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Progressing From Initially Ambiguous Functional Analyses: Three Case Examples

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Abstract

Most often functional analyses are initiated using a standard set of test conditions, similar to those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). These test conditions involve the careful manipulation of motivating operations, discriminative stimuli, and reinforcement contingencies to determine the events related to the occurrence and maintenance of problem behavior. Some individuals display problem behavior that is occasioned and reinforced by idiosyncratic or otherwise unique combinations of environmental antecedents and consequences of behavior, which are unlikely to be detected using these standard assessment conditions. For these individuals, modifications to the standard test conditions or the inclusion of novel test conditions may result in clearer assessment outcomes. The current study provides three case examples of individuals whose functional analyses were initially undifferentiated; however, modifications to the standard conditions resulted in the identification of behavioral functions and the implementation of effective function-based treatments.

Descriptors

aggression; autism; functional analysis; methodology; motivating operations; negative reinforcement; peer attention; siblings; social escape

Functional analysis is a robustly-researched and experimentally-rigorous behavioral assessment technique for identifying environmental variables that occasion and maintains problem behavior (Hanley, Iwata, & McCord, 2003). This assessment technique, first described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994), involves exposing consumers' problem behavior to potentially evocative environmental situations in which putative reinforcing events are withheld and delivered dependent upon problem behavior. Through direct observation and measurement of problem behavior during repeated exposure to these

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test conditions, individuals' levels of problem behavior during each test condition are compared to a control condition in which the same reinforcing events are provided independent of problem behavior (i.e., on fixed-time schedules). When elevated levels of problem behavior are observed in a given test condition (relative to the control condition), it indicates that the behavior is sensitive to the reinforcer delivered in that test condition.

Functional analyses are typically arranged to assess behavioral sensitivity to a number of sources of positive and negative reinforcement. The most common test conditions included in a functional analysis are (a) a test for behavioral sensitivity to social positive reinforcement in the form of attention in which a therapist withholds attention, except to deliver a mild reprimand each time the client engages in a targeted problem behavior, (b) a test for behavioral sensitivity to social negative reinforcement in the form of escape from demands in which a therapist provides continuous instruction to engage in tasks (typically academic or self-care) and provides a brief break from these demands following each instance of problem behavior, and (c) a test for behavioral sensitivity to automatic sources of reinforcement (either positive or negative) in which an individual is placed in an austere environment and no consequences are provided for problem behavior other than the direct sensory products of the behavior (e.g., the stimulation generated by contact of the hand to the head).

Reviews of functional analysis methodology have suggested that functional analyses result in a determination of behavioral function in about 94% of the cases in which they are applied (Hanley, Iwata, & McCord, 2003; Iwata, Pace, Dorsey et al., 1994). The remaining 6% of reported cases are commonly referred to as undifferentiated or ambiguous functional analysis results (i.e., analyses which did not result in a determination of behavioral function). There are at least 3 potential reasons why functional analyses may be undifferentiated. First it is possible that problem behavior for that individual is maintained by a source of reinforcement that was not included in the original functional analysis. Second, it is possible that the appropriate test condition was arranged, but that there was not a sufficient establishing operation in place to potentiate that source of reinforcement. Third, it is possible that although the correct reinforcement contingency was arranged, the behavior was under the stimulus control of some event not specifically programmed into the assessment setting.

There have been a number of studies in which reinforcers other than those typically included in a functional analysis have been shown to maintain problem behavior, such as access to toys, (Iwata et al., 1994), food (Vollmer, Borrero, Lalli, & Daniel, 1999), wheel chair movement (DeLeon, Kahng, Rodriguez-Catter, Sveinsdottir, & Saddler, 2003), and compliance with requests (Bowman, Fisher, Thompson, & Piazza, 1997) or termination of non-preferred events such as noise (McCord, Iwata, Galensky, Ellingson, & Thompson, 2001) or social interaction (Hagopian, Wilson, & Wilder, 2001; Vollmer et al. 1998). For example, Hagopian et al. conducted a functional analysis with a 6-year-old boy diagnosed with autism and mental retardation who was referred for the assessment and treatment of aggression, self-injurious behavior (SIB), and disruptive behavior. The initial results of a functional analysis of this problem behavior were undifferentiated, however the results became clear when the authors included additional test conditions including one to test for problem behavior's sensitivity to escape from attention as a reinforcer. That is, this test condition involved providing continuous social interaction and terminating this interaction for 30-s contingent upon each instance of problem behavior. An effective intervention was then implemented based upon the outcomes of this revised assessment.

Several studies have demonstrated the importance of arranging appropriate establishing conditions to occasion problem behavior as well. For instance, escape-maintained behavior may occur only in the presence of "Don't" requests as opposed to "Do" requests (Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998), in the presence of general instructions but

not in the presence of more specific instructions (Harding, Wacker, Cooper, Millard & Jensen-Kovalan, 1994), when provided instructions are novel but not when they are familiar, when instructions are provided rapidly, but not when they are provided at a slower pace, or when instructional sessions are lengthy, but not when they are short in duration (Smith, Iwata, Goh, & Shore, 1995).

