. Behavior analysts have identified a number of ways in which this can be done, and examples include (a) strengthening the establishing operation (EO) for aberrant behavior (Call et al., 2005; Smith, Iwata, Goh, Shore, 1995; Tarbox et al., 2004; Wallace & Iwata, 1999), (b) adding arbitrary or idiosyncratic discriminative stimuli (Conners et al., 2000; Tiger et al., 2006), (c) modifying the parameters of reinforcement (Fisher et al., 1996; Richman & Hagopian, 1999), and (d) testing for idiosyncratic functions of aberrant behavior (Bowman et al., 1997; Fisher et al., 1998; Hagopian et al., 2001).

When the aforementioned procedures are infeasible or unsuccessful in clarifying the results of an inconclusive FA, some researchers have found success by implementing treatments matched to the putative reinforcer maintaining aberrant behavior (Carter, 2009; Kuhn et al., 1999; Lalli et al., 1996; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Thompson et al., 1998). An effective treatment that addresses the function of aberrant behavior can serve to corroborate the presence of the function targeted (Carter, 2009; Kuhn et al., 1999; Lalli et al., 1996). For example, if aberrant behavior decreases when attention is delivered according to a time-based schedule but not when attention is provided following aberrant behavior, aberrant behavior is likely maintained by attention.

Thompson et al. (1998) combined several approaches to clarify the inconclusive results of one boy's FA of aggression. The boy (Ernie) engaged in a specific topography of aggression (chin grinding on others) that occurred regardless of the type of condition conducted during the initial FA; however, other forms of aggression were more likely to be observed during the attention condition. The experimenters conducted a second FA in which attention was provided (a) according to a time-based schedule, (b) contingent on all topographies of aggression (including chin grinding), or (c) following all topographies of aggression other than chin grinding. From these data, separate consequences appeared to maintain chin grinding (automatic reinforcement) from other forms of aggression (attention).

More recently, Ringdahl, Call, Mews, Boelter, and Christensen (2008) attempted to clarify initially inconclusive FA results for two individuals by conducting a series of consecutive ignore sessions for one individual and by implementing a pairwise design (similar to Iwata, Duncan, et al., 1994) for the other individual. These modifications helped clarify the maintaining consequences of aberrant behavior for one of the two individuals. For one individual (Jeff), whose function of pinching was not identified, a low-effort (i.e., the therapist remained in close proximity to Jeff) and response-cost procedure (i.e., the loss of ongoing activities) were combined to decrease the rate of aggression. For this individual, manipulations of response effort and the use of a punishment procedure were required to treat aggression when automatic reinforcement was not ruled out as a maintaining consequence for pinching.

The purpose of the current study was to extend the literature on clarifying the results of an inconclusive FA when one boy's aggression appeared to be maintained by automatic reinforcement. In Study 1, we conducted an FA of aggression and disruptive behavior. In study 2, we then modified the FA conditions such that only aggression was targeted (Asmus et al., 2003). In Study 3, we implemented a treatment matched to the putative reinforcer of aggression to provide further evidence that aggression was maintained by automatic reinforcement. Finally, in Study 4 we evaluated a more practical treatment for aggression maintained by automatic reinforcement using stimuli selected from a competing-stimulus assessment (Piazza et al., 1998).

General Method

Participant and Setting

Isaac was a 5-year-old boy admitted to a severe behavior disorders program who was diagnosed with autism spectrum disorder, disruptive behavior disorder, and pica including coprophagia. He was ambulatory, non-verbal, and required assistance for all self-help tasks. Over the course of assessment and treatment, Isaac was taking 1.0 mg of guanfacine (Tenex) for hyperactivity and 0.1 mg of clonidine (Catapres) as a sleep aid. Isaac engaged in aggression and disruptive behavior in addition to pica. Isaac's caregivers were primarily concerned with treating Isaac's aggressive behavior, particularly his scratching and pinching others.

During Studies 1 and 2, sessions were conducted in an empty 2.5-m by 2.5-m therapy room. The room contained a one-way mirror that allowed trained observers positioned behind the mirror to collect data. During Studies 3 and 4, sessions were conducted in a 2.5-m by 1.5-m enclosure. The enclosure was centered in a larger therapy room that was 6 m by 6 m. Data collectors stood outside the enclosure (in the larger room) and were able to observe Isaac and the therapist inside the enclosure by looking over the enclosure wall that was approximately 1-m tall. Sessions were conducted in this smaller enclosure because Isaac would frequently engage in disruptive behavior (e.g., running into and knocking down objects) in larger rooms. This enclosure also allowed the therapist to remain within arm's distance of Isaac, presumably decreasing the response effort to engage in aggression (Ringdahl et al., 2008). Isaac was unable to leave the enclosure without the therapist's assistance. Across settings (i.e., the therapy room and the enclosure), only the materials necessary to conduct sessions were present.

Response Definitions and Measurement

Sessions were 5 min, and data were collected on the frequency of aggression, frequency of disruptive behavior, and the duration of item interaction. Isaac engaged in four topographies of aggression that were categorized as either primary or secondary. This was done to better distinguish between the topographies of aggression that occurred at a considerably lower rate (secondary topographies) from those for which Isaac was specifically referred (primary topographies). Therefore, data on secondary topographies were collected only during the FA of aggression and disruption (Study 1).

