JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2004, **37,** 431–444 NUMBER 4 (WINTER 2004)

# *A DESCRIPTIVE ANALYSIS OF POTENTIAL REINFORCEMENT CONTINGENCIES IN THE PRESCHOOL CLASSROOM*

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In recent years, functional analysis methods have been extended to classroom settings; however, research has not evaluated the extent to which consequences presented during functional analysis are associated with problem behavior under naturalistic classroom conditions. Therefore, the purpose of this study was to determine whether the social consequences commonly manipulated in functional analyses occur in typical preschool classrooms. A total of 14 children attending preschool programs participated in the study. Data were collected on the occurrence of antecedent events (e.g., presentation of tasks), child behaviors (e.g., aggression), and teacher responses (e.g., delivery of attention). The probability of various teacher responses given child behavior was then calculated and compared to the response-independent probabilities of teacher responses. Attention was found to be the most common classroom consequence (100% of children), followed by material presentation (79% of children), and escape from instructional tasks (33% of children). Comparisons of conditional and response-independent probabilities showed that the probability of teacher attention increased given the occurrence of problem behavior for all children, suggesting that a contingency existed between these two events. Results suggest that functional analyses that test the effects of attention, escape, and access to materials on problem behavior may be appropriate for preschool settings.

DESCRIPTORS: descriptive analysis, preschool, problem behavior, reinforcement contingencies

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Functional analysis procedures (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) have recently been incorporated into the treatment of behavior problems exhibited by school-aged children in classroom environments (Broussard & Northup, 1997; Dunlap et al., 1993; Frea & Hughes, 1997; Harding et al., 1999; Sasso et al., 1992). Due to the mandate of the Individuals with Disabilities Education Act (IDEA; 1997) for the use of functional assessment procedures to develop educational plans for children with behavior problems, it is likely that the use of functional analyses in classrooms will continue to increase. Thus, it is necessary to identify functional analysis procedures that can be implemented effectively and efficiently in school settings.

Although the utility of functional analysis in the development of treatments for problem behavior has been well documented (e.g., Derby et al., 1992; Iwata, Pace, Cowdery, & Miltenberger, 1994; Kurtz et al., 2003; Smith, Iwata, Vollmer, & Zarcone, 1993), some researchers have questioned the external validity of experimental functional analyses (Conroy, Fox, Crain, Jenkins, & Belcher, 1996; Mace, 1994; Martin, Gaffan, & Williams, 1999). A dominant criticism is that the reinforcement contingencies tested in functional analyses may be overly restrictive or may not occur in the natural environment, rendering the results of the functional analysis potentially irrelevant outside the experimental preparations (Mace, Lalli, & Lalli, 1991).

Mace et al. (1991) recommended con-

We thank Gregory Hanley and Jennifer Zarcone for their comments and suggestions regarding this manuscript.

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ducting descriptive analyses (Bijou, Peterson, & Ault, 1968) to develop functional analysis test conditions that are similar to reinforcement contingencies present in the natural environment. Although this method may occasionally be useful in determining the function of behavior, conducting additional analyses may be time consuming (Mace, 1994), thus postponing treatment. Furthermore, Iwata, Pace, Dorsey, et al. (1994) found that functional analyses that consisted of common test conditions were effective in identifying variables that maintained self-injury in the majority of cases, and suggested that additional analyses be conducted only when initial functional analysis results are inconclusive (e.g., Harding et al., 1999).

The recommendation of Iwata, Pace, Dorsey, et al. (1994) presumes that the functional analysis includes conditions that assess the events that follow problem behaviors under naturalistic conditions. Thompson and Iwata (2001) conducted descriptive analyses with 27 adults with developmental disabilities in an institutional setting to determine the extent to which the events assessed during functional analyses are present in naturalistic settings. They found that attention, escape from demands, and presentation of tangible items followed problem behavior for 89%, 36%, and 30% of participants, respectively. These results suggest that these events naturally occur following problem behavior exhibited by adults in institutional settings.

Extending Thompson and Iwata's (2001) descriptive analysis results to young children in typical school settings would help to determine the utility of assessing the social contingencies that are commonly evaluated during functional analyses (i.e., attention, access to materials, and escape from demands) with this population. If the reinforcement contingencies typically manipulated in functional analyses are found to occur naturally between teachers and children in the classroom, it would be reasonable to use these conditions in the assessment and treatment of behavior problems in the classroom (i.e., additional analyses may be unnecessary).

Researchers have used a variety of measurement and data-analysis techniques when attempting to describe naturally occurring interactions during descriptive analysis (e.g., Atwater & Morris, 1988; Gunter, Jack, Shores, Carrell, & Flowers, 1993). Recently, Vollmer, Borrero, Wright, Van Camp, and Lalli (2001) attempted to identify naturally occurring reinforcement contingencies by comparing the conditional probability of various events (i.e., the probability of an event given a behavior) to the response-independent probability of these events (i.e., the probability of an event independent of behavior) considering potential establishing operations (EOs; e.g., low attention). Using these probabilities, a "contingency value" (positive, neutral, or negative) can be generated by subtracting the response-independent probability from the conditional probability. A positive contingency (i.e., conditional probability greater than response-independent probability) would indicate that the probability of a consequent event increases given the occurrence of a given behavior (e.g., a teacher provides a preferred toy more often following tantrums than at other times). A negative contingency (i.e., conditional probability less than response-independent probability), on the other hand, would suggest that the probability of a consequent event might actually decrease given the occurrence of a given behavior (e.g., a teacher withholds attention following a tantrum). A neutral contingency is said to occur when the probability of an event is the same following a given behavior and at other times (e.g., a teacher frequently provides a child with attention both following tantrums and in the absence of tantrums).

