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Assessment and treatment of arranging and ordering in individuals with autism

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Abstract

Among the diagnostic features of autism, relatively little research has been devoted to restricted and repetitive behavior. In particular, forms of repetitive behavior that have been described as *higher-level* (e.g., rigidity in routines or *compulsive behavior*[1] such as arranging objects in patterns or rows; Turner, 1999) have been understudied. Like vocal or motor stereotypy, higher-level repetitive behavior can be associated with negative outcomes such as impaired skill acquisition, negative social consequences, and severe problem behavior associated with interruption of stereotyped behavior. In the first phase of the present study, the Repetitive Behavior Scale-Revised (RBS-R; Bodfish, Symons, Parker, & Lewis, 1999) was used to identify the reported prevalence and severity of 45 forms of repetitive behavior within a sample of 102 individuals with autism spectrum disorder. Based on preliminary data (n = 16), one form of higher-level repetitive behavior—arranging and ordering—was selected for further study. The functional assessment model was then extended to the assessment and treatment of arranging and ordering in phases 2-4. Specifically, we (a) identified environmental events associated with the problem behavior through interviews and direct observation (b) experimentally manipulated a subset of environmental events to determine their effects on arranging and ordering, and then (c) developed interventions based on results of our experimental analyses.

Assessment and Treatment of Arranging and Ordering in Individuals with Autism

Restricted and repetitive behavior is among the three diagnostic features of autism (American Psychiatric Association, 2000). This category encompasses a wide range of behaviors including rigid adherence to routines, repetitive language or motor movements, and preoccupation with parts of objects. In his early characterization of autism, Kanner (1943) included vivid descriptions of the lack of variation and spontaneity in children's behavior as well as their apparent need for sameness within their environment. For example, several children were described as engaging in "monotonously repetitious" motions (e.g., repetitively spinning toys) or perseverating, crying, or aggressing when there was a change in routine, items or furniture were rearranged, a pattern was disrupted, or items were broken or incomplete (e.g., the cross bar on the garage door was broken or windows and doors did not remain closed).

Although restricted and repetitive behavior is observed in other developmental disabilities (Bodfish, Symons, Parker, & Lewis, 2000) and in typically developing individuals (Leekman et al. 2007), repetitive behavior is of particular concern among individuals with autism due to its prevalence, frequency, and severity in autism relative to other populations (Turner, 1999). Based on teacher ratings, Bodfish et al. (2000) identified a significantly higher percentage of cases of repetitive behavior in a group of individuals with autism compared to a matched (age, gender, IQ) control group of adults with mental retardation but no autism diagnosis. The autism group was also rated as having more severe or interfering compulsions.

Restricted and repetitive behavior in autism has been associated with a number of adverse effects. For example, repetitive behavior has been shown to interfere with skill acquisition (e.g., Dunlap, Dyer, & Koegel, 1983), can be socially stigmatizing (Jones, Wint, & Ellis, 1990), and has been found to be highly correlated with parent-reported stress levels (Gabriels, Cuccaro, Hill,

Ivers, & Goldson, 2005). In addition, problem behavior such as self-injury or aggression is sometimes associated with interruption of restricted and repetitive behavior (Cuccaro, et al., 2003; Flannery & Horner, 1994; Turner, 1999). In fact, several researchers have demonstrated a functional relation between aggression and disruptions and access to compulsions in individuals with autism (e.g., Hausman, Kahng, Farrell, & Mongeon, 2009; Kuhn, Hardesty, & Sweeney, 2009) or other developmental disabilities (e.g., Murphy, Macdonald, Hall, & Oliver, 2000).

Based on the complexity of particular forms of repetitive behavior, Turner (1999) suggested subdividing restricted and repetitive behavior into two classes: *higher-level* repetitive behavior and *lower-level* repetitive behavior. As described by Turner, higher-level repetitive behavior includes complex behavior such as circumscribed interests (e.g., preoccupation with serial numbers on electronics), rigid and invariant routines (e.g., dressing, eating, or playing in a particular pattern), and insistence on sameness (e.g., insisting that items or furniture remain in the same place; e.g., Kanner, 1943; Prior & MacMillan, 1973). Lower-level repetitive behavior, on the other hand, includes less complex forms of stereotypy such as repetitive motions (e.g., hand-flapping and body-rocking) and repetitive manipulation of objects (e.g., object-spinning).

Despite the prevalence and severity of restricted and repetitive behavior in autism, a number of researchers have noted that restricted and repetitive behavior has been largely ignored in comparison to the amount of attention dedicated to understanding, preventing, and treating social and communication deficits in autism (Bodfish, 2004; South, Ozonoff, & McMahon, 2005; Turner, 1999). In particular, Bodfish and Turner identified the paucity of studies addressing higher-level restricted and repetitive behavior.

Given our limited understanding of the variables that contribute to the development and maintenance of higher-level repetitive, there is a need for a thorough empirical investigation of

this characteristic of autism. One productive approach to this undertaking may be to apply a functional assessment model to the study of higher-level repetitive behavior in individuals diagnosed with autism. The general model involves (a) gathering information, through interviews and direct observation (e.g., descriptive assessment), regarding environmental events that are correlated with the target behavior, (b) experimentally manipulating a subset of environmental events to empirically determine the effects on the target behavior (i.e., functional analysis), and (c) developing interventions informed by the results of experimental analyses (i.e., function-based treatment; see Hanley, Iwata, & McCord, 2003 for a review of functional analysis research).

Although several researchers have applied the functional assessment approach to the assessment and treatment of lower-level repetitive responses such as motor stereotypy (e.g., Kennedy, Meyer, Knowles, & Shukla, 2000) and repetitive vocalizations (e.g., Ahearn, Clark, MacDonald, & Chung, 2007), this approach has not yet been applied to higher-level repetitive behavior. Thus, our goal was to conduct a comprehensive analysis of one form of higher-level repetitive behavior, arranging and ordering. This topography was selected based on the results of the first phase of our study, which identified the prevalence of a variety of repetitive behavior forms in a sample of individuals with autism. In addition to informing treatment for participants, the functional assessment process served to provide a more complete description and understanding of arranging and ordering and related environmental variables.