Frequency data were collected on *aggression,* which included scratching (primary), pinching (primary), hitting (secondary), and kicking (secondary). During Study 1, data were also collected on *disruption*, which included throwing and hitting or kicking objects. Additionally, duration data were collected on *item interaction* with competing items and were reported as a percentage of session with item interaction during the treatment evaluation (Study 4).

Interobserver Agreement

Trained data collectors used laptop computers to record instances of aggression and disruptive behavior as well as the duration of item interaction. An independent second observer collected data simultaneously with the primary data collector. Sessions were divided into 10-s intervals, and an agreement was recorded for each interval in which both observers measured the same number of responses (or seconds of the response). We summed the number of agreement intervals and then divided the number of agreement intervals by the total number of intervals within the session. Each quotient was then converted to a percentage.

In Study 1, interobserver agreement (IOA) data were collected for 42.3% of sessions and averaged 99.1% (range, 93.3% to 100%) for aggression and 93.7% (range, 86.6% to 96.6%) for disruption. In Study 2, IOA data were collected for 73.9% of sessions and averaged 94.8% (range, 73.3% to 100%) for aggression. In Study 3, IOA data were collected for 82.9% of sessions and averaged 92.9% (range, 66.6% to 100%) for aggression. Also in Study 3, data were collected on response allocation toward different arms of the therapist's body. Mean IOA for aggression directed toward the left and right arms was 81.2% (range, 66.6% to 96.6%) and 81.7% (range, 63.3% to 96.6%), respectively. In Study 4, IOA data were collected for 69.4% of sessions and averaged 92.8% (range, 76.6% to 100%) for aggression and 98.9% (range, 93.3% to 100%) for item interaction.

Patient and Therapist Safety Precautions

Throughout the four studies, Isaac was permitted to engage in aggressive behavior toward therapists, often with no programmed consequences. As such, a number of safeguards were implemented to ensure his and the therapist's well being. First, only highly trained staff conducted Isaac's sessions, and all staff received training on assaultive procedures and protective techniques. Second, a supervising psychologist established session-termination criteria in the event that aggression resulted in tissue damage or increased physical risk to staff. No sessions were terminated as a result of these criteria. Third, following each session, both Isaac and the therapists were examined for injuries that may have occurred during session. Forth, therapists were entitled to decline participation in the assessment and treatment of Isaac's aggressive behavior at any point. Finally, all sessions were observed by a Board Certified Behavior Analyst® to ensure all procedures were implemented accurately and safely.

Study 1: Functional Analysis of Aggression and Disruption

Procedure

Using procedures similar to those described by Iwata, Dorsey, et al. (1994) with modifications (Fisher et al., 1996), an FA was conducted to test whether aberrant behavior was maintained by escape from instructions (e.g., gross motor instructions consisting of clapping hands and touching body parts), access to adult attention (e.g., statements of concern and physical interaction), or access to preferred tangible items (identified via a paired-choice stimulus preference assessment; Fisher et al., 1992). Rates of aggression and disruption during these conditions were compared to response rates during a control condition that was void of instructions and consisted of continuous attention as well as access to preferred items. To aid in discrimination between conditions, the therapists wore uniquely colored shirts that were associated with each condition (e.g., a purple shirt during the toy-play condition and a red shirt during the escape condition).

Attention—During the attention condition, the therapist interacted with Isaac for 1 min prior to the session and then informed him that he or she "had to work." The therapist moved across the room and ignored Isaac. Contingent on the occurrence of aggressive or disruptive behavior, the therapist moved toward Isaac and provided gentle physical comfort in the form of patting Isaac on the back while delivering statements of concern (e.g., "Don't do that, you'll hurt yourself!"). Following 20 s of interaction, the therapist reinstated the antecedent conditions (i.e., began to ignore Isaac). During these sessions, Isaac had access to moderately preferred tangible items.

Escape—During the escape condition, the therapist continuously instructed Isaac to complete simple gross-motor instructions (e.g., clap your hands, stand up, touch your toes). The therapist used a three-step prompting procedure (instruction, model, and physical guidance) to ensure Isaac completed each task. Contingent on instances of aggression or disruption, the therapist turned away from Isaac and allowed a 20-s break from instructions. The therapist then began delivering instructions while ignoring all other behavior.

Tangible—During the tangible condition, the therapist allowed 1-min access to Isaac's highly preferred item (a toy tambourine) prior to each session. The therapist then said "my turn" and engaged with the toy while withholding it from Isaac. Contingent on aggression or disruption, the therapist returned the toy to Isaac and allowed him to interact with it for 20 s. The therapist then removed and withheld the toy.

Toy-play—During the toy-play condition, the therapist delivered continuous attention in the form of praise statements (e.g., "I like the way you're playing with those toys!") and provided continuous access to Isaac's two most highly preferred toys (a toy tambourine and a toy guitar). The therapist did not deliver instructions and ignored all behavior including aggression and disruption.