In the current study, we used procedures similar to those described by Vollmer et al. (2001) to determine whether the social consequences typically manipulated in functional analyses occur naturally in preschool classrooms and to identify the presence of potential contingencies between child and teacher responses.

## METHOD

### *Participants and Setting*

Participants were 14 children who attended one of three inclusive preschool programs at the University of Kansas. Research and teacher training were regularly conducted in these programs, which provided the children with frequent exposure to classroom visitors. All participants were between the ages of 1 year 5 months and 5 years 2 months and were selected based on teacher report of daily problem behavior and receipt of parental consent. Twelve of the children were typically developing, 1 child had been diagnosed with autism, and 1 child had been diagnosed with developmental delays. All typically developing children had age-appropriate receptive (e.g., followed simple one-step instructions) and expressive (e.g., made simple requests) language skills. The children with autism and developmental delay engaged in some echoic vocalizations and had minimal receptive language skills.

All teachers had received a minimum of general in-service training in teaching and basic behavior-management skills (e.g., differential reinforcement, extinction, redirection, and brief time-out) as well as other teaching strategies (e.g., incidental teaching). Several of the teachers were working in the classrooms as part of a practicum course in early education and child development. These teachers received periodic feedback and training from their supervisor as part of the practicum course. In all classrooms, the teacher-to-student ratio ranged from 1:2 to 1:5 throughout the study, and class size ranged from 12 to 21 students.

### *Procedure*

Observations were 15 min in length and were scheduled according to observer availability and child attendance at school. For each child, data were collected during a minimum of 10 observations or until 10 intervals with problem behavior were recorded to insure that an adequate sample of problem behavior was obtained (additional observations were conducted with 2 children). On three occasions, observations were terminated early due to the child's departure from the classroom, but all sessions were at least 11 min in length.

Each child was observed individually during at least three of six regularly scheduled activities (i.e., circle time, free play, meals, outside play, small group, and transitions) to insure that the sample included a variety of situations that children typically experience in preschool classrooms. Activities were chosen based on convenience, and observations were not distributed equally across activities. Observers were positioned either behind a one-way window or in a corner of the classroom or playground. To minimize their reactivity to the observations, teachers were given no instructions regarding their interactions with the children and were not informed which child was being observed. In addition, no attempt was made to control for children's access to a teacher.

For each session, a data sheet partitioned into 90 10-s intervals was used to record the occurrence of child and teacher responses using a partial-interval recording method. Observers circled codes for child and teacher responses in three categories: antecedent event, behavior, and consequent event. Multiple responses could be recorded in the same interval, and responses were recorded in all intervals in which they occurred (i.e., if a response continued to occur across two intervals, then it was recorded in both intervals). The antecedent event category included codes for attention, materials present, material removal, demand, and escape; the behavior category included codes for aggression, disruptive behavior, off-task behavior, and compliance; and the consequent event category included codes for attention, material presentation, and escape.

*Response Measurement and Interobserver Agreement*

Target behaviors for all children included aggression (hitting, kicking, pushing, pulling hair, and biting), disruptive behavior (screaming, crying, throwing objects, swiping objects off of furniture, banging forcefully on objects with hand or foot, turning lights off, and destroying property), off-task behavior (leaving the designated activity area, engaging in activities other than the planned activity, noncompliance with group demands), and compliance (completion of a demand without physical guidance).

Data were also collected on a variety of teacher responses. Attention was recorded when a teacher initiated vocal (e.g., "Do we hit our friends?"; "I think you need to find a new activity") or physical (e.g., rubbing back, holding on lap) social interaction with the child (except when attention was in the form of a demand). Materials present was recorded when the child was interacting with a toy or food item or was within arm's length of a toy or food item with which he or she previously interacted (during the observation). Material removal was recorded when a teacher removed an item that the child was interacting with or when a teacher denied access to a requested item. Material presentation was recorded when the teacher presented the child with an item or allowed the child to interact with a previously denied item. Demand was defined as any discrete, teacher-delivered request or demand (e.g., "Come to potty") for a child to initiate an action (requests to terminate an action, e.g., "Stop running," were not scored). Demands made to the class were not scored as demands (e.g., "Clean up time, class") because teachers often did not require that each child participate in these activities. A demand was scored only following the initial prompt. Once a demand was presented (and scored), a new demand was not recorded until (a) the child complied with the previous demand, (b) the child was physically guided to complete the demand, or (c) escape from the previous demand was provided. Escape was recorded when the demand materials or prompts relevant to the initial demand were removed prior to completion of that demand. For example, escape was recorded if, after one prompt to complete a demand (e.g., "Stand up"), the child did not comply and the teacher failed to give additional prompts or presented a new demand (e.g., "Pick up your plate") within one interval of the initial prompt.