Research has also shown that the presence of particular stimuli, such as toys or individuals, may also impact the extent to which functional analyses yield differentiated or undifferentiated outcomes. (e.g., Carr, Yarbrough, & Landgon, 1997; Flood, Wilder, Flood, & Masuda, 2002; McAdam, DiCesare, Murphy, & Marshall, 2004; Northup et al., 1995; Progar et al., 2001; Ringdahl & Sellers, 2000; Tiger, Hanley, & Bessette, 2006; Van Camp et al., 2000). For instance, the problem behavior of 3 children with developmental disabilities was shown to be sensitive to attention as positive reinforcement when caregivers conducted therapy sessions, but not when the staff of an outpatient clinic conducted sessions in Ringdahl and Sellers (2000).

Although some functional analyses may initially yield undifferentiated results, these outcomes suggest neither that the assessment process has failed nor that the contingencies controlling problem behavior cannot be understood. Rather, these assessments may simply be missing an important variable present in the novel environment. Studies that identify novel antecedent and consequent variables provide two distinct services to both the research and application of functional analysis methodology. First, they help identify possible sources of influence on problem behavior which are seemingly less common, and thus provide practitioners faced with initially undifferentiated functional analyses a guide by which to advance their assessments. Second, each idiosyncratic antecedent or consequent event requires the development of a novel test and control condition by which to evaluate their influence. Research along this line also provides a model of these modified assessment methodologies for each reported variable, providing guidance not only for what sources of influence for which to look, but also how they may be systematically evaluated.

The current study highlights this approach to progressing from initially ambiguous functional analysis by including novel test conditions with 3 individuals referred for the assessment and treatment of problem behavior. The novel test conditions incorporated an idiosyncratic motivating condition (Case I), reinforcement contingency (Case II), and the presence of a particular individual (Case III). Each of these cases progressed through three steps: an initial functional analysis, a modified functional analysis, and a function-based treatment evaluation.

Case I: Carl

Case General Method

Participant and Setting—Carl was a 10-year-old boy diagnosed with mental retardation, hydrocephalus, and an ocular cyst causing a mild level of visual impairment. He attended a residential state school for children with visual impairments. He was referred by the school director for the assessment and treatment of aggressive behavior, including hitting, kicking, and grabbing, and disruptive behavior, including crumbling, tearing, and throwing work or leisure materials, and overturning and banging hands on furniture. All sessions were conducted in an unused common room in the dormitory area of the residential program.

Measurement and Interobserver Agreement—The frequency of Carl's aggressive and disruptive behaviors was measured during each assessment using hand-held computers. Data were collected on each response separately, but are reported as aggregate response rates (i.e., the mean number of problem behaviors per min). Data were also collected on the number of instructions that were completed following a vocal or model prompt during the modified

functional analysis and treatment evaluation and on the frequency of an alternative communicative response (saying, “Help me, please”) during the treatment evaluation. Interobserver agreement (IOA) was assessed during 31% of sessions during the initial functional analysis, 36% of sessions during the modified functional analysis, and 50% of sessions during the treatment evaluation by having a second observer simultaneously, but independently, score the occurrence of target behaviors. Each observer’s records were portioned into 10-s intervals and were compared on an interval-by-interval basis. Intervals with exact agreement were given a score of 1. Proportional agreement coefficients were calculated for all other intervals by dividing the smaller number of responses by the larger number of responses. The scores for each interval were then summed, divided by the total number of intervals, and the resulting quotient was converted to a percentage. Mean agreement scores for disruptions were 99% (range, 95% to 100%) during the initial functional analysis, 98% (range, 87% to 100%) during the modified functional analysis, and 100% during the treatment evaluation. Mean agreement scores for aggression were 100% during all analyses. Mean agreement scores for compliance were 96.8% (range, 80% to 100%) during the modified functional analysis and 93.2% (range, 85% to 100%) during the treatment evaluation. The mean agreement score for the alternative communicative response was 96% (range, 85% to 100%; treatment evaluation only).