PHASE 1: PREVALENCE

Research on higher-level repetitive behavior has generally focused on the prevalence of various forms of repetitive behavior and their specificity to autism as well as the proper categorization of subtypes of repetitive behavior (e.g., Bodfish et al., 2000; Cuccaro et al., 2003; Lam & Aman, 2007; McDougle et al., 1995; Militerni, Bravaccio, Falco, Fico, & Palermo, 2002). This emphasis is due, at least in part, to the idea that identification of subtypes of restricted and repetitive behavior may guide research on the genetic neurobiological underpinnings of autism (Cuccaro et al.; Militerni et al.). However, these data also can be used to describe the prevalence of the range of topographies that comprise the restricted and repetitive category of behavior in autism (e.g., Lam & Aman; also see Lewis & Bodfish, 1998 for a review of prevalence of subcategories of restricted and repetitive behavior in autism).

Interviews and rating scales are typically used to measure the prevalence of the wide range of topographies included in the restricted and repetitive category in autism. Such assessment strategies offer a practical alternative to direct observation, which would require an enormous amount of time and resources to obtain an appropriate sample of a range of behaviors (or lack thereof) for a large sample of a population.

Noting that previous studies on the prevalence and co-occurrence of varieties of repetitive behavior have relied on the use of multiple instruments, resulting in item overlap and therefore inaccurate estimates (e.g., Campbell et al., 1990), Bodfish, Symons, and Lewis (1999) developed an item-independent scale (Repetitive Behavior Scale [RBS]) comprised of three subcategories (stereotypic behavior, self-injurious behavior, and compulsions). A revised version, the Repetitive Behavior Scale-Revised (RBS-R), was later developed to accommodate additional categories of higher-level repetitive behavior such as ritualized behaviors, insistence

on sameness, and restricted interests (Lam & Aman, 2007). The reliability and validity of the RBS-R was independently confirmed by Lam and Aman.

For our purposes, the RBS-R provided a comprehensive list of repetitive behavior that could be used to identify participants and higher-level topographies of repetitive and restricted behavior for further assessment in later phases of this study. Using an item-independent scale also allowed for a more accurate estimate of the prevalence of various topographies of restricted and repetitive behavior among sampled population.

Method

Participants and Setting

Participants included all children and adolescents diagnosed with autism spectrum disorder receiving both school and residential services through specialized school (N = 102). Diagnoses were provided by an independent, outside agency. The majority of the sample was diagnosed with autism (75.49%) and 22.55% were diagnosed with pervasive developmental disorder (PDD). Age ranged from 7 to 22 years with a mean of 15.31; 83.33% of the sample were males.

In all, 16 residential units with 6 to 10 students per unit were sampled . Students living in the same residence shared a classroom at school. Classrooms were divided into several rooms or areas designed for more concentrated instruction and services. All students received one-to-one or one-to-two (teacher-to-student) care throughout the day.

Scale

The RBS-R (Bodfish et al., 2000; Lam & Aman, 2007; see *Appendix A*) was used to gather information from caregivers regarding the occurrence and severity of several forms of repetitive behavior. The scale consisted of 43 items, grouped into six subscales: stereotyped

behavior (e.g., body rocking and hand flapping), self-injurious behavior (e.g., self-hitting and self-biting), compulsive behavior (e.g., arranging and ordering and washing or cleaning), ritualistic behavior (e.g., performing mealtime and self-care routines in a similar manner, following a rigid routine during play), restricted behavior (e.g., fascination with one subject or with parts of an object rather than the whole), and sameness behavior (e.g., resisting changes in activities). Two additional forms of restricted and repetitive behavior that are commonly described in individuals with autism but not included in the RBS-R (Bourreau, Roux, Gomot, Bonnet-Brilhault, & Barthelemy, 2009; Lam & Aman), vocal stereotypy and echolalia, were also included in the scale.

Raters

Two independent raters completed a scale for each participant. Teachers selected as raters had known the student for at least 3 months (M = 14.92, range, 3 to 60) and worked with the student on a regular basis and across multiple contexts (e.g., school and residence). All teachers had a bachelor's degree, and the majority of teachers were also enrolled in a Special Education or Behavior Analysis master's degree program.

Administration Procedure

Scales were distributed to teachers on each residential unit. Teachers were asked to read the instructions and rate the student's behavior accordingly. For each of the 43 items on the scale, informants were asked to rate items based on their observations over the last 3 months: 0 (*does not occur*), 1 (*mild problem*), 2 (*moderate problem*), or 3 (*severe problem*). Ratings on the severity of the problem were based on (a) frequency, (b) difficulty in interrupting the behavior, and (c) degree of interference with ongoing events (see *Appendix A*).

A primary and secondary rater was assigned from each pair of raters according to the order in which the scales were received. The mean time between completion of scales by the primary and secondary rater was 9 days (range, 0 to 45). Data collection for all residential units was distributed across approximately 16 months. For those students participating in multiple phases of the study, less than one month elapsed between the end of one phase and initiation of the next phase (between scale and interview, interview and naturalistic observation, or naturalistic observation and functional analysis and treatment).

Interrater Agreement

Interrater agreement was assessed by comparing the primary and secondary raters' responses for each participant. For each item, three forms of agreement were calculated. The most stringent form, exact agreement (Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991), was used to identify the degree to which raters provided the same rating for each item (e.g., both raters recorded a 2 for arranging and ordering). For occurrence/ nonoccurrence, an agreement was scored if each rater agreed that a particular form of repetitive behavior occurs (rating of 1, 2, or 3) or does not occur (rating of 0). For severity of problem/ rating of 3, an agreement was scored only if both raters provided a rating of 3 for a particular item. Percentage agreement for each form of interrater agreement (identical, exact, occurrence/ nonoccurrence, and severity of problem/ rating of 3) was calculated for each subscale by taking the total number of agreements divided by the total number of agreements and disagreements and multiplying the resulting number by 100. The denominator for the exact and occurrence/ nonoccurrence method equaled the total number of items in a subscale, whereas the denominator for the severity of problem/ rating of 3 equaled the total number of items in a subscale rated a 3 by at least one rater. See Table 1 for agreement scores for each subscale.