Results

Results of Isaac's FA of aggression and disruption are displayed in Figure 1. Aggregated aggression and disruption data (top panel) indicated moderate-to-high levels of aberrant behavior in all conditions except for the toy-play condition, in which relatively low levels of responding were observed. Similar to Derby et al. (1994), we graphed individual topographies for each targeted response to determine the composition of the aggregated data and to help identify the consequences maintaining each response. Disruptive behavior (middle panel) occurred at higher rates across all test conditions ($M = 0.92$ responses per min in attention; range, 0.6 to 1.2; $M = 0.68$ responses per min in escape; range, 0.2 to 1.6; $M = 1.3$ responses per min in tangible; range, 0.2 to 3.0) relative to rates of disruption during the control condition ($M = 0.12$ responses per min in toy-play; range, 0.0 to 0.6). Therefore, we concluded that Isaac's disruption was either multiply controlled or was maintained by automatic sources of reinforcement. Rather than clarifying the maintaining contingencies of Isaac's disruption, we chose to focus our efforts on identifying the function of Isaac's aggression (the caregiver's primary concern). However, results obtained for aggressive behavior (bottom panel) revealed no clear function, with low-to-zero rates of aggression occurring across conditions.

Low rates of aggression during Isaac's FA of aggression and disruption may have occurred for at least three reasons. First, Asmus et al. (2003) noted that when a single topography of aberrant behavior contacts reinforcement often during an FA (yielding a high response rate), the behavior analyst's ability to identify the function of a second, lower-rate topography of aberrant behavior is compromised. As such, a second FA in which contingencies are programmed only for the lower-rate response may be necessary to identify the function of the second response (Asmus et al., 2003). Second, aggression followed disruptive behavior in a response-class hierarchy such that reinforcement obtained from engaging in disruptive behavior (a potentially lower-effort response) precluded observation of aggression (a potentially more effortful response because the therapist was not in close proximity; Richman, Wacker, Asmus, Casey, & Andelman, 1999). A third possibility was that the experimental design failed to evoke discriminated responding across test conditions. As suggested by previous research, alternative experimental designs may be necessary to mitigate possible discrimination failures or interaction effects (Iwata, Duncan, et al., 1994; Vollmer, Iwata, Duncan et al., 1993; Vollmer et al., 1995). Therefore, we conducted an FA of aggression using an alternative experimental design to address these concerns and to identify the environmental consequences maintaining aggressive behavior.

Study 2: Functional Analysis of Aggression

Procedure

An FA of aggression was conducted that tested whether Isaac's aggression was maintained by social escape, social attention, or automatic reinforcement. The therapist remained in close proximity to Isaac (i.e., within 0.25 m) throughout each condition to decrease the effort associated with engaging in aggression and to increase the likelihood that aggression would be observed at higher response rates than those observed in Study 1. Across conditions, the therapist followed Isaac around the room as he moved to maintain close proximity to Isaac. As in Study 1, the therapists wore uniquely colored shirts that were associated with each condition.

Escape—Because Isaac was observed to engage in aggression when therapists and caregivers were in close proximity, we hypothesized that aggression was potentially maintained by negative reinforcement in the form of escape from others. This condition varied somewhat from the escape condition used during Study 1. Contingent on aggression, the therapist left the therapy room for 20 s. All other responses were ignored. The time in which the therapist was outside of the therapy room was removed from the total-session duration so as to not deflate the rate of aggression, as it was impossible for Isaac to engage in aggression during this time. The therapist then re-entered the therapy room, moved close to Isaac, and reinstated the antecedent conditions (i.e., ignore).

Ignore—During the ignore condition, the therapist maintained close proximity to Isaac. All instances of aggression as well as all other responses were ignored. In an attempt to control for flinching, wincing, and shying away that commonly occurs in response to aggression, therapists were instructed to keep their bodies in a neutral, relaxed position and preserve a flat expression on their faces.

Continuous Attention—Similar to Thompson et al. (1998), we compared rates of aggression during a condition in which continuous attention was available to response rates observed when attention was delivered following aggression. During the continuous-attention condition, the therapist provided continuous verbal (e.g., praise, lullabies, songs) and physical (e.g., tickles, high fives) attention throughout the session. The therapist ignored all instances of aggression as well as other responses.

Attention—During the attention condition, the therapist did not interact with Isaac. Aggression during this condition produced the same type of verbal and physical interaction delivered during the continuous-attention condition and was delivered for 20 s. Following the delivery of attention, the therapist reinstated the antecedent conditions (i.e., ignore) until subsequent instances of aggression occurred. All other responses were ignored.

Following the attention vs. continuous-attention comparison phase, we were concerned about the possibility of interaction effects between attention and continuous-attention conditions. Therefore, we conducted a phase of consecutive continuous-attention sessions to determine whether aggression would persist in the presence of noncontingent attention.

Results

Results of the FA of aggression are displayed in Figure 2. During the test for aggression maintained by social escape, Isaac engaged in decreasing levels of aggression (M = 0.9 responses per min; range, 0.2 to 2.5). These results suggest that when therapist removal was made contingent on aggression, Isaac engaged in fewer responses; this is contradictory to the social escape hypothesis. During the ignore condition, Isaac engaged in moderate and relatively consistent levels of aggression (*M* = 2.7 responses per min; range 0.8 to 4.8). When no programmed differential consequences were provided for aggression, Isaac continued to aggress toward the therapist. During the subsequent phase, we compared a condition in which aggression produced therapist attention (*M* = 2.2 responses per min; range, 0.6 to 4.6) to a condition in which attention was provided continuously and independently of behavior (*M* = 2.4 responses per min; range 1.6 to 3.4). In both conditions, Isaac engaged in moderate and consistent levels of aggression. When Isaac was exposed to a series of continuous-attention sessions during the final phase, Isaac continued to engage in aggression at levels similar to those observed during previous phases (*M* = 2.2 responses per min; range, 1.2 to 5.0).