Initial Functional Analysis Method

Carl’s assessments began by conducting a functional analysis using the procedures described by Iwata et al. (1982/1994). Three test conditions (attention, escape, and ignore) were alternated with a control condition (toy play) in a random but counterbalanced order within a multi-element experimental design. Carl was provided with access to a moderately preferred item (identified by a paired-stimulus preference assessment; Fisher et al., 1992), and the therapist diverted their attention except when delivering a brief reprimand (e.g., “Don’t throw your toys, you could hurt somebody”) contingent upon each instance of problem behavior during *attention* sessions. Carl was instructed to complete academic tasks (e.g., completing single-digit by single-digit multiplication problems) using a three-step prompt hierarchy (vocal, model, and physical), and the therapist terminated instructions for a 30-s break, signaled by the vocal statement, “Okay, you don’t have to,” following each instance of problem behavior during *escape* sessions. All materials were removed from the room while a therapist sat or stood in close proximity to Carl, but did not attend to any of his behaviors during *ignore* sessions. Carl was provided access to a book, a car and a slinky (identified as highly preferred items by a stimulus preference assessment), and the therapist provided continuous interaction without delivering any instructions during *toy-play* sessions.

Initial Functional Analysis Results

The results of Carl’s initial functional analysis are shown in the top panel of Figure 1. Carl did not engage in problem behavior during ignore, attention, or toy-play sessions and engaged in problem behavior during only one escape session ($M = 0.5$). The low rates of problem behavior seen during the functional analysis differed from the high rate of problem behavior reported and observed in the classroom, particularly during instructional periods. One observed difference between classroom instruction and instruction provided during the escape condition was that the classroom teacher did not use a graduated-prompting procedure (i.e. there were no modeled or physical prompts). Rather, the teacher frequently repeated the initial vocal instruction multiple times. It was possible that repeated instructions (as were presented in the classroom) were necessary to establish the value of escape as a reinforcer, and that the assistance provided in the form of model and physical prompts during the functional analysis served to abolish the value of escape as a reinforcer. Therefore, we conducted a modified functional analysis to test this hypothesis.

Modified Functional Analysis Methods

Carl was instructed to complete single-digit by single-digit multiplication problems using a three-step prompting sequence (vocal, model, and physical) during *graduated-prompting* sessions. Specifically, an initial vocal instruction was provided (e.g., “Write the answer to three times two”), and following 5 s without a correct response, the therapist provided a model prompt (e.g., “Three times two equal six. Write three times two equals six like this. You do it.”). If Carl did not write the correct answer after another 5 s, he was physically guided to write the correct response while the therapist stated (“Write three times two equals six like this.”). Problem behavior during any part of this sequence resulted in a 30-s break from instruction and the removal of task materials. *Vocal-prompting-only* sessions were identical to graduated prompting sessions, except that model prompts and physical guidance were not provided if the problem was not answered correctly. Instead, the therapist repeated the vocal prompt (e.g., “Write the answer to three times two,”) every 5 s to equate the instruction frequency between the two conditions. Problem behavior continued to result in a 30-s break from instruction and the removal of tasks. Problem behavior rates during graduated-prompting sessions and vocal-prompting-only sessions were compared in an ABAB reversal design. These test conditions were also alternated with a toy-play condition (identical to those described during the initial functional analysis) within a multi-element design to ascertain the levels of problem behavior when no instructions were provided.

Modified Functional Analysis Results

The results of the modified functional analysis are depicted in the middle panel of Figure 1. Carl engaged in high rates of problem behavior during the vocal-prompting-only sessions ($M = 1.7$; second and fourth phases) and zero rates of problem behavior during the graduated-prompting (first and third phases) and toy-play sessions (all phases). These data indicated that Carl’s problem behavior was evoked only under conditions in which instructions to complete tasks were repeatedly presented and assistance in the form of model and physical prompts were not provided.

There are two possible interpretations of these data. First, it is possible that the repeated vocal instructions were more aversive than the instructions presented during the graduated-prompting sessions, evoking greater levels of escape-maintained problem behavior. However, this interpretation seems unlikely as the tasks themselves were held constant by presenting similar problems across sessions, and by holding both the vocal content (e.g., “Write three times two,”) and the rate of instructions (every 5 s) constant across the two conditions. An alternative interpretation is that the model and physical-guidance prompts provided during the graduated-prompting sessions minimized the value of escape, abating escape-maintained problem behavior. In other words, it appeared that Carl would engage in problem behavior to escape the instructional context when the correct response was unknown; however, the instructional context was not aversive when the therapist provided assistance in the form of a model prompt. During the latter context, Carl did not engage in escape behavior, but rather he completed mathematics problems following a model prompt even though escape remained available (Carl completed 71% of instructions following a vocal or model prompt during the graduated-prompting conditions relative to 0% during the vocal-prompting-only conditions). We evaluated a treatment based upon this second interpretation by teaching Carl an alternative communicative response that resulted in the delivery of model and physical prompts.