Results

Results from the administration of the RBS-R were summarized across participants to provide information on the overall percentage of participants who reportedly displayed various forms of repetitive behavior and at various degrees of severity. Table 2 shows the percentage occurrence (rating of 1, 2, or 3) for each topography according to primary and secondary raters as well as the distribution of ratings 1, 2, and 3 (according to primary raters only). Numbers in italics represent the percentage of participants reported as engaging (rating of 1, 2, or 3) in at least one topography listed in the corresponding subscale.

According to primary raters, approximately 92% of participants were reported to engage in at least one topography within the stereotypy subscale and 90% of participants were reported to engage in at least one topography within the self-injurious subscale. The percentage of participants reported to engage in at least one topography within the higher-level repetitive behavior subscales—sameness, restricted, compulsive, and ritualistic subscales—were 86%, 78%, 76%, 75%, and, respectively.

The mean percentage of endorsements for occurrence (according to primary raters) was 40% (SD_{all} = 18) across all subscales and 35% ($SD_{higher\text{-}level}$ = 16) across higher-level restricted and repetitive behavior subscales (i.e., excluding stereotypy and self-injurious subscales; higher-level items at least one SD greater than the mean $_{higher\text{-}level}$ are noted in boldface). When calculated across all subscales, 4 of 6 items in the stereotypy subscale were at least one SD greater than the mean. Higher-level items one SD greater than the $mean_{all}$ included *no interruption* and *preoccupation with one subject*. Of all the topographies included in the scale, *vocal stereotypy* was rated as most prevalent (83%) and severe (31%).

The mean percentage of endorsements for rating of 3 was 10% (SD_{all} = 7) across all subscales and 8% ($SD_{higher\text{-}level}$ = 5) across higher-level restricted and repetitive behavior subscales. Higher-level items at least one SD greater than the mean $_{higher\text{-}level}$ for rating of 3 included *likes same music/ movie*, *eating/ mealtime, communication*, *needs to touch/ tap, arranging and ordering*, *preoccupations with one subject*, and *attached to specific subject* (noted in boldface in Table 2). *Arranging and ordering* was rated as severe (rating of 3) across the greatest percentage of participants (14%) within the compulsive subscale and the second greatest percentage of participants across all other higher-level repetitive behavior subscales, tied with *strongly attached to one subject*. *Ritualistic communication/ social interactions* was rated as severe across the greatest percentage of participants, 17%.

Because our preliminary analysis (n = 16) showed that *arranging and ordering* was among the most prevalent higher-level topographies, this topography was selected as the main topography of interest for the remainder of the study.

Discussion

Based on a gross comparison of the hierarchy of items ordered with respect to prevalence, our results are somewhat consistent with Lam and Aman's (2007) results. For 4 of 6 subscales, items receiving the greatest number of endorsements (rating of 1, 2, or 3) within each subscale in Lam and Aman also received the greatest number of endorsements for our sample (*hits w/ body, no interruption, eating/ mealtime, preoccupation with one subject*). For the remaining 2 subscales (stereotypy and compulsive), *sensory* and *arranging and ordering* received the most endorsements in the study by Lam and Aman and received the second and third highest number of endorsements for our sample.

The percentage of endorsements for *individual* items, however, varied considerably across our study and that of Lam and Aman (2007). Only 26% of the 45 items that overlapped between our study and that of Lam and Aman[2] received a similar percentage of endorsements (within 10 percentage points; 51% of items were within 15 percentage points) across studies and most of these items were within the stereotypy and self-injurious subscales. The mean absolute difference in the percentage of endorsements was 17, ranging from 3 to 38. For example, whereas 72% of Lam and Aman's participants reportedly arranged and ordered, only 38% of our participants received endorsements for this item. Thus, although there is some preliminary support for the generality of the *hierarchy* of prevalence of items within each subscale reported by Lam and Aman, the generality of the prevalence of individual items remains unclear.

Because the size of our sample was significantly less than that of Lam and Aman (2007) (102 versus 307), our results are less likely than Lam and Aman's to be representative of the general autism population. The generality of our findings is further limited by the fact that we sampled only those individuals receiving school and residential services from one particular institute. It is possible that characteristics of residential living (e.g., changes in daily routine due to other students' problem behavior) may have systematically influenced (e.g., via habituation) the prevalence of certain topographies (e.g., *insists on same routine* or *insists that events take place at a certain time*). Such variables may account for, for example, the fact that the prevalence of items on the sameness subscale were each between 12 and 35 percentage points lower than those reported by Lam and Aman. Other factors such as school-wide teaching practices may also influence the occurrence of particular items on the scale.

Despite these downfalls, the RBS-R was useful for identifying higher-level topographies of repetitive and restricted behavior for further assessment in later phases of our study, which

was one of the main purposes of the school-wide distribution of the RBS-R in this phase. Thus, although these results may be limited with respect to their representativeness of the general autism population, they do help to characterize the prevalence and severity of the variety of restricted and repetitive behavior observed in individuals with autism spectrum disorders for the students receiving school and residential services at the institute sampled in our study.