These results suggest that the delivery of continuous social interaction may have occasioned aggression, attention functioned as a reinforcer, and contingent therapist removal may have functioned as a punisher. Alternatively, because Isaac engaged in aggression that persisted across conditions of the FA of aggression and responding maintained when consecutive continuous-attention sessions were conducted, these results also suggest that Isaac's aggression was maintained by automatic sources of reinforcement. Given the extremely low prevalence of aggression maintained by automatic reinforcement (Beavers et al., 2013), we conducted an additional evaluation in which we investigated the results of a treatment matched to the reinforcer believed to maintain Isaac's aggression.

Study 3: Further Evaluation of Automatic Reinforcement Function with Sensory Extinction

Procedure

The purpose of the sensory-extinction assessment was to confirm results obtained from Study 2, which indicated Isaac's aggression was maintained by automatic reinforcement contingencies. We evaluated an extinction procedure that would be effective if and only if Isaac's aggression was maintained by automatic reinforcement. That is, we hypothesized that his aggression was automatically reinforced by the sensory consequences he experienced when scratching or pinching another person's bare (or exposed) skin. Thus, our sensory-extinction procedure involved covering the therapist's skin with thick clothing material that blocked the hypothesized sensory consequences. It remained possible, however, that Isaac targeted bare skin because individuals flinched or winced when aggression resulted in tissue damage or pain (i.e., when aggression procedured a subtle reaction). Therefore, we minimized the possibility of subtle therapist reactions to Isaac's aggression by providing continuous attention across all sessions in Study 3. There were no programmed consequences for aggression.

During the final two conditions of Study 3, we provided differential access to select areas of the therapist's exposed skin. The purpose of these conditions was to determine whether Isaac's aggression would be sensitive to the change in where automatic reinforcement was available (i.e., on exposed skin and not on covered areas). These conditions were added to provide evidence that Isaac's aggression was maintained by automatic reinforcement, as the presumed sensory consequences afforded by engaging in pinching and scratching could be obtained only by aggressing toward the exposed parts of the therapist's body.

Exposed—During the exposed condition, therapists wore shirts that revealed the skin on their arms, neck, and hands (identical to how therapists were dressed in Studies 1 and 2). These areas of skin were selected for exposure because Isaac often aggressed toward these locations. Therapists also wore pants that were rolled up to the knee to expose the lower half of their legs.

Covered—During the covered, or sensory-extinction phase, the therapist rolled down their pants and tucked the pant legs into their socks. Therapists also wore a ski mask over their head that covered all parts of their face and neck expect for small eyeholes. A long-sleeve hooded sweater was zipped up and worn over the scrub tops. The sleeves of the sweater were tucked into cotton gloves that therapists wore on their hands. All parts of the therapist's skin were covered except for the small areas around the therapist's eyes.

Left Exposed and Right Exposed—The left-exposed condition was identical to the covered condition, except the therapist removed the left glove and rolled up the left sleeve of the sweater to their shoulder. Therefore, the only exposed part of the therapist was the therapist's left arm. During this condition, data collection on aggression was modified to determine the specific location on the therapist (i.e., exposed or covered) to which Isaac aggressed. When the therapist's left arm was exposed, aggression toward the left arm was recorded as such, and aggression toward all other body parts (including aggression toward the right arm) was recorded as aggression toward the therapist's covered body parts. This was done to ensure that all instances of Isaac's aggression were recorded. The right-exposed condition was identical to the left-exposed condition, except the right arm was exposed.

Results

The results of the sensory-extinction assessment are displayed in Figure 3. When all parts of the therapist's body were exposed (i.e., skin available), Isaac engaged in moderate levels of aggression (M = 2.1 responses per min; range, 1.0 to 3.8) consistent with the results obtained from the continuous-attention condition in Study 2. Subsequently, levels of aggression decreased (M = 0.5 responses per min, range; 0.0 to 1.2) when the therapist implemented sensory extinction. When the therapist's skin was again made available during the subsequent exposed condition, Isaac engaged in higher levels of aggression than those observed during the first phase (M = 4.0 responses per min; range, 2.8 to 5.8). Levels of aggression again decreased (M = 0.5 responses per min; range, 0 to 1.6) during the second implementation of sensory extinction.

Results of the response-allocation analysis produced results consistent with the hypothesis that the sensory consequences provided by pinching and scratching the skin of other individuals were maintaining Isaac's aggressive behavior. During the first phase, Isaac aggressed primarily toward the exposed left arm (M = 3.0 responses per min; range, 2.8 to 3.6) and rarely toward the covered parts of the therapist's body (M = 0.3 responses per min; range, 0.2 to 0.4). During the subsequent phase, Isaac engaged in aggression primarily toward the exposed right arm (M = 3.8 responses per min; range, 1.4 to 5.0) and seldom toward the covered parts of the therapist's body (M = 0.4 responses per min; range, 0.2 to 0.6). These results were replicated in the final two phases.