Treatment Evaluation Methods

Initially, a series of vocal-prompting-only sessions (identical to those in the previous modified functional analysis) was conducted to establish a behavioral baseline against which to evaluate the effects of teaching an alternative communicative response upon Carl’s problem behavior. The alternative response, “Help me, please,” was taught in a single session using a time-delay

procedure. To start this session, the therapist provided an instruction (e.g., “Write the answer to three times two”), then immediately prompted, “If you need help, say, ‘Help me, please.’” After Carl engaged in the alternative response, the therapist then provided a model prompt to complete the problem (e.g., “Three times two equals six. Write three times two equals six like this”). Completion of each problem resulted in praise and an instruction to complete the next problem. The first three instructions were immediately followed by a prompt to engage in the alternative response; thereafter, the alternative-response prompt was delayed by 5 s. After 10 instructions in which the alternative response occurred independently (i.e., prior to the alternative-response prompt) the alternative-response evaluation was initiated. Alternative-response sessions were identical to those of the vocal-prompt-only baseline, except that model and physical prompts were delivered following each instance of the alternative response. Problem behavior continued to result in a 30-s break from instruction throughout this evaluation.

Treatment Evaluation Results

The results of Carl’s treatment evaluation are depicted in the bottom panel of Figure 1. The mean rate of problem behavior was 1.6 responses per min during baseline. Problem behavior immediately decreased to 0, while a mean of 1.9 alternative responses per min occurred during the alternative response condition. We then conducted a reversal in which the alternative response no longer resulted in the delivery of model prompts. Problem behavior increased to 1.1 and the alternative response rapidly declined to low levels ($M = 0.13$). We then re-implemented reinforcement of the alternative response following a second brief training session, and problem behavior rates returned to zero levels, while the alternative response reoccurred at high levels ($M = 2.2$).

Case Discussion

This case provided an example of a functional analysis initially unsuccessful at identifying the function of problem behavior because it incorporated an idiosyncratic abolishing operation for escape-maintained behavior (i.e., graduated prompting). This finding is unique in that graduated prompting is typically included in the escape condition of a functional analysis to establish the value of escape from demands as a reinforcer (i.e., progressively more intrusive prompts are likely to evoke escape-maintained behavior) and to ensure a dependent relationship between problem behavior and escape as a reinforcer (i.e., escape can only be obtained by engaging in problem behavior). In many cases, providing only vocal prompts would allow individuals to obtain “passive” escape (i.e., they could simply ignore instructions from their teacher or therapist and obtain escape without engaging in problem behavior). This was clearly not the case for Carl, who only engaged in problem behavior when more intrusive prompts were not impending.

These data extend research related to variables that establish and abolish the value of escape as a reinforcer (Ebanks and Fisher, 2003; Horner, Day, Sprague, O’Brien & Heathfield, 1991; Smith et al., 1995; Smith & Iwata, 1997). It is unclear how often graduated prompting will serve as an abolishing operation for escape-maintained behavior. The current case example provides a methodology for examining this unique behavioral relationship, which may be the focus of future research.

The treatment implemented in this case involved teaching an alternative response that was reinforced by the delivery of an event that served as an abolishing operation for escape (i.e., assistance), similar to the approach employed by Carr and Durand (1985). This treatment approach may be beneficial in cases of escape-maintained problem behavior relative to more common differential-reinforcement approaches that involve the delivery of *escape* following communicative behaviors. In the latter strategy, the consumer may completely avoid engaging

in important albeit non-preferred tasks (e.g., tooth brushing, bathing, other academic learning), which ultimately is undesirable. Differential reinforcement procedures that use escape as a reinforcer require relatively complex fading procedures to gradually teach the participant to complete or tolerate the task prior to requesting a break (e.g., Lalli, Casey, & Kates, 1995). By contrast, identifying a means of minimizing aversive aspects of the demand situation allows for the immediate reduction in problem behavior without allowing total avoidance of the task. The extent to which such abolishing operations can be identified is not clear but poses an important challenge in future research (see also Horner, Day, & Day, 1997).

Case II: Jimmy

Case General Method

Participant and Setting—Jimmy, a 13-year-old boy diagnosed with autism, was referred to a day treatment center for the assessment and treatment of aggression. Aggression included hitting, kicking, biting, grabbing, shoving, and throwing materials at therapists. All sessions were conducted in an empty classroom at the day treatment center.

Measurement and Interobserver Agreement—The frequency of Jimmy's aggression was measured during each assessment using pencil and paper data sheets and is reported as a response rate (i.e., the mean number of responses per min). Data were also collected upon the frequency of Jimmy's card exchanges during his treatment evaluation. Interobserver agreement (IOA) was assessed during 25% of sessions during the initial functional analysis, 25% of sessions during his modified functional analysis, and 31% of sessions during the treatment evaluation. IOA was determined using the same calculations as in Case I. Mean agreement scores for aggression were 92% (range, 86% to 100%) during the initial functional analysis, 95% (range, 93% to 100%) during the modified functional analysis, and 90% (range, 77% to 100%) during the treatment evaluation. Mean agreement scores for card exchanges were 95% (range, 77% to 100%; treatment evaluation only).