Of course, the validity of data based on indirect measures such as scales should be scrutinized given the fact that they are based on subjective ratings. That is, despite efforts to increase accuracy by providing clear instructions as to how to judge each item (based on frequency, difficulty in interrupting the behavior, and degree of interference with ongoing events over the past three months) and to reduce item ambiguity by operationally defining items, there are a number of variables that may influence raters' behavior. For example, ratings may be influenced by recent changes in trend (e.g., a topography has decreased in frequency in the last week but occurs at a relatively high frequency overall), the intensity of the most recent instance (e.g., the latest occurrence was uncharacteristically difficult to interrupt or led to severe problem behavior such as aggression), or comparisons to the behavior of other individuals (e.g., the severity of a topography seems mild when compared to the severity of the behavior of other students). Further, interrater agreement scores obtained in this study suggest that prevalence based on ratings should be interpreted with caution. Even when reliability was measured according to extreme ratings (occurrence/ nonoccurrence and severity/ rating of 3), agreement ranged between 36% and 89% across items and participants.

Nevertheless, because it would be nearly impossible to corroborate each of these ratings with independent direct observations due to the number of topographies (items) included in the scale and the difficulty of obtaining a proper sample for all participants, scales represent an

efficient means of obtaining reported prevalence as well as identifying participants who reportedly engage in the topography of interest.

PHASE 2: INTERVIEW

We conducted a semi-structured interview with caregivers in order to gather additional information that could inform later phases of the study. Although informant reports have been shown to be an unreliable means of determining the *function* of problem behavior (e.g., Zarcone et al., 1991), they may provide useful information regarding the topography of problem behavior, the conditions under which problem behavior is likely to occur, and environmental consequences correlated with problem behavior. Obtaining such information at the front-end of a functional assessment can inform the design of a functional analysis by assisting in (a) developing operational definitions of the target behavior, (b) identifying session materials, and (c) developing test or control conditions. For our purposes, information from interviews also assisted in determining appropriate observation times for naturalistic observations as well as qualitative information regarding caregivers' concerns associated with this behavior.

Method

Participants

Twenty-two students' teachers were interviewed (see Table 3 for participant characteristics). Students participating in this phase were identified from the RBS-R as engaging in arranging and ordering to a degree that was considered problematic by at least one teacher (rating of 3). Students rated a 2 (*moderate problem*) for arranging and ordering were included in this phase if they also received a rating of 2 or 3 in at least one other topography from the compulsive subscale, not including touch/ tap, which based on Turner's (1999) categorization

appeared to be more representative of lower-level repetitive behavior (see *Appendix A* for item descriptions).

Interview data were excluded for two students in this phase. The description of one student's behavior during the interview did not appear to be consistent with the description of arranging and ordering provided in the RBS-R. The informant described this student as having a preference for completing chores related to cleaning and organizing; however, the student's cleaning and organizing was appropriate both in the manner and the times at which it occurred. For another participant, at the start of the interview, the informant expressed that the student no longer engaged in arranging and ordering or other related compulsive behavior previously reported in the RBS-R scale. Thus, interview responses were summarized for 20 of 22 students who initially met criteria for inclusion in this phase.

Participant characteristics and an outline of participation in phases 2 thru 4 of the present study are provided in Table 3.

Informants

Criteria for selecting informants were the same as those used to select raters in phase 1. It was not required that the same teachers completing the scale in Phase 1 served as informants for the interview.

Assessment Tool

The assessment tool consisted of open- and close-ended questions adapted from Durand and Crimmins's (1988) *Motivation Assessment Scale* and O'Neil et al.'s (1997) *Functional Analysis Interview Form*. The interview consisted of questions related to five categories: (a) description of behavior(s), (b) description of problem, (c) setting event factors, (d) antecedents, and (e) consequences (see *Appendix B*). The description of behavior category assisted in

developing operational definitions for later phases of the study. We included the question, "does it involve any particular objects or materials? Which ones?" in order to further identify the range of topographies included in arranging and ordering as well as to identify which materials should be included in the functional analysis.

Questions in the setting events factors and antecedents categories identified environmental events such as times of day, settings, and teachers associated with higher levels of compulsive behavior and informed the timing of naturalistic observations (Phase 3). Questions in the description of problem category informed whether the participant would proceed toward the functional analysis and treatment phases and which types of treatments would be considered for evaluation. Questions in the antecedents and consequences categories informed the arrangement of experimental conditions in later phases and identified common reactions to the target behavior. For example, the interviewer asked staff whether arranging and ordering objects results in staff attention, a delay in activities, redirection to another (perhaps more preferred) activity and/or simply the natural result of producing an orderly physical environment. The question, "Why do you think it happens?" was included to probe responses that may have not been evoked by questions regarding specific environmental events.

Administration Procedure

Interviews were administered by trained graduate research assistants and were completed either in person or by phone, according to each teacher's schedule and preference. Each interview began with a brief description of the study's purpose and a description of the topography of interest (i.e., arranging and ordering). The informant was provided with the definition of arranging and ordering as described in the compulsive behavior subscale. The informant was then asked to answer the questions with respect to arranging and ordering to the

best of their ability. Throughout the interview, informants were encouraged to expand on their response by, for example, providing rationale for their rating or including additional examples. Informants were sometimes asked to clarify a response. For example, if the informant said, "We don't *let* him do that anymore," the interviewer asked the informant to describe what teachers did such as physically block, say "no," or restrict access to the materials.

If during the description of the behavior, the informant included topographies other than arranging and ordering that were in the compulsive behavior subscale (e.g., completeness, washing/ cleaning, or repeating); these topographies were noted and included in the remainder of the interview. Informants were also encouraged to provide separate ratings for topographies, when applicable (e.g., some topographies occurred more frequently than others or were more probable at differing times of day).

Results

Because there are relatively few studies on arranging and ordering in autism, we were particularly interested in gathering information regarding the range of topographies reported as arranging and ordering as well as why arranging and ordering may be considered problematic.