Rapid differentiation between covered and exposed conditions may have occurred because Isaac had been previously exposed to contexts resembling the sensory-extinction condition prior to the experimental arrangement. In fact, Isaac's caregivers reported that he frequently aggressed toward their legs when they wore shorts but rarely when they wore pants. Despite the effectiveness of sensory extinction, it was infeasible for Isaac's caregivers to implement. Isaac could have worn gloves to block the sensory properties afforded by pinching and scratching, but we were concerned that gloves would reduce Isaac's dexterity and his ability to manipulate objects in the natural environment. Additionally, Isaac was often observed to remove other types of clothing (e.g., shoes and socks) throughout Studies 1 through 3. Therefore, we evaluated the ability of other stimuli to compete with aggression.

Study 4: Treatment of Aggression Maintained by Automatic Reinforcement

Procedure

A competing-stimulus assessment (Piazza et al., 1998) was conducted to identify stimuli that were associated with lower levels of aggression even when aggression produced reinforcement (i.e., while pinching and scratching were permitted). Thirteen items were evaluated, and three items that were associated with the lowest rates of aggression and high levels of item interaction were included in the treatment evaluation. The stimuli selected consisted of materials presumed to match the sensory properties of the targeted response (e.g., a rubber ball that was easily stretched and manipulated with fingers) and stimuli dissimilar to the putative reinforcer (e.g., a toy drum). In all sessions, therapists were clothing identical to that in Studies 1 and 2.

Ignore—The ignore condition was identical to the ignore condition described in Study 2.

Competing Items—During the competing-items phase, the three identified stimuli were freely available. The therapist did not prompt or assist Isaac in engaging with the items. During the second implementation of the competing-items condition, it was observed that although Isaac engaged with the competing items at high levels, he also engaged in aggression that was above a clinically acceptable level. Therefore, a response-cost contingency was implemented to supplement the competing-items treatment.

Competing Items with Response Cost—This phase was identical to the competing-items condition, except that a response-cost contingency was in place for aggression. Contingent on aggression, the therapist removed all competing items (regardless of item interaction) and moved away from Isaac for 20 s or until Isaac approached the therapist. Therefore, the duration of response cost could have been less than 20 s. Response cost was implemented in this manner to minimize exposure to the EO for aggression while evaluating the effectiveness of the punishment procedure. All competing items were re-presented following response cost. Item-interaction data were adjusted to remove times in which response cost was implemented.

Results

Figure 4 shows the effects of competing items as well as competing items with response cost on Isaac's aggression. Across both ignore baseline phases, Isaac engaged in moderate to high levels of aggression ($M = 3.4$ responses per min; range, 0.0 to 6.6). During the introduction of the competing items, aggression decreased to zero levels and item interaction was high ($M = 97.8\%$; range, 97% to 99%). Aggression remained relatively low ($M = 0.7$ responses per min, range, 0.0 to 2.4) and item interaction remained high ($M = 94.1\%$; range, 70% to 99%) during the second evaluation of the competing items. However, aggression was above a clinically significant level (i.e., above a 90% reduction from baseline). The inability to replicate the initially low levels of aggression observed in the competing-items condition poses one limitation during the treatment analysis. When response cost was added to treatment, levels of aggression decreased to near zero ($M = 0.1$ responses per min; range, 0.0 to 0.4), and item interaction remained high ($M = 95.3\%$; range, 88% to 100%). Response cost was then removed, and levels of aggression increased (*M* = 0.9 responses per min in the final 3 sessions; range, 0.2 to 2.2) even though Isaac engaged with the competing items at high levels (*M* = 96% in the final 3 sessions; range, 90% to 99%). Competing items with response cost was evaluated over a large number of sessions during the last phase. Aggression decreased to near-zero levels (*M* = 0.1 responses per min; range, 0.0 to 0.8), and high levels of item interaction were observed (*M* = 94.6%; range, 42.6% to 100%). Although response cost was a necessary component of Isaac's treatment plan, response cost was implemented in fewer than half of the sessions in which it was programmed, and response cost was implemented only once in the final seven sessions.

Discussion

The current series of studies adds to the behavior-analytic literature on the assessment and treatment of aberrant behavior by demonstrating the benefit of combining various approaches to clarify the results of an inconclusive FA. Specifically, we (a) graphed separate topographies of responding (Derby et al., 1994), (b) conducted a separate FA of aggression after high rates of disruption masked the function of aggression during an initial FA (Asmus et al., 2003), (c) modified the experimental design and procedures (positioning of the therapist) used during the FA of aggression to improve discrimination and decrease interaction effects between conditions (Iwata, Duncan, et al., 1994; Vollmer et al., 1995), and (d) evaluated two treatments matched to the reinforcer believed to maintain aggression (Carter, 2009; Iwata, Pace, et al., 1994; Kuhn et al., 1999; Lalli et al., 1996; Thompson et al., 1998).

In a recent review of the FA literature, Beavers et al. (2013) found aggression to be the second most common topography of aberrant behavior exposed to an FA, with aggression targeted in approximately 43% of published cases. The authors also found that aggression is often maintained by social negative (41 of 95 total cases or 43.2%) or social positive (37 cases or 38.9%) reinforcement, followed by multiple sources (15 cases or 15.8%) of reinforcement. Somewhat unsurprisingly, the authors found a disproportionately lower percentage of cases (2 cases or 2.1%) in which aggression was maintained by automatic reinforcement. Automatically reinforced aggression is also far less common when compared to the prevalence of all automatically reinforced aberrant behavior (16.3% overall). Therefore, our study also adds to the behavior-analytic research on the assessment and treatment of aggression in that our results are one of only three reported cases (the other two of which are reported by Ringdahl et al., 2008 and Thompson et al., 1998) in which aggression was maintained by automatic reinforcement.