A second observer independently recorded child and teacher responses during a minimum of 30% of sessions for each child. Agreement percentages were calculated on an interval-by-interval basis. An agreement was defined as both observers recording the occurrence of the same event in the same category (e.g., antecedent) in a given 10-s interval. Percentage of agreement was calculated by dividing the number of intervals with agreements by the number of intervals with agreements plus disagreements and multiplying by 100%. Mean interobserver agreement across children was 90.6% (range, 61% to 100%) for attention, 99% (range, 91% to 100%) for material removal, 93.4% (range, 70% to 100%) for materials present, 95.6% (range, 81% to 100%) for demands, 99.6% (range, 90% to 100%) for escape, 99.6% (range, 97% to 100%) for material presentation, 99.7% (range, 96% to 100%) for aggression, 99.1% (range, 92% to 100%) for disruptive behavior, 99.9%

(range, 98% to 100%) for off-task behavior, and 97.5% (range, 83% to 100%) for compliance.

*Data Analysis*

First, associations between environmental events (antecedent and consequent) and child behavior were determined by identifying events that occurred in the same interval as the child behavior or in the interval adjacent the child behavior (Lerman & Iwata, 1993). Next, these data were used to calculate conditional and response-independent probabilities to further analyze the relation between teacher responses (e.g., delivery of attention) and child responses (e.g., disruptive behavior). These calculations were done for individual response topographies (i.e., aggression, disruptive behavior, off-task behavior, and compliance) and for combined problem behavior (i.e., the combination of aggression, disruptive behavior, and off-task behavior).

*Conditional probability.* The conditional probability of each consequent event (i.e., attention, materials, escape), with and without consideration of potential EOs (i.e., low attention, restricted materials, and demand), was calculated. To determine the conditional probability without considering potential EOs for each consequent event, the number of intervals with child behavior (i.e., problem behavior, compliance) followed by the specific consequent event was divided by the total number of intervals with child behavior.

To determine the conditional probability of consequent events while considering potential EOs, only those child–teacher interactions that occurred with the hypothesized EO present were analyzed. That is, when calculating conditional probabilities for attention and material presentation, only those intervals of child behavior that were preceded by at least one interval in which the same event was absent were included in the formula. The conditional probability of escape was calculated only in the presence of the potential demand EO because escape could only be provided on these limited occasions. To determine the conditional probability of escape, the number of intervals in which (a) a demand was presented, (b) a problem behavior occurred within one interval of the demand, and (c) the problem behavior was followed by escape (within one interval) was divided by the number of intervals in which a demand was presented and a problem behavior occurred within one interval.

*Response-independent probability.* The response-independent probability of attention, materials, and escape was also determined with and without consideration of potential EOs. The response-independent probability was used as the background against which to compare the conditional probability and, in turn, determine the value of the potential contingency (i.e., positive, neutral, negative). If the conditional probability of an event was greater than the response-independent probability of that event, the contingency was identified as potentially positive. If the conditional probability and response-independent probability were equal, a possible neutral contingency was identified. If the conditional probability of the event was lower than the response-independent probability, a possible negative contingency was identified (Vollmer et al., 2001).

Without consideration of potential EOs, the response-independent probability was calculated by dividing the number of intervals with a specific event by the total number of intervals in the session. To determine the response-independent probability of attention and material presentation while considering potential EOs, only those intervals with a specific event (e.g., attention) that were preceded by at least one interval in which the same event was absent were included in the formula. To calculate the response-independent probability of escape

Table 1
Number of Intervals Observed and Number of Intervals with Problem Behavior

| Participant | Age (years-months) | Number of intervals | Total intervals problem behavior | Intervals problem behavior in each EO: Low attention | Restricted materials | Demand |
|---|---|---|---|---|---|---|
| 1 | 1-6 | 900 | 21 | 13 | 0 | 3 |
| 2 | 3-0 | 695 | 201 | 147 | 3 | 77 |
| 3 | 3-0 | 900 | 41 | 35 | 3 | 0 |
| 4 | 3-0 | 787 | 102 | 80 | 3 | 52 |
| 5 | 4-8 | 1,440 | 11 | 11 | 0 | 0 |
| 6 | 1-8 | 900 | 23 | 19 | 0 | 1 |
| 7 | 1-5 | 900 | 28 | 14 | 4 | 8 |
| 8 | 3-3 | 875 | 10 | 7 | 0 | 0 |
| 9 | 2-10 | 1,170 | 14 | 10 | 0 | 3 |
| 10 | 1-5 | 900 | 67 | 39 | 1 | 2 |
| 11 | 5-2 | 900 | 38 | 33 | 1 | 0 |
| 12 | 2-2 | 900 | 18 | 11 | 1 | 3 |
| 13 | 1-11 | 900 | 60 | 37 | 1 | 0 |
| 14 | 3-0 | 900 | 30 | 24 | 0 | 1 |

considering the demand EO, the number of intervals with escape (preceding or following child behavior) following intervals in which a demand was presented was divided by the number of intervals in which demands were presented.

## RESULTS

The number of intervals observed and the number of intervals with problem behavior for individual children are provided in Table 1. Data were collected during a total of 13,067 intervals, ranging from 695 to 1,440 ($M$ = 933.4) intervals for each participant, and a total of 664 intervals with problem behavior were observed, ranging from 10 to 201 ($M$ = 47.4) intervals for each participant. The number of intervals in which problem behavior occurred under each of the potential EOs ranged from 7 to 147 ($M$ = 34.3) for low attention, 0 to 4 ($M$ = 1.2) for restricted materials, and 0 to 77 ($M$ = 10.7) for demand.