Teacher responses to questions a, b, and f of the *description of behavior(s)* category of the interview are summarized in Table 4. Fourteen of 20 students' arranging and ordering included placement or organization of items (not necessarily including alignment or positioning of objects relative to other objects or surfaces; e.g., moving objects or people to certain places or replacing items that are out of order but not necessarily assuring that objects are aligned). Four students stacked or lined materials in rows or patterns (Adam, Elle, Mike, and Nic), and two students aligned materials against other objects or surfaces (Dex and Jim). In our post hoc analysis of teacher's descriptions, teachers did not provide enough detail to be able to discern

whether items were ordered such that they were even or symmetrical. There were, however, a few exceptions. For example, Ross was described as aligning books on shelves such that their bindings were even, Nic adjusted tokens (pennies) such that they were all facing the same direction and aligned, and Christie adjusted tokens (poker chips) such that the Velcro on the token was perfectly aligned with the Velcro on her token board.

Table 4 also contains a list of materials involved in arranging and ordering and other compulsive behavior such as completeness and washing/ cleaning. Materials involved in arranging and ordering included protective equipment, curtains, napkins, loose hairs, doors, clocks, clothes, furniture, leisure items, trash in trash bin, tokens, and academic materials. For two students, arranging and ordering involved arranging the placement of other people in the room or the placement of other people's limbs (e.g., uncrossing arms or legs). Materials involved in completeness included doors, light, containers, and puzzles, and materials involved in washing/ cleaning included loose threads, hairs, and trash on floor.

On occasion interviewees included descriptions of behavior that met the definition of other items in the same subscale on the RBS-R (the compulsive behavior subscale) as arranging and ordering. Those responses that met the definition of an item listed in the compulsive subscale were documented and included in further assessments for those students participating in phases 3 and 4 of our study. Topographies that met the definition for completeness (item 16) included assuring that containers were completely empty (Alice), doors and lights were closed (May, Mike, and Nic), and puzzles were completely put together and then completely taken apart before returning to a box on a shelf (Adam). Topographies that met the definition for washing/ cleaning (item 17) included picking at loose threads and lint (Ross) and picking at loose hairs (Ross and Christie).

Table 5 outlines the reported frequency of arranging and ordering as well as teacher responses to the *description of problem* category of the interview. This description included the degree of interference with ongoing events, difficulty to interrupt, whether interruption leads to problem behavior and the type of problem behavior, or "other" problems associated with arranging and ordering. When asked whether the subject of the interview engaged in arranging and ordering hourly, daily, weekly, monthly, or less often, 13 of 20 students' teachers reported that ordering occurred hourly. When asked how much arranging and ordering interfered with ongoing events, 13 of 20 students' teachers responded that arranging and ordering was either moderately (rating of 2) or very disruptive (rating of 3). When asked how difficult it was to interrupt arranging and ordering, 9 of 20 students' teachers reported that it was either moderately (rating of 2) or very (rating of 3) difficult to interrupt. Fifteen of 20 students' teachers reported that, when interrupted, arranging and ordering could lead to problem behavior such as aggression (Agg), self-injurious behavior, (SIB), environmental destruction (ED), yelling, crying, screaming, or tantrums. Other reported problems included intrusiveness of ordering when it involved other people, verbal perseveration on arranging and ordering (e.g., Dean would talk about arranging and ordering until the item was replaced to its original position), lack of more appropriate leisure skills (e.g., when lining up leisure items rather than engaging in dramatic play), eloping to arrange and order items (e.g., curtains across the room), or potential danger from arranging and ordering large pieces of furniture.

For those participants in the treatment phase, the *description of problem* category guided treatment selection. For example, among the reported problems associated with Christie's arranging and ordering of furniture was that physically blocking her from arranging and ordering often resulted in other problem behavior such as aggression or self-injury. Additional

assessments were conducted with Christie in order to identify a less intrusive way to prevent arranging and ordering that did not involve physical contact (i.e., immediately replacing furniture).

With respect to *setting event factors* (category 3) and *antecedents* (category 4), for 19 of 20 students, teachers either (a) reported that arranging and ordering was equally probable across settings, times of day, or contexts (e.g., meals, bathroom, academics, or play) or (b) associated the probability of arranging and ordering with the availability of materials typically ordered within particular settings, times, or contexts (e.g., student orders leisure items, which are only available during play). When asked whether arranging and ordering occurred when a request was made of the student—a question included to identify a potential escape function—4 of the 11 students' teachers who responded that it did (seldom, half the time, usually, or always) elaborated that this relation was more likely due to the availability of materials typically ordered (e.g., blocks for counting during academics) or opportunity to access materials typically ordered (e.g., following a demand to move from one area of the room to another a student may stop to arrange items on a counter or following a demand to throw something away a student may arrange items in the trash can). When asked how often arranging and ordering occurred when a teacher stopped attending to the student (never/ seldom/ half the time/ usually/ always)—a question included to assess a potential attention function—teachers reported that arranging and ordering occurred at least half the time for 11 of 20 students.

Consequent-based and antecedent-based strategies reported to be used by teachers are described in Table 6. Consequences for arranging and ordering reported in questions a and c from the *consequences* category included vocal or physical redirection to the current activity or to a new activity (n = 11), rule-reminders (e.g., teacher tells the student the contingencies

outlined in his behavior management guidelines such as time out for perseverating on ordering, rewards for remaining on task; *n*= 4), prompts to problem solve (e.g., "What should you do the next time we are in the hall and you see something that you want to fix?"; *n* = 1), prompts to appropriately request to order (*n* = 2), physical blocking (*n* = 6), removal of materials involved in ordering (*n* = 3), and prompts to take a break (*n* = 2). Teachers reported that, for 12 students, arranging and ordering could be *avoided* by either (a) removing materials that were typically ordered from the environment (*n* = 3) or not presenting those materials to the student (*n* = 4), (b) assuring that items were "in their place" and remained there (*n* = 4), or (c) providing rule-reminders prior to encountering situations typically associated with ordering (*n* = 2). When asked whether ordered items were left according to the student's arrangement or replaced by the teacher, all teachers said that they typically left the ordered items according to the student's arrangement (i.e., they did not replace the items following arranging and ordering).