Initial Functional Analysis Methods

Jimmy's assessments began by conducting a functional analysis using the same conditions and procedures as described in Carl's case except that Jimmy was instructed to complete physical tasks (e.g., touching body parts or walking to different locations in the classroom) using a three-step prompt hierarchy (vocal, model, & physical) during escape sessions.

Initial Functional Analysis Results

The results of Jimmy's initial functional analysis are shown in the top panel of Figure 2. Jimmy engaged in low rates of problem behavior during ignore sessions ($M = 0.13$) and zero rates of problem behavior during attention sessions. Jimmy engaged in elevated rates of problem behavior during escape sessions ($M = 1.5$) and high rates of problem behavior during toy-play sessions ($M = 13.67$). These results are unusual as the toy-play condition is typically used as a control condition, resulting in low levels of problem behavior by removing the establishing operation and reinforcement contingencies present in the other test conditions. The relatively elevated rates of problem behavior observed under this condition indicate that there was some evocative variable present during the control condition that was absent from the other test conditions. Given that problem behavior was elevated during the toy-play and escape conditions (conditions in which the therapist interacts with the participant) relative to the ignore and attention sessions (conditions in which the therapist does not interact with the participant), it was possible that Jimmy's problem behavior was evoked by social interaction and maintained by the termination of that interaction (e.g., Hagopian et al., 2001). Therefore, we conducted a modified functional analysis to directly test this hypothesis.

Modified Functional Analysis Methods

One test condition (social escape) and one control condition (no interaction) were alternated in a random and counterbalanced order in a multi-element design using similar procedures to those described by Hagopian et al. (2001). During *social-escape* sessions, the therapist engaged in continuous interaction with Jimmy except following an instance of aggression when they turned away and terminated their interaction for 30 s. The therapist remained in close proximity to Jimmy, but did not engage in any social interaction (i.e., arranged for the noncontingent elimination of social interaction) during *no-interaction* sessions.

Modified Functional Analysis Results

The results of Jimmy's modified functional analysis are depicted graphically in the middle panel of Figure 2. Jimmy engaged in high rates of aggression during social-escape sessions ($M = 2.0$) and low rates of aggression during no-interaction sessions ($M = 0.03$). These data indicated that Jimmy's aggression was evoked by social interaction and was maintained by the termination of that social interaction. Therefore, a treatment for Jimmy's problem behavior was evaluated based upon this function.

Treatment Evaluation Methods

Initially, a series of social-escape sessions, identical to those in the previous modified functional analysis, was conducted to establish a behavioral baseline against which to evaluate the effects of functional communication training (FCT) upon Jimmy's aggression. FCT (Carr & Durand, 1985) is a treatment procedure in which the reinforcer identified to maintain problem behavior is delivered contingent upon a more desirable alternative response while problem behavior is placed on extinction (i.e., no longer results in the delivery of the reinforcer; Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquistio, & LeBlanc, 1998; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997). In this case, we taught Jimmy to emit an alternative response in the form of a card exchange (handing the therapist a card with the printed word "break") using a time-delay procedure.

In order to train the alternative response, one therapist (a communicative partner) engaged in continuous social interaction with Jimmy while a second therapist (the prompting therapist) physically guided Jimmy to emit the alternative response, resulting in a 30-s break from social interaction. Initially, the prompting therapist immediately physically guided the response at the onset of social interaction. The prompting therapist then delayed their subsequent prompts by 5 s to provide Jimmy with the opportunity to respond independently. Aggression during this training period resulted in no consequence (i.e., social interaction continued until the card was exchanged). This training continued until Jimmy independently exchanged the break card (requiring approximately 15 min to complete); the evaluation of FCT was initiated immediately following this training.

During FCT sessions, Jimmy had continuous access to the break card. The communicative partner approached Jimmy and provided continuous vocal attention. Each card exchange terminated this interaction for 30 s, while aggression resulted in no programmed consequences. The effects of FCT upon Jimmy's aggression were evaluated in a reversal design.

Treatment Evaluation Results

The results of Jimmy's treatment evaluation are depicted graphically in the bottom panel of Figure 2. Jimmy engaged in a mean of 1.7 aggressive responses per min during baseline. Jimmy's aggression immediately decreased to 0, while card exchanges occurred at a mean of 1.6 responses per min during FCT. When card exchanges were placed on extinction and reinforcement was again provided following aggression, aggression increased to 1.6.

Aggression then returned to near zero levels ($M = 0.04$; a 98% reduction from the initial baseline) and card exchanges occurred at high levels ($M = 1.7$) when FCT was reimplemented.