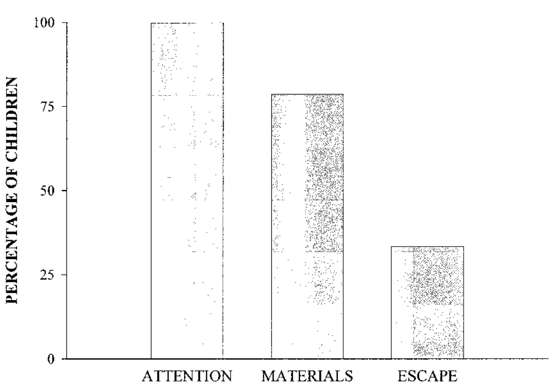


Figure 1. Percentage of children for whom attention, material presentation, and escape were observed at least once following problem behavior.

The percentage of children for whom attention, material presentation, and escape were observed following problem behavior on at least one occasion is presented in Figure 1. Attention was observed to follow problem behavior on at least one occasion for all 14 children (100%), material presentation was recorded following problem behavior at least once for 11 of the 14 children (78.6%), and escape followed problem behavior at least once for 3 of the 9 children (33.3%) for whom a demand preceded the occurrence of problem behavior.

Figure 2 shows the conditional probabilities of attention, material presentation, and escape for combined topographies of prob-

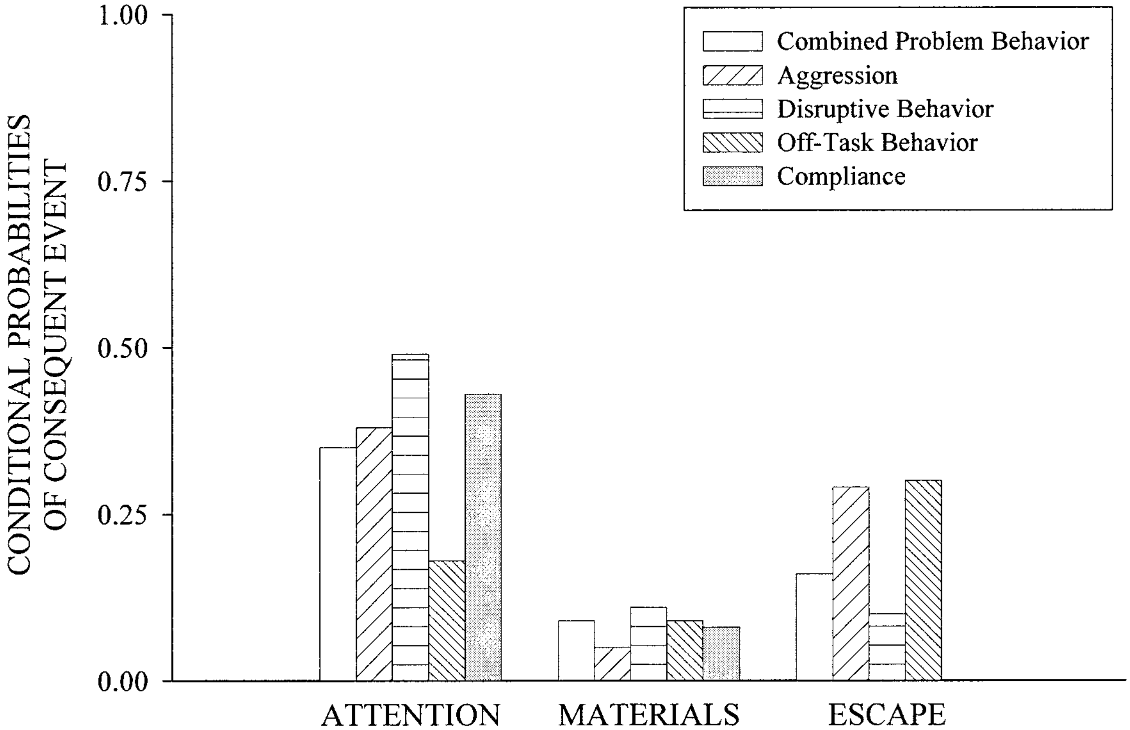


Figure 2. Mean conditional probabilities of attention, material presentation, and escape given combined problem behavior, aggression, disruption, off-task behavior, and compliance.

lem behavior and for specific topographies of child behavior. The most probable event following combined problem behavior (i.e., aggression, disruption, and off-task behavior) was the delivery of attention (.35). Disruption, compliance, and aggression were most likely to be followed by attention with conditional probabilities of .49, .43, and .38, respectively. Escape from demands was the most probable (.30) event following off-task behavior. Presentation of materials was least likely to follow child behavior overall (i.e., .09, combined; .05, aggression; .11, disruption; .09, off-task behavior; .08, compliance).

A summary of the conditional probabilities (based on combined problem behavior), response-independent probabilities, and contingency values for attention, materials, and escape with and without consideration of EOs for each participant is provided in Table 2. The left side shows the conditional and response-independent probabilities for attention and materials without considering potential EOs. The right side shows the conditional and response-independent probabilities for attention, materials, and escape, but includes only those intervals for which the relevant EO was present (e.g., the conditional probability of attention following problem behavior when problem behavior was preceded by at least one interval in which attention was absent). It should be noted that the conditional probabilities for escape were calculated only with consideration of the potential EO, because, by definition, escape was not possible in the absence of a demand (the EO).