Discussion

We administered a semi-structured interview with teachers of students for whom arranging and ordering had been rated as moderately to severely problematic on the RBS-R from phase 1. The interview was designed to obtain a more detailed description of arranging and ordering and when applicable, other topographies of higher-level restricted and repetitive behavior (completeness and washing/ cleaning) on the compulsive behavior subscale of the RBS-R. Teachers reported a wide range of topographies and materials included in arranging and ordering. Questions in the description of problem category were particularly useful in providing information regarding why arranging and ordering or other compulsive behavior might be considered problematic. Programmed opportunities for teachers to elaborate their responses when rating the frequency, level of interference with ongoing events, and difficulty interrupting

arranging and ordering revealed a number of interesting problems associated with this largely understudied behavior (e.g., intrusiveness, related verbal perseverations, and dangerous topographies). Future research might further assess why arranging and ordering and other compulsive-like behavior are considered problematic.

A wide range of antecedent and consequent events were reported to be associated with arranging and ordering. Thus, it seems reasonable to suggest that arranging and ordering, like other problem behavior more commonly assessed in comprehensive functional analyses (e.g., Iwata et al. 1982/ 1994), may come into contact with social contingencies such as attention from caregivers or avoidance or escape from demands under naturally occurring conditions.

It is commonly assumed that restricted and repetitive behavior in autism reflects a "need for sameness" (e.g., Prior & MacMillan, 1973; Turner, 1999). According to this hypothesis, arranging and ordering, completeness, and washing/ cleaning would function to maintain consistency (or sameness) in one's environment. Teachers of three participants indicated that arranging and ordering could be avoided if the teacher assured that items were "in their place," which suggests that the correct place stayed the same and that this particular placement may have served as the reinforcer for arranging and ordering. Interestingly, all teachers reported that they did not replace items that had been ordered, leaving items as had been arranged by the student. If arranging and ordering was maintained by access to a particular arrangement, teacher reports suggest that this automatic reinforcer was never disrupted. Future research is needed in order to assess the role of sameness or consistency in the arrangement of materials in the environment on the development and maintenance of arranging and ordering in autism.

Finally, these results should be considered in light of generic limitations associated with obtaining information via interviews such as interviewer bias and item ambiguity (Shapiro &

Kratochwill, 2000). In addition, it should be noted that informants' responses to questions are based on their recollections of past events and are limited by their range of experiences (over time and across settings) with the student (Zarcone et al., 1999). To address this latter concern, we identified informants that had worked regularly with the student for at least 3 months across various settings.

Despite limitations associated with relying on subjective verbal reports, interviews provide an efficient means of gathering a wide range of information. For our purposes, information gathered from teachers was particularly useful in providing a diverse range of qualitatively rich information regarding arranging and ordering. Information gathered from this phase also informed later phases of the study, assisting in the development of operational definitions, identifying times and settings for naturalistic observations, and determining materials and consequences for experimental analyses.

PHASE 3: NATURALISTIC OBSERVATION

Descriptive assessments involve the direct observation of behavior under naturally occurring conditions. In behavior analysis, this includes the direct measurement of target behaviors and observable environmental events. Such information is useful for determining the prevalence of behavior-environment relations in the natural environment and can inform (or validate) the arrangement of experimental conditions that test the relevance of these relations to the behavior of interest.

Studies demonstrating that the variables manipulated in experimental analyses occur regularly under natural conditions provide support for the ecological validity of the functional relations determined via experimental analysis. In other words, conclusions regarding prevailing contingencies are supported by experimental data demonstrating a functional relation *and*

observational data demonstrating that the relation occurs naturally (Bijou, Peterson, & Ault, 1968). For example, Thompson and Iwata (2001) confirmed that attention and escape, which are commonly arranged in a comprehensive functional analysis (modeled after Iwata et al., 1982/1994), are also frequently delivered in the natural environment following problem behavior exhibited by adults with developmental disabilities. McKerchar and Thompson (2004) found similar results for the types of consequences following problem behavior (e.g., aggression, disruptive behavior, and off-task behavior) exhibited by children of typical development within preschool settings. These data support the ecological validity of the standard attention and escape conditions arranged in the Iwata et al. functional analysis and suggest that these conditions may also reveal prevailing contingencies for problem behavior exhibited by children of typical development.

Descriptive data may be particularly important when examining a relatively understudied behavior like arranging and ordering in autism. To date, there are no descriptive data on the relation between arranging and ordering and potentially influential environmental events. Thus, it is unclear the extent to which the consequences typically arranged in a functional analysis naturally occur following arranging and ordering. In addition, it seems reasonable to presume that the *form* of antecedents and consequences for arranging and ordering may differ from those typically arranged for self-injurious or aggressive behavior and that observational data may reveal idiosyncratic events associated with arranging and ordering.

Thus, the purpose of this phase was to identify common naturally occurring antecedents and consequences for arranging and ordering. Our procedures were designed to assess the prevalence of general categories of social consequent events as was done in the Thompson and Iwata (2001) and McKerchar and Thompson (2004) studies and to provide more detailed

descriptions of observed antecedent and consequent events through the use of narrative recording. This phase also was used to gather information that could inform the arrangement of functional analyses and treatment evaluations in phase 4. Given the goals of this study, we chose not to conduct analyses designed to detect naturally occurring contingencies by comparing conditional and background probabilities (e.g., Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001).) as there are no data to suggest how these more complex analyses might inform the development of a functional analysis or treatment.

Method

Participants

Fifteen of 20 students from phase 2 participated. Participants for whom (a) the interview did not confirm that arranging and ordering was problematic (Anna), (b) target behavior reportedly no longer occurred (Jon), or (c) observations or video recordings were not approved (Al, May, Sara), were excluded from this phase.

Setting

Participants were observed during their typical routines at school or in their residence. Observation times (e.g., morning, afternoon, or evening) and settings (e.g., residence, classroom, or cafeteria) were based on information provided in interviews and the availability of the observer.