Case Discussion

This case provided an example of a functional analysis initially unsuccessful because it failed to test for an idiosyncratic source of reinforcement. We conducted a modified functional analysis to directly test escape from social interaction as a reinforcer for aggression based upon patterns of aggression observed during the initial functional analysis (i.e., high levels during conditions in which social interaction was provided and low levels of aggression during conditions in which social interaction was absent). Results of this assessment clearly indicated aggressions' sensitivity to escape from social interaction as a reinforcer, an interpretation that was strongly supported by the effective replacement of aggression with a communicative response that resulted in the same reinforcer (i.e., during the treatment evaluation with FCT).

Results similar to those of Jimmy have also been reported in Frea and Hughes (1997), Hagopian et al. (2001), Iwata et al. (1994), Taylor and Carr (1992), and Vollmer et al. (1998). Somewhat interestingly though, the current study is only the third which has experimentally demonstrated that the problem behavior of a child with autism was sensitive to escape from social interaction as a reinforcer (also Hagopian et al. and Taylor and Carr) and only the second to arrange a function-based treatment (Hagopian et al.). We believe this to be surprising given that aversion to social interaction has been commonly reported among individuals diagnosed with autism (Ingersoll, Schriebman, & Stahmer, 2001; Richer, 1976). It would seem likely that that this pattern is more prevalent in practice than the available research base would suggest. Thus, this replication of the assessment and treatment procedures implemented by Hagopian et al. should have value in extending this limited literature base.

Case III: Phillip

Case General Method

Participant and Setting—Phillip, a 15 year-old male diagnosed with autism, was referred to a day treatment center for the assessment and treatment of aggression. Aggression included hitting, kicking, grabbing, and shoving. The aggression seen in our clinic were fairly gentle versions of these forms of behavior; Phillip's parents reported at home his aggression would often start gently and then escalate in severity. Phillip was Jimmy's (Case II) older brother. All sessions were conducted in an empty classroom at the day treatment center.

Measurement and Interobserver Agreement—The frequency of Phillip's aggression was measured during each assessment using laptop computers. IOA collected during 29% of sessions during the initial functional analysis, 27% of sessions during his modified functional analysis, and 71% of sessions during the treatment evaluation and was calculated using the same procedures described in Carl and Jimmy's cases. Mean agreement scores for aggression were 100% during the initial functional analysis, 99% (range, 97% to 100%) during the modified functional analysis, and 92% (range, 35% to 100%) during the treatment evaluation. We were not able to determine the reason for the one low-agreement score during the treatment evaluation; however, the agreement scores for 35 out of 38 sessions with reliability data were above 88%.

Initial Functional Analysis Methods

Phillip's assessment began by conducting a functional analysis including the same conditions and procedures as described in Carl and Jimmy's cases with the exception that Phillip was instructed to complete academic tasks using flash cards (e.g., "point to the number 12") during escape sessions.

Initial Functional Analysis Results

The results of Phillip's functional analysis are shown in the top panel Figure 3. Phillip did not engage in problem behavior during any test conditions with the exception of one escape session (Session 5). Therefore, no conclusions could be reached regarding variables maintaining Phillip's problem behavior. Phillip's parents reported that his problem behavior was typically directed towards his brother, Jimmy; therefore, it was possible that Jimmy's presence served as a discriminative stimulus that occasioned problem behavior (i.e., Jimmy has historically been associated with the availability of a social reinforcer for aggression). Therefore, we conducted a modified functional analysis in which Jimmy was present during Phillip's functional analysis, and therapist-mediated contingencies were applied to aggression directed towards Jimmy.

Several safeguards were put into place to ensure both children's safety during this assessment. First, at least two therapists were present at all times during this assessment (including observing from outside the session room during the no-therapist present sessions). Early session termination criteria were also established. As noted previously, Phillip's aggression typically consisted of gentle instances of pinching, shoving, and kicking. However if these aggressive behaviors escalated to more dangerous levels or if Jimmy engaged in severe aggressive behavior, sessions were immediately terminated and both brothers were separated for at least 10 min. Specific criteria for session termination involved (a) any instance of closed fist punching or (b) any behavior that resulted in any redness or swelling to either brother. Only one session was terminated early by meeting these criteria.

Modified Functional Analysis Methods

Jimmy was provided access to high-preference leisure items (drawing materials and toy animals) at a table in the center of the room during all sessions of Phillip's modified functional analysis, with the exception of the no therapist present sessions. Phillip was provided with low-preference materials and was prompted to sit at the table while the therapist's attention was diverted towards a magazine during attention sessions except to deliver a 5-s reprimand following each instance of aggression directed towards Jimmy (e.g., "Don't hit your brother, Phillip. You may hurt him") during attention sessions. Phillip was seated at the table and was provided with continuous demands to engage in academic tasks (e.g., picture and number discriminations) using a three-step prompting procedure, and a 30-s break from demands was provided following each instance of aggression directed towards Jimmy during escape sessions. The no-therapist-present condition served as a modified alone condition in which all materials were removed and the therapist observed the session from outside the room. No therapist-mediated consequences were provided to Phillip during these sessions. Finally, both Phillip and Jimmy were provided access to high-preference materials during toy-play sessions, and the therapist engaged in continuous social interaction with Phillip. At no time during this assessment were social consequences provided for Jimmy's behavior.