The specific reinforcer of automatically reinforced aberrant behavior is often difficult to identify, as the reinforcer responsible for behavioral maintenance is inseparably tied to the response (Vaughan & Michael, 1982) and is therefore available continuously (throughout all FA conditions). Treatment development under these conditions may be difficult because the specific reinforcer is often unknown or cannot be directly manipulated (Piazza, Hanley, & Fisher, 1996; Rapp & Vollmer, 2005). One limitation of the current set of studies is that although we concluded that Isaac's pinching and scratching were maintained by automatic reinforcement, we did not identify the precise source of reinforcement maintaining his aggression. However, results from Study 3 suggest Isaac's pinching and scratching were likely due to tactile feedback.

Several studies have used protective equipment during FAs to identify the presence or absence of automatic reinforcement functions of aberrant behavior by blocking the sensory properties of responding during sessions in which protective equipment was worn (Borrero, Vollmer, Wright, Lerman, & Kelley, 2002; Le & Smith, 2002; Moore, Fisher, & Pennington, 2004). Rates of aberrant behavior were then compared to those in similar FA conditions in which protective equipment was discontinued. Therefore, an alternative approach to assessing the function of Isaac's aggression would have been to conduct FA conditions with and without similar protective equipment (e.g., gloves). Furthermore, it is possible that protective equipment as used in Study 3 may have functioned to reduce behavior through mechanisms other than sensory extinction. For example, equipment can serve as timeout from sensory stimulation thus reducing behavior via a punishment contingency (Mazaleski, Iwata, Rodgers, Vollmer, & Zarcone, 1994). However, it should be noted that this effect has been demonstrated when protective equipment was applied to participants rather than therapists, as was done in the current investigation.

A number of cautionary points are worth discussing with respect to the treatment analysis (Study 4) where response cost included the loss of access to competing items as well as removal of the therapist from Isaac's immediate vicinity. First, it is likely that competing items reduced aggression because they provided reinforcement that competed with the reinforcement obtained from engaging in aggression (presumably attenuating the EO for aggression). When the EO was reinstated by removing competing items, as was done in the response-cost condition, one may expect a subsequent increase in aggression. However, this was not observed with Isaac likely because the EO was minimized during the response-cost interval by immediately delivering competing items when Isaac approached the therapist. Furthermore, the removal of the therapist closely resembled the escape condition in Study 2, which also reduced aggression. Therefore, the decrease in aggression during the competing-items with response-cost condition may have been due to this alternative punishment contingency. From this standpoint, it is possible that aggression was maintained by additional controlling variables. However, therapists ignored aggression throughout all phases of Study 3, and higher rates of aggression were observed only when therapist's skin was exposed. This finding suggests that aggression was maintained only by automatic sources of reinforcement. Therefore, we conceptualized therapist removal as a punishment procedure that temporarily suspended Isaac's ability to contact the sensory consequences of pinching and scratching following instances of aggression.

One limitation of the current set of studies was our inability to completely prevent therapist flinching or wincing in response to Isaac's aggression. Although highly trained therapists implemented multiple strategies to minimize reactions to aggression, it remained possible that subtle changes in therapist behavior may have maintained Isaac's aggression. However, the combined results of the present set of analyses provide compelling evidence suggesting that Isaac's aggression was reinforced by automatic sources of stimulation. The current investigation provides a synthesis of some of the recommendations offered by Hagopian et al. (2013) and offers behavior analysts a framework from which behavioral function might be identified in future cases when initial FA results are inconclusive, leading to the development of effective, function-based treatments.