Participants were staffed 1:1 or 1:2 (staff: student). On rare occasions, when other students in the classroom were engaging in severe problem behavior that required extra staffing, one teacher managed up to four students. This occurred during only one observation with Jim. All participants had formal behavior management guidelines (e.g., time out contingent on aggression, application of protective helmet contingent on 6 or more hand-to-head self-injurious

responses within 1 min); however, only Ross' guidelines directly addressed arranging and ordering or other related compulsive behavior. Specifically, Ross's guidelines stated that he was allowed to engage in "appropriate fixing," which included ordering community or personal items as long, as it was not disruptive to his or others' routines. Examples of inappropriate fixing were provided (e.g., pulling a string off a stranger's pants without permission or straightening items in a trash can); however, the consequence for inappropriate fixing was not specified.

All teachers had received in-service training in teaching strategies (e.g., errorless teaching) and basic principles of behavior analysis (e.g., reinforcement).

Response Measurement and Interobserver Agreement

Data were collected on arranging and ordering for all participants. When applicable, data were also collected on other higher-level restricted and repetitive behaviors rated a 2 or 3 on the compulsive subscale such as *completeness, washing/ cleaning,* or *repeating*. Other behaviors listed in the compulsive subscale (i.e., *checking*, *counting*, *hoarding/ saving*, and *touch tap*) were not included either because of their covert nature or, in the case of touch/ tap, because of their resemblance to lower-level restricted and repetitive behavior, which were not the focus of the current study.

Definitions provided in the RBS-R were modified based on information from the structured interview to encompass each individual's specific form of the target behavior. Arranging and ordering was defined as moving objects from one location to another (when not related to an activity such as retrieving or putting away leisure items or academic materials or interacting with items as the manufacturer intended), aligning objects against another surface such as a wall, corner, or another object, and lining up or stacking objects. Completeness was defined as closing drawers, closing books, and placing tops on containers (not including

instances during which it would be natural to do so such as after retrieving an item from drawer or reading a book) [3]. Washing/ cleaning was defined as picking at lint or loose threads, picking up trash from floor or other surfaces, and wiping surfaces with hand. Repeating was defined as repeating movements such as going from sitting to standing and then sitting again or moving an item (e.g., chair, desk, or cup) in one direction and then back in the other direction. Arranging and ordering was recorded using a duration measures, and washing/ cleaning, completeness, and repeating were recorded using a frequency measure.

An arranging-and-ordering comment (Alex, Christie, and Ross) was defined as (a) saying "fix," "furniture," or "move" or (b) saying "help" or the name of the item while pointing to or attempting to move that item. Each utterance was recorded as an episode; specifically, a new episode was recorded when at least 1 s elapsed from the previous utterance (e.g., "fix it [1 s pause] I want to fix it please" would be recorded as two episodes).

Data also were recorded on several forms of teacher behavior. Attention was defined as any teacher-initiated vocalization or physical interaction (e.g., rubbing back, blocking) that did not meet the definition for demand. This included requests to terminate an action (e.g., "Stop moving that"), statements of concern (e.g., "Careful, you'll hurt yourself"), comments on the student's behavior (e.g., "I don't understand why you do that"), and general statements of acknowledgement (e.g., "Sure" or "That is correct"). Demand was defined as any teacher-initiated verbal or physical prompt to initiate an action, including presentation of demand materials. Demand was recorded only for the initial prompt, which was defined as the first prompt of the observation period or the first prompt following compliance or escape. Escape was recorded following (a) removal of task materials, (b) 10 s without an additional prompt, or (c) presentation of a new demand without completion of the initial demand. Presentation of

materials was defined as teacher-presentation of a tangible item (e.g., food or leisure item), not including presentation of demand materials or tokens. Tokens were not included in this category because tokens were typically delivered as part of academic or behavior management programs. Removal of materials was defined as teacher-removal of an item that the participant was interacting with (not including demand materials) or teacher-denial of access to a requested item. Both removal and denial were included because both events may evoke problem behavior maintained by access to materials.

All observations were videotaped and scored at a later time. Data on the above-mentioned responses were collected using handheld computers equipped with real-time data collection software. A second, independent observer collected data for 39.9% of observations (range, 34.8% to 55% per participant). Interobserver agreement for duration and frequency measures was determined by partitioning sessions into 10-s bins and comparing data collectors' observations on an interval-by-interval basis. For each interval, the smaller number (duration or frequency) was divided by the larger number. The quotient was then multiplied by 100 and averaged across all intervals. Intervals during which both data collectors agreed that the target behavior did not occur were factored into the above equation as 100 % agreement for that interval. Mean interobserver agreement across participants was 98.2% (range, 77.9% to 100%) for arranging and ordering, 99.9% (range, 94.6% to 100%) for completeness (n = 12), 100% for washing/ cleaning (n = 7), 99.6% (range, 91.9% to 100 %) for repeating (n = 6), 99.6% (range, 96.2% to 100 %) for arranging-and-ordering comments (n = 5), 85.2% (range, 63.2% to 100%) for attention, 93.5% (range, 72.7% to 100%) for demand, 98.3% (range, 89.5% to 100%) for escape, 97.3% (range, 77.8% to 100%) for presentation of materials, and 99.6% (range, 92.3% to 100%) for removal of materials.

Data streams from each observation were reviewed to identify times at which target behavior occurred (hereafter referred to as time stamps); these times were noted on a separate data sheet, which was then used to produce narrative records of the target behavior(s) and consequences (e.g., Bijou et al., 1968; Groden, 1989). Specifically, data collectors viewed portions of video tapes in which a target behavior was noted and described in detail (a) the form of the target behavior, including any materials that were involved and (b) all stimulus changes occurring within 10 s following the target behavior. For example, for removal of materials, data collectors noted the form of arranging and ordering (e.g., aligning), the materials that were involved in arranging and ordering, and whether those were the same materials that were removed. For attention, data collectors noted verbatim what was said and/ or the form of physical attention provided (e.g., pat on back or blocking).