Modified Functional Analysis Results

The results of Phillip's modified functional analysis are depicted in the middle panel of Figure 3. Phillip engaged in low levels of problem behavior during attention ($M = 0.1$), escape ($M = 0.0$), and toy-play ($M = 0.0$) sessions, with the highest observed rates occurring during the no-therapist-present sessions ($M = 0.3$). However, this responding was variable throughout the assessment. We conducted an extended number of sessions in which no therapist-mediated consequences were provided for Phillip's problem behavior based upon the recommendations of Vollmer, Marcus, Ringdahl, and Roane (1995). The purpose of this extended evaluation was to minimize carry-over effects from other conditions in the functional analysis (i.e., it is possible that the stimulation provided during the other test and control conditions minimized the value of the non-therapist mediated reinforcers produced by aggression). Phillip's

aggression was variable, but averaged 0.5 aggressive behaviors per minute towards Jimmy during this extended series of no-therapist consequence sessions.

The results of this assessment may be interpreted in one of two ways. First, Phillip's aggression towards Jimmy may have been maintained by some form of automatic reinforcement, as would be the typical interpretation of functional analyses when the highest rates of problem behavior are observed during no-interaction conditions. Thompson, Fisher, Piazza, and Kuhn (1998) showed that, although rare, aggression can be maintained by its direct sensory consequences. The second (and more likely) explanation was that Jimmy's response to Phillip's problem behavior served as a reinforcer. Anecdotally, Jimmy typically responded to Phillip's aggression by hitting him back (note that Jimmy's aggression was maintained by escape from social interactions) and sometimes engaging in other emotional behavior (e.g., his face would turn red and he would yell). We did not collect systematic data on these reactions, so the results of the current assessment do not conclusively support either interpretation but do provide convincing evidence that Phillip's aggression was not maintained by any therapist-mediated consequences. Further, we noted that even when the automatic or Jimmy-related reinforcers were available during all test conditions, Phillip's aggression only emerged during modified alone (no therapist present) conditions, and never during the sessions in which alternative sources of reinforcement were available. That is, the materials present during toy-play, attention, and escape sessions successfully competed with the reinforcers for Phillip's aggression. In other words, Phillip hit Jimmy, but only when there was "nothing else to do." Therefore, we evaluated a treatment based upon providing alternative sources of competing reinforcement known as an enriched environment (Vollmer, Marcus, & LeBlanc, 1994).

Treatment Evaluation Methods

The same safety precautions described earlier remained in effect throughout the treatment evaluation. *Baseline* sessions were similar to those of the modified alone condition with the exception that data collectors observed the interaction of Jimmy and Phillip from within the session room to make observation more tenable (i.e., previous observations were conducted through a small window in the door). There were no materials available and data collectors did not interact with either Jimmy or Phillip during sessions. Sessions during the *enriched-environment* conditions were identical to baseline sessions except that a number of high-preference activities were made available in the room. These materials included a TV with a video cassette recorder and a variety of video cassettes, puzzles, drawing materials, small toy cars, and small toy dinosaurs. Therapist-mediated consequences were not provided to either individual during this assessment and at no time was it necessary to terminate sessions due to the severity of problem behavior. The baseline and enriched-environment conditions were compared in reversal designs.

Treatment Evaluation Results

The results of Phillip's treatment evaluation are shown in the bottom panel of Figure 3. Phillip engaged in a mean of 0.9 aggressive responses per minute during the initial baseline condition, which decreased to 0.04 during the first enriched environment phase. Aggression then increased to 0.74 responses per minute when the enriched environment was withdrawn during the return to baseline phase. Aggression then decreased to 0.09 responses per minute when the enriched environment was replaced (a 90% reduction in aggression from the initial baseline).

Case Discussion

This case provided an example of an initially unsuccessful functional analysis because it failed to incorporate a specific individual, in this case the participant's sibling (Jimmy). Based upon parental report and naturalistic observations, we conducted a modified functional analysis to test for sensitivity to therapist-mediated sources of reinforcement for Phillip's aggression

directed towards Jimmy. The results of this evaluation ruled out several potentially influential social variables (i.e., those delivered by the therapist) as aggression occurred most often during the no-therapist-present condition. Functional analyses in which behavior occurs most frequently during the alone or ignore condition are most commonly interpreted as displaying behavior's sensitivity to automatic sources of reinforcement; however, this alone condition was unique in that it did not eliminate all social consequences, only those delivered by the therapist. Thus, it seemed most likely that Phillip's aggression was maintained by social attention delivered by Jimmy.