When the probabilities were calculated without considering EOs, positive contingency values were observed between problem behavior and attention delivery for 93% of children (Participants 1 through 12, 14; range, .01 to .58). However, the contingency

Table 2

Conditional Probabilities, Response-Independent Probabilities, and Contingency Values for Attention, Materials, and Escape With and Without Considering EOs

| | Without considering potential EOs | | | | | | Considering potential EOs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conditional | | Response-indep | | Contingency value | | Conditional | | | Response-indep | | | Contingency value | | |
| Participant | Att | Mat | Att | Mat | Att | Mat | Att | Mat | Esc | Att | Mat | Esc | Att | Mat | Esc |
| 1 | .48 | .05 | .32 | .72 | +.16 | −.67* | .77 | | 0 | .22 | 1.0 | .07 | +.55* | **−1** | −.07 |
| 2 | .26 | .12 | .25 | .61 | +.01 | −.49* | .22 | .67 | .14 | .14 | .57 | .1 | +.08* | +.1 | +.04 |
| 3 | .37 | .02 | .17 | .57 | +.20* | −.55* | .37 | 0 | | .12 | .22 | .06 | +.25* | −.22 | **−.06** |
| 4 | .26 | .07 | .14 | .53 | +.12* | −.46* | .25 | .33 | .23 | .1 | .56 | .19 | +.15* | −.23 | +.04 |
| 5 | .64 | 0 | .06 | .56 | +.58* | −.56* | .64 | | | .05 | 1.0 | 0 | +.59* | **−1** | |
| 6 | .48 | .13 | .35 | .59 | +.13 | −.46* | .74 | | 0 | .22 | .5 | .11 | +.52* | **−.5** | −.11 |
| 7 | .75 | .25 | .28 | .63 | +.47* | −.38* | .71 | .5 | 0 | .22 | .5 | .21 | +.49* | 0 | −.21 |
| 8 | .4 | 0 | .16 | .43 | +.24* | −.43* | .14 | | | .08 | .33 | .05 | +.06 | **−.33** | **−.05** |
| 9 | .43 | .14 | .15 | .57 | +.28* | −.43* | .40 | | 0 | .08 | 1.0 | 0 | +.32* | **−1** | |
| 10 | .58 | .13 | .33 | .61 | +.25* | −.48* | .64 | 0 | 0 | .24 | .44 | .28 | +.40* | −.44 | −.28 |
| 11 | .18 | .03 | .11 | .41 | +.07 | −.38* | .15 | 0 | | .08 | .4 | .08 | +.07 | −.4 | **−.08** |
| 12 | .57 | .21 | .32 | .67 | +.25* | −.46* | .55 | 1.0 | .33 | .2 | .8 | .09 | +.35* | +.2 | +.24 |
| 13 | .22 | .07 | .24 | .74 | −.02 | −.67* | .24 | 0 | | .17 | .75 | 0 | +.07 | −.75 | |
| 14 | .4 | 0 | .13 | .47 | +.27* | −.47* | .38 | | 0 | .09 | .5 | .05 | +.29* | **−.50** | −.05 |

*Note.* Probabilities for contingency values shown in bold print could not be calculated because the relevant EO was never observed (and it is not possible to divide by 0).

* $p < .05$

values for some of the participants were close to zero (e.g., .1 for Participant 2). Therefore, we determined which contingency values were significantly different from zero by transforming the contingency values into standard scores (i.e., $Z$ scores) and then using the corresponding area under the normal curve to determine the chance probability of those standard scores. We calculated the standard scores using the formula $Z = (P - p)$ divided by the square root of $[P \times (1 - P)]/n$, where $P$ is the response-independent probability, $p$ is the conditional probability, and $n$ is the number of intervals with problem behavior. For contingency values calculated with consideration of potential EOs, $n$ is the number of intervals with problem behavior preceded by the relevant EO. Contingency values that were statistically different from zero ($p < .05$) are marked with an asterisk in Table 2. As can be seen in Table 2, the contingency values for attention were significantly greater than zero for 9 of the 14 children, suggesting that attention delivery increased following problem behavior for these children. For Participant 13, a possible negative contingency of .02 was identified, but this value was not significantly different from zero. For all 14 children, there was a statistically significant negative contingency value (range, .38 to .67) associated with the occurrence of problem behavior and the presentation of materials. That is, the probability of receiving materials decreased following the occurrence of problem behavior.

When potential EOs were considered, a positive contingency value (range, .06 to .59) was identified between problem behavior and attention delivery following low attention for 100% of children, and of these, 11 met our criterion for statistical significance ($p < .05$). That is, for at least 11 children, the likelihood that attention would be delivered increased following problem behavior during periods of low attention. For 62.5% of children (Participants 3, 4, 10, 11, and 13) for whom problem behavior was observed following the removal of materials

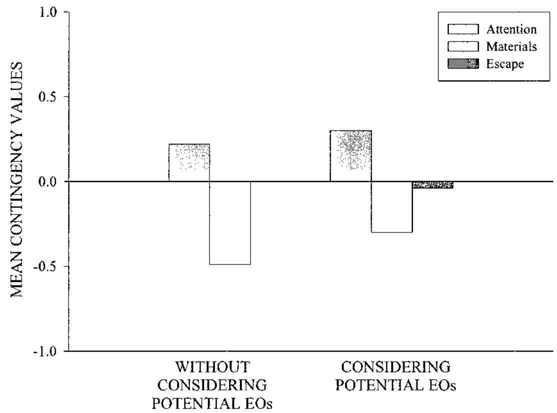


Figure 3. Mean contingency values for attention, materials, and escape with and without considering potential EOs.