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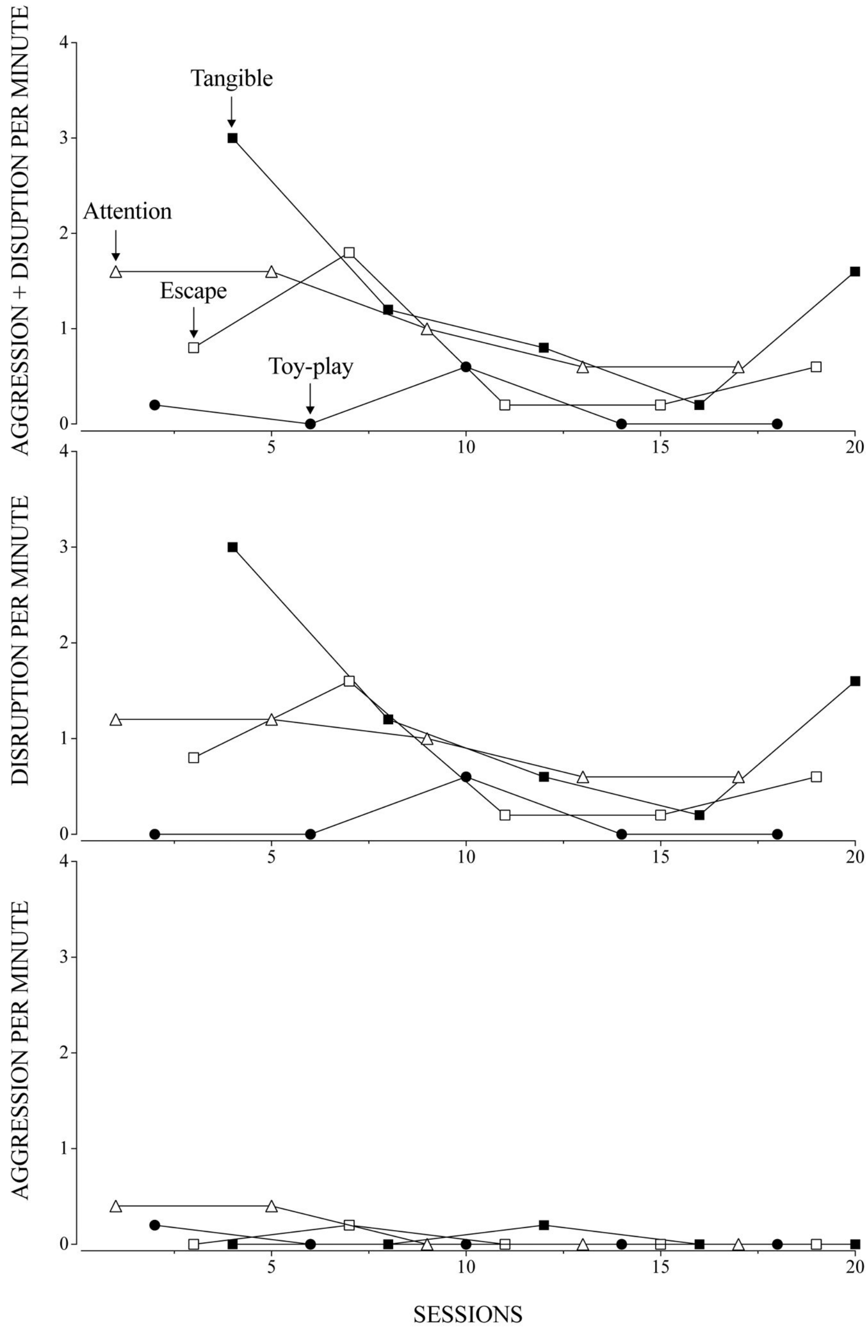

Figure 1.

Rate of aggression and disruption (top panel), rate of disruption alone (middle panel), and rate of aggression alone (bottom panel) during Isaac's functional analysis of aggression and disruption.

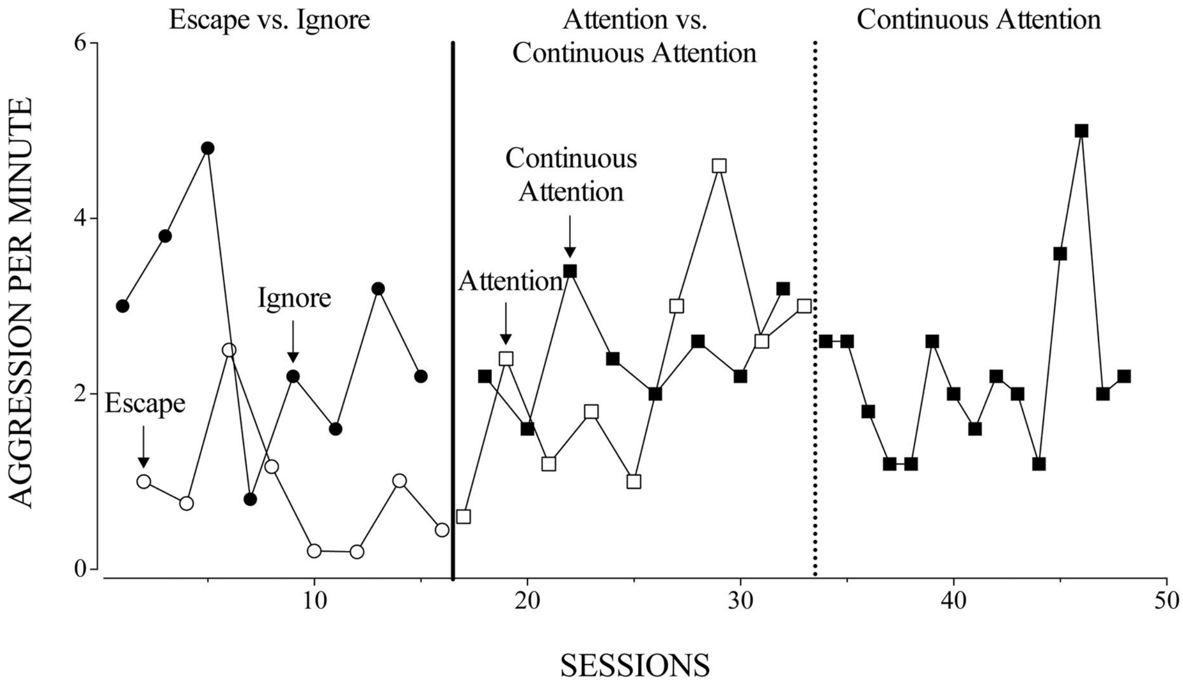

Figure 2.

Rate of aggression during the escape, ignore, attention, and continuous-attention conditions of Isaac's functional analysis of aggression.