Previous studies have demonstrated sensitivity to peer reinforcement among children with problem behavior by training a typically-developing peer confederate to administer reinforcement contingencies similar to a therapist (Flood et al., 2002; Northup et al. 1995). The surety of the conclusions drawn from our modified functional analysis would have been stronger had we been able to train Jimmy to administer ideal reinforcement contingencies. However, we felt such training would have been unsuccessful (Jimmy had a relatively weak instruction following repertoire and the social interaction required to conduct the training would likely have evoked prolonged periods of aggression). Thus, we were required to infer the sources of reinforcement operating during this condition, much as we might infer that stimulation to the mouth or to the digits serves as a reinforcer for automatically-maintained hand mouthing.

We opted for an antecedent treatment approach that could be initiated immediately in lieu of attempting to further parse the reinforcement contingency that remained in place for Phillip's aggression. Enriched environments have frequently been implemented as treatments for problem behavior whose source of reinforcement remains intact (DeLeon, Anders, Rodriguez-Catter, & Neidert, 2000; Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000; Ringdahl, Vollmer, Marcus, & Roane, 1997). This treatment approach is based upon the notion that alternative sources of reinforcement will compete with the reinforcers available for problem behavior (in this case, movies and games were more valuable than Jimmy's emotional reaction to being pinched). In cases in which no alternative stimuli can be identified to compete with problem behavior, other response-reduction procedures may be necessary to eliminate problem behavior and promote engagement with the alternative materials (e.g., response blocking and differential reinforcement; Vollmer et al., 1994).

General Discussion

This paper presents three case reports in which initially undifferentiated functional analyses were modified, and the results of these modified analyses led to the development of effective behavioral treatments. In progressing from initially undifferentiated functional analyses, there are three particular concerns for practitioners: identifying potential idiosyncratic sources of influence, evaluating the suspected source of influence in a systematic functional analysis, and incorporating the results of this analysis into a behavioral intervention.

A number of strategies have been reported for identifying potential idiosyncratic sources of influence including casual observation, caregiver interviews, and descriptive assessments (e.g., Carr et al. 1997; Fisher, Lindauer et al., 1998; Tiger et al., 2006). The current study utilized similar strategies by conducting unstructured observations in Carl's classroom (Case I), unstructured interviews with Phillip's parents (Case III), and by noting patterns in Jimmy's initial functional analysis data (Case II).

After identifying a potential idiosyncratic source of influence on behavior, it is necessary to systematically evaluate the effects of that variable on levels of problem behavior through a modified functional analysis. The procedures used to conduct the modified functional analysis

will differ based upon the particular variable of interest, but will generally involve a test condition in which the hypothesized reinforcer and its establishing operation (EO) are present and a relevant control condition in which that reinforcer and its EO are absent. The current manuscript identified uncommon sources of environmental influence on problem behavior and also provided three methodologies by which to examine functional relations between each of these idiosyncratic environmental events and problem behavior. The social-escape test condition (Case II: Jimmy) has been reported elsewhere (Hagopian et al. 2001); however, the modified prompting analysis (Case I: Carl) and the modified sibling-present analysis (Case III: Phillip) are novel to our knowledge. We believe that this final sibling-present analysis may have particular value in clinical practice, where we often see children who only engage in problem behavior towards a particular sibling or peer, as long as participants' safety can be assured as it was in the present study. The methodology should be useful for determining whether the other child serves as a discriminative stimulus for the availability of reinforcement (e.g., if their mother or teacher had differentially attended to aggression directed towards the sibling) or if the other child serves as a mediator of reinforcement (as was the case in Phillip's analysis). Additional replications will be needed to determine the utility of this assessment format.

The final goal of conducting functional analyses (modified or otherwise) is to nominate specific treatment packages that are likely to be successful (e.g., teaching Jimmy to request a break from social interaction) and others that are likely to be unsuccessful or contraindicated (e.g., delivering praise to Jimmy for the non-occurrence of aggression). In all presented cases, modified functional analyses led to the development of behavioral interventions designed to abolish the value of the maintaining reinforcer (Carl), eliminate and reassign the reinforcer maintaining problem behavior (Jimmy), and compete with a reinforcer which was not controlled by the therapist (Phillip). None of these three interventions were likely to be arrived at without the information derived from the modified functional analyses; thus highlighting the utility of this approach of progressing from initially ambiguous functional analyses.

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Figure 1. Results of Carl's initial functional analysis of problem behavior (top panel), modified functional analysis (middle panel), and treatment evaluation (bottom panel).

Figure 2. Results of Jimmy's initial functional analysis of aggressive behavior (top panel), modified functional analysis (middle panel), and treatment evaluation (bottom panel). Note that the y-axis range varies between panels.

Figure 3. Results of Phillip's initial functional analysis of aggressive behavior (top panel) modified functional analysis (middle panel), and treatment evaluation (bottom panel). Note that the y-axis range varies between panels.