(restricted materials EO), a potential negative contingency (range, .22 to .75) was identified between problem behavior and material presentation, and a positive contingency was identified for 25% of these children (Participants 2 and 12; range, .1 to .2). However, none of these contingency values met our criterion for statistical significance, and in most cases, this was due to the small number of intervals in which problem behavior was preceded by removal of materials. For Participant 7, the conditional and response-independent probabilities that materials would be presented following restricted access to materials were equal (i.e., a neutral contingency was identified).

For 62.5% of children (Participants 1, 6, 7, 10, and 14) for whom problem behavior was recorded following a demand presentation, a negative contingency (range, .05 to .28) between problem behavior and escape from demands was found, and for 37.5% of these children (Participants 2, 4, and 12) possible positive contingencies (range, .04 to .24) were found. However, none of these contingency values met our criterion for statistical significance.

Figure 3 shows the mean contingency values across all participants for each consequent event with and without consideration of potential EOs. The mean contingency value for the relation between attention delivery and problem behavior was .22 ($N$ = 14), and this value increased to .30 ($N$ = 14) when only those intervals following periods of low attention were analyzed. Material presentation following problem behavior resulted in a mean contingency value of −.49 ($N$ = 14) when all intervals were considered, and increased to −.30 ($n$ = 9) when only those intervals following restricted access to materials were considered. The contingency values for relations between escape delivery following problem behavior were analyzed only for those intervals preceded by a demand and resulted in a mean of −.04 ($n$ = 9).

## DISCUSSION

We attempted to determine the extent to which social stimuli typically manipulated during functional analyses (i.e., attention, materials, and escape) were associated with problem behavior exhibited by young children under natural classroom conditions. The most common event following problem behavior was the delivery of attention. This finding is consistent with the results of Thompson and Iwata (2001), in which the delivery of attention was the most common event following problem behavior exhibited by adults in institutions. In the present study, teachers frequently provided attention following problem behavior despite basic training in behavior management. This finding suggests a need for more effective training in the use of differential reinforcement and extinction with regard to attention delivery, as well as methods for monitoring and evaluating teachers' accuracy and progress in regard to the use of these skills.

The presentation of materials was observed following problem behavior for 78.6% of children in the current study, whereas Thompson and Iwata (2001) observed material presentation following problem behavior for only 29.6% of participants. This difference may be due in part to the abundance of materials available in early childhood classrooms compared to many institutional settings or to the restricted preferences common among institutionalized populations (Ivancic & Bailey, 1996). These results suggest that material presentation may be an important variable to examine when young children present with behavior problems.

Escape was provided following problem behavior for 33.3% of children, a finding that is similar to the results of Thompson and Iwata (2001), who found that escape from demands followed problem behavior for 36.4% of participants. It is interesting to note that, although escape appeared to be less common as a consequence for problem behavior when compared to attention, some researchers have identified escape as the more common maintaining variable for problem behavior (Derby et al., 1992; Iwata, Pace, Dorsey, et al., 1994). It is possible that descriptive analyses may fail to detect functional escape contingencies because escape is presented more intermittently than other events (e.g., attention).

Results of comparisons between response-independent and conditional probabilities (considering potential EOs) were similar to those reported by Vollmer et al. (2001) in that analyses of teacher attention resulted in the majority of potential positive contingencies. More specifically, the probability of attention was higher following problem behavior and periods of low attention for all 14 children and met our statistical significance in 11 of these children. This finding further suggests attention to be the most relevant variable to test when conducting a functional analysis with a young child.

Also consistent with Vollmer et al. (2001), a limited number of positive contingency values were identified between problem behavior and access to materials and escape. That is, although materials and escape were frequently presented following problem behavior, problem behavior did not appear to increase (and in some cases appeared to decrease) the likelihood of these events during our observations with many children. Thus, the relation between problem behavior and these events was unclear. However, given that a potential positive contingency was identified for 2 of 14 and 3 of 14 children for materials and escape (considering potential EOs), respectively, it seems reasonable to recommend that these events be included in functional analyses conducted with young children. Although some authors have suggested that responses may come under the control of reinforcement contingencies not present in the natural environment as a result of experimentally arranged (but not naturally occurring) reinforcement contingencies (e.g., Mace et al., 1991; Martin et al., 1999), there is little evidence to suggest that this occurs (for a notable example see Shirley, Iwata, & Kahng, 1999).

Our primary goal was to identify the prevalence of potential reinforcement contingencies that are common to analogue functional analysis; however, given that a variety of responses are available to children in the classroom, it may be important to consider the relative rates of reinforcement provided for appropriate versus inappropriate behavior. We recorded data for one appropriate behavior, compliance, and found that the conditional probability of attention following compliance exceeded the conditional probabilities of attention following all categories of problem behavior except disruptive behavior. Therefore, although potential contingencies between problem behavior and attention were observed, relative rates of reinforcement may have favored compliance over some topographies of problem behavior. In addition, although data were not collected on appropriate communicative responses, it is possible that relative rates of reinforcement also favored these responses. Given the rapid changes in verbal repertoires that occur in early childhood, the measurement of communicative responses and the consequences teachers provide to those responses may be particularly important to understanding the development of appropriate and inappropriate behavior among young children.