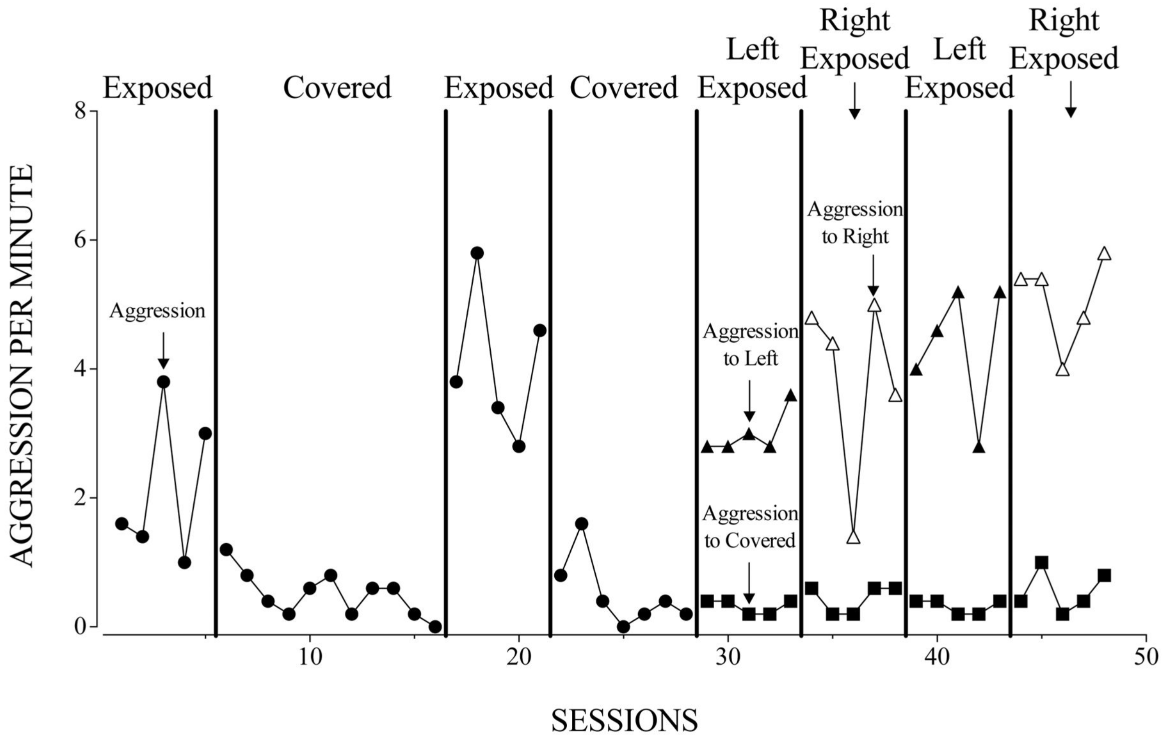

Figure 3.

Rate of aggression during the exposed, covered, left exposed, and right exposed conditions of Isaac's sensory-extinction evaluation. The final four phases depict aggression directed toward left, right, and covered areas of the therapist's body.

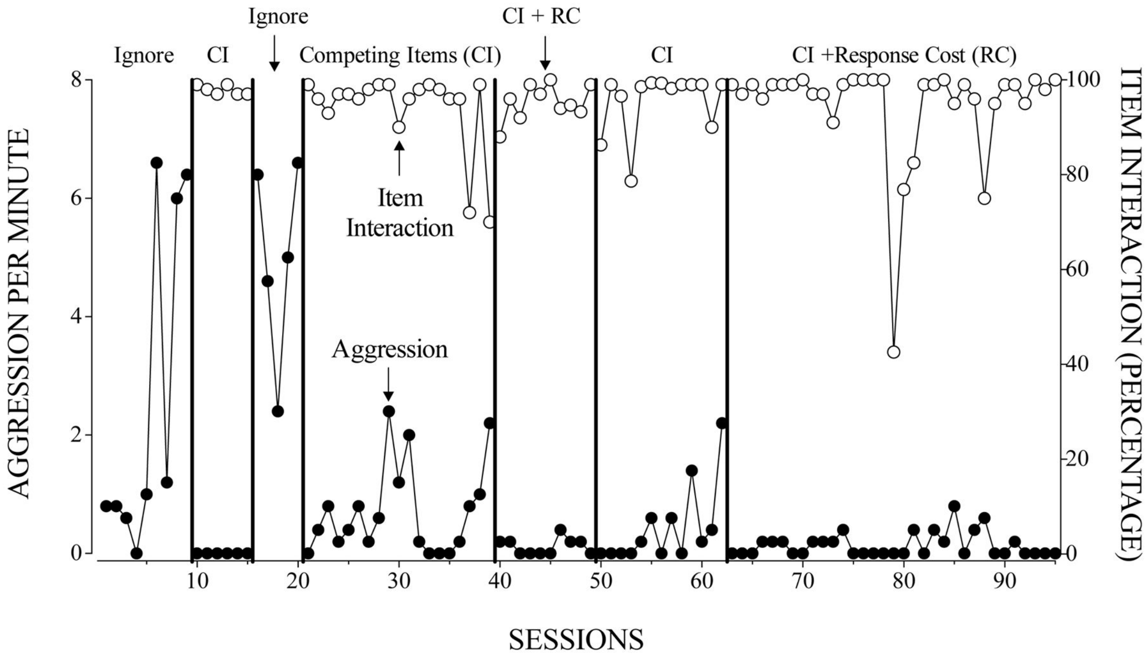

Figure 4.

Rate of aggression and percentage of item interaction during the ignore, competing items (CI), and competing items with response cost (CI + RC) conditions of Isaac's treatment evaluation.