The interpretation of these data is limited in several additional ways. First, the training received by many teachers in the current study included basic training in behavior management, which might not be representative of most teacher training. It is possible, for example, that a possible positive contingency between material presentation and problem behavior was not observed because the current sample of teachers had been explicitly taught not to deliver toys following problem behavior. However, it appears that teachers who have had prior training in behavior-management techniques occasionally provide attention, materials, and escape following problem behavior.

Second, our analysis included only broad categories of EOs. That is, only the total absence of attention, the restriction of any and all materials, and the presentation of any and all demands were treated as potential EOs. For some children, however, these may not have been the most relevant events. For example, the absence of attention from a favorite teacher may serve as an EO in some cases, even when attention from other teachers remains available. Similarly, in early childhood settings, the value of a particular toy may increase when in use by a peer, despite the availability of alternative materials.

Third, our analysis of potential escape contingencies considered only those occasions in which demands were presented and then removed. However, this analysis does not address the potential effects of avoidance (i.e., preventing the presentation of demands) on children's behavior in the classroom. An alternative method for analyzing negative reinforcement contingencies is to consider both instances involving the presentation and subsequent removal of a demand (escape) and intervals in which demands are simply absent (avoidance) as potential instances of negative reinforcement. With this alternative analysis, negative reinforcement (i.e., escape and avoidance) could be delivered both following and in the absence of a demand. Future research should continue to refine and develop procedures that most effectively detect and describe naturally occurring negative reinforcement contingencies.

Fourth, neutral contingency values were identified only when the conditional and response-independent probabilities were exactly the same, although in some cases the difference between these probabilities was as small as .01. Hammond (1980) evaluated the effects of various reinforcement probabilities on responding and nonresponding. The difference in the probability of reinforcement for either behavior was interpreted as a contingency value, ranging from very highly positive to strongly negative. Results showed that responding decreased as the probability of reinforcement for responding (relative to nonresponding) approached a neutral value. Similarly, Borrero, Vollmer, and Wright (2002) investigated the effects of strong positive (i.e., 1, .5, and .33) and neutral (i.e., 0) contingencies on the rate of problem behavior. They found that the rate of problem behavior given equal probabilities of reinforcement for the occurrence and nonoccurrence of problem behavior (i.e., neutral contingency) was suppressed relative to the rate of problem behavior given an increased probability of reinforcement for the occurrence of problem behavior (i.e., positive contingency). The results of these studies suggest that the strength of the reinforcement contingency affects the rate of behavior, but further evaluation of the effects of more subtle differences (e.g., positive contingency = .01) between reinforcement contingencies given the occurrence and nonoccurrence of behavior is needed.

Finally, it is unclear the degree to which the participants' behavior was influenced by the potential reinforcement contingencies identified in the current study. However, several factors may mediate against the development and maintenance of behavior problems in a preschool population. Such factors included the relatively low levels of problem behavior observed in our sample, which would reduce exposure to potential reinforcement contingencies, the existence of appropriate alternative responses (e.g., communicative responses), and the relatively small contingency values detected in many cases. Nevertheless, information regarding naturally occurring consequences for the problem behavior of young children may further our understanding of the contingencies that contribute to problem behavior in naturalistic settings.

The procedure described in this study is intended as a method for further evaluating complex human interactions in the natural environment, rather than as a clinical tool for identifying stimuli for inclusion in a functional analysis. Results of Mace and Lalli (1991) and Lerman and Iwata (1993) suggest that formal descriptive analyses may provide insufficient data for determining the function of behavior. In addition, the data-analysis procedures involved in descriptive analyses (e.g., Lerman & Iwata; Vollmer et al., 2001) are often extremely complex and time consuming. Thus, although it is certainly desirable to obtain information regarding naturally occurring antecedents and consequences associated with problem behavior, the potential costs of a detailed descriptive analysis may outweigh the benefits in some cases. In addition, descriptive analyses may not permit the identification of idiosyncratic variables that contribute to problem behavior when observers record only those child and teacher responses that are targeted for data collection. Thus, additional assessment may be needed to examine idiosyncratic influences on problem behavior (Hanley, Iwata, & McCord, 2003).

## REFERENCES

Atwater, J. B., & Morris, E. K. (1988). Teachers' instructions and children's compliance in preschool classrooms: A descriptive analysis. *Journal of Applied Behavior Analysis, 21,* 157–167.

Bijou, S. W., Peterson, R. F., & Ault, M. H. (1968). A method to integrate descriptive and experimental field studies at the level of data and empirical concepts. *Journal of Applied Behavior Analysis, 1,* 175–191.

Borrero, J. C., Vollmer, T. R., & Wright, C. S. (2002). An evaluation of contingency strength and response suppression. *Journal of Applied Behavior Analysis, 35,* 337–347.

Broussard, C., & Northup, J. (1997). The use of functional analysis to develop peer interventions for disruptive classroom behavior. *School Psychology Quarterly, 12,* 65–76.

Conroy, M., Fox, J., Crain, L., Jenkins, A., & Belcher, K. (1996). Evaluating the social and ecological validity of analog assessment procedures for challenging behaviors in young children. *Education and Treatment of Children, 19,* 233–256.

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northup, J., Cigrand, K., et al. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis, 25,* 713–721.

Dunlap, G., Kern, L., dePerczel, M., Clarke, S., Wilson, D., Childs, K. E., et al. (1993). Functional analysis of classroom variables for students with emotional and behavioral disorders. *Behavior Disorders, 18,* 275–291.

Frea, W. D., & Hughes, C. (1997). Functional analysis and treatment of social-communicative behavior of adolescents with developmental disabilities. *Journal of Applied Behavior Analysis, 30,* 701–704.

Gunter, P. L., Jack, S. L., Shores, R. E., Carrell, D. E., & Flowers, J. (1993). Lag sequential analysis as a tool for functional analysis of student disruptive behavior in classrooms. *Journal of Emotional and Behavioral Disorders, 1,* 138–148.

Hammond, L. J. (1980). The effect of contingency upon the appetitive conditioning of free-operant behavior. *Journal of the Experimental Analysis of Behavior, 34,* 297–304.

Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003).

Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis, 36,* 147–185.

Harding, J., Wacker, D. P., Cooper, L. J., Asmus, J., Jensen-Kovalan, P., & Grisolano, L. A. (1999). Combining descriptive and experimental analyses of young children with behavior problems in preschool settings. *Behavior Modification, 23,* 316–333.

Individuals with Disabilities Education Act, 20 U.S.C. § 1400 *et seq.* (1975, as amended, 1997).

Ivancic, M. T., & Bailey, J. S. (1996). Current limits to reinforcer identification for some persons with profound multiple disabilities. *Research in Developmental Disabilities, 17,* 77–92.

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

Iwata, B. A., Pace, G. M., Cowdery, G. E., & Miltenberger, R. G. (1994). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis, 27,* 131–144.

Iwata, B. A., Pace, G. M., Dorsey, M. F., Zarcone, J. R., Vollmer, T. R., Smith, R., et al. (1994). The functions of self-injurious behavior: An experimental-epidemiological analysis. *Journal of Applied Behavior Analysis, 27,* 215–240.

Kurtz, P. F., Chin, M. D., Huete, J. M., Tarbox, R. S. F., O'Connor, J. T., Paclawskyj, T. R., et al. (2003). Functional analysis and treatment of self-injurious behavior in young children: A summary of 30 cases. *Journal of Applied Behavior Analysis, 36,* 205–219.

Lerman, D. C., & Iwata, B. A. (1993). Descriptive and experimental analyses of variables maintaining self-injurious behavior. *Journal of Applied Behavior Analysis, 26,* 293–319.

Mace, F. C. (1994). The significance and future of functional analysis methodologies. *Journal of Applied Behavior Analysis, 27,* 385–392.

Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. *Journal of Applied Behavior Analysis, 24,* 553–562.

Mace, F. C., Lalli, J. S., & Lalli, E. P. (1991). Functional analysis and treatment of aberrant behavior. *Research in Developmental Disabilities, 12,* 155–180.

Martin, N. T., Gaffan, E. A., & Williams, T. (1999). Experimental functional analyses for challenging behavior: A study of validity and reliability. *Research in Developmental Disabilities, 20,* 125–146.

Sasso, G. M., Reimers, T. M., Cooper, L. J., Wacker, D., Berg, W., Steege, M., et al. (1992). Use of descriptive and experimental analyses to identify the functional properties of aberrant behavior in school settings. *Journal of Applied Behavior Analysis, 25,* 809–822.

Shirley, M. J., Iwata, B. A., & Kahng, S. (1999). False-positive maintenance of self-injurious behavior by access to tangible reinforcers. *Journal of Applied Behavior Analysis, 32,* 201–204.

Smith, R. G., Iwata, B. A., Vollmer, T. R., & Zarcone, J. R. (1993). Experimental analysis and treatment of multiply controlled self-injury. *Journal of Applied Behavior Analysis, 26,* 183–196.

Thompson, R. H., & Iwata, B. A. (2001). A descriptive analysis of social consequences following problem behavior. *Journal of Applied Behavior Analysis, 34,* 169–178.

Vollmer, T. R., Borrero, J. C., Wright, C. S., Van Camp, C., & Lalli, J. S. (2001). Identifying possible contingencies during descriptive analyses of severe behavior disorders. *Journal of Applied Behavior Analysis, 34,* 269–287.

*Received September 2, 2003*
*Final acceptance August 17, 2004*
*Action Editor, Henry Roane*

## STUDY QUESTIONS

1. According to the authors, what is a common criticism of functional analysis procedures?

2. What was the criterion for the minimum amount of data collected per child?

3. What three response categories were scored, and what events were included in each category?

4. Describe how a conditional probability was calculated without and with consideration of potential establishing operations (EOs).

5. Why were response-independent probabilities included in the analysis, and how were they calculated?

6. Summarize the results shown in Figure 1 with respect to the consequences that were observed to follow problem behavior.

7. How did consideration of potential EOs influence contingency values?

8. How did the authors reconcile their findings on escape as a consequence for problem behavior with those of previous studies on the prevalence of escape-maintained problem behavior?

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