A second, independent observer collected narrative records for a minimum of 33% of time stamps across participants. A third party rated the degree to which narrative records matched by comparing each raters' notations of vocal and nonvocal stimulus changes for each time stamp. For vocal stimulus changes, the number of identical words noted by each rater was divided by the total number of words for that time stamp. When the total number of words varied across raters, the greater number was selected for the denominator. The quotient for each time stamp was multiplied by 100 and averaged across all time stamps. Time stamps during which both data collectors agreed that a vocal stimulus change did not occur were factored into the above equation as 100 % agreement for that time stamp. For nonvocal stimulus changes, interobserver agreement was calculated by dividing the number of agreements by the total number of time stamps (i.e., 32), multiplied by 100. Each time stamp was scored as either an agreement or a disagreement. An agreement was scored if both narrative records provided a

similar description of the stimulus change, including the teacher's action. For example, an agreement was scored if one observer recorded that the teacher "moved the student's hand toward his pockets" and the other observer recorded that the teacher "blocked ordering by touching the student's hand and moving it away from the object." However, a disagreement would be scored if one observer recorded that the teacher "moved the student's hand toward his pockets" and the other observer recorded that the teacher "touched his hand" but provided no additional detail. If materials (presentation or removal) were involved in the stimulus change, an agreement was scored only if both narrative records also contained a similar description of the materials. For example, an agreement would be scored if one observer recorded that the teacher "presented blocks" and the other observer recorded that the teacher "presented a bin of blocks." However, a disagreement would be scored if one observer recorded that the teacher "presented blocks" and the other observer recorded that the teacher "presented a toy." Interobserver agreement for vocal stimulus changes was 95% (range, 60 to 100). Interobserver agreement for the descriptions of nonvocal stimulus changes was 94%.

Procedures

To evaluate the range of possible consequences associated with arranging and ordering and other related compulsive behavior, we observed each participant for approximately 20 min within demand and low attention contexts (40 min total) to insure adequate sampling across contexts typically associated with socially-mediated problem behavior (e.g., Thompson & Iwata, 2001). A demand context was one in which there was (a) a designated task (e.g., academic or daily life skill such as toothbrushing, including an initial prompt to transition to a new activity) and (b) a teacher oriented toward, or within arm's reach of, the participant. A low-attention context was one in which (a) there was no designated task or activity and (b) the teacher was

either not oriented toward the participant or occupied with another student, teacher, or materials. Low attention contexts did not include times during which the participant was alone in a room (analogous to the alone condition of a functional analysis) or engaged in a group activity in which attention was continuously available (e.g., playing catch; analogous to the play condition of a functional analysis). Observations of demand and low attention contexts were scheduled in accordance with those times (e.g., morning, afternoon, or evening) and settings (e.g., classroom, school, cafeteria) identified from the interviews as being associated with relatively high levels of arranging and ordering. Observations within the participants' residence were scheduled based on the availability of observers. Prior to each observation, the observer introduced him or herself and informed the teacher that the observer was interested in observing the student within his/ her typical routine. Teachers were asked to continue with their schedule as if the observer was not present. Teachers who served as informants were not included within observations. Because we videotaped events as they occurred naturally, the introduction and duration of demand and low attention contexts were not controlled. As a result, each observation sample varied (range, 17 s to 780 s). Observation samples were gathered until the sum of the total duration of observation obtained was at least 20 min for demand contexts and 20 min for low attention contexts per student. Because duration of observation within each context was often determined after watching the videos, the total observation obtained for each participant sometimes exceeded 40 min (M = 42 min)

Data Analysis

Conditional probabilities were calculated for the purposes of identifying the prevalence of various consequences following arranging and ordering and other behavior identified as problematic on the RBS-R (e.g., see McKerchar & Thompson, 2004; Thompson & Iwata, 2001).

Conditional probability of a consequence given a target behavior was calculated by counting the number of times a target response was followed by a particular consequence (i.e., attention, escape, materials presented, materials removed) within 10 s of the target response and dividing that number by the total number of target responses. For example, if washing/ cleaning occurred at seconds 10 and 15 and attention was delivered at second 11, then attention occurred within 10 s for one of two responses; the conditional probability of attention following washing/ cleaning was 0.5. This method of calculating conditional probabilities was extended to duration measures by converting target responses that were recorded as duration to a measure of frequency. That is, each episode of the target behavior was partitioned into units of up to 10 s, and each unit was counted as one occurrence of target behavior (frequency of 1). The number of times a unit was followed by the consequence of interest within 10 s of the *beginning* or *end* of that response (or unit) was counted and then divided by the total number of units. Multiple occurrences of the consequence of interest (e.g., attention) within a 10-s window were counted as only 1 consequence. Conditional probability data revealed which social consequences, if any, were associated with arranging and ordering and other compulsive behavior under naturally occurring conditions.

Results

The percentage of students for whom attention, escape, item presentation, and item removal were observed following arranging and ordering on at least one occasion was 90%, 0%, 20%, and 10%, respectively (n = 10). The percentage of students for whom attention, escape, item presentation, and item removal were observed following other related compulsive behavior on at least one occasion was 100%, 20%, 0%, and 20%, respectively (n = 5).

Figure 1 shows the conditional probability of attention, escape, item presentation, and item removal for each topography and student as well as the total number of responses or 10 s bins (for duration measures) for each target behavior.

Attention was the most probable event following each topography for 9 of 10 students. The probability of attention following a target behavior ranged from .02 to 1 (*M* = .54). By contrast, escape occurred following target behavior for only one participant (.02 conditional probability following Jim's repeating). Items were presented following target behavior for only two participants, Adam and Elle, with a conditional probability of .02 and .03, respectively. Similarly, items were removed following target behavior for only two participants, Jim and Ross; the conditional probability of item removal given completeness was .25 for Jim, and the conditional probability item removal following arranging and ordering for Ross was .04. In both cases, the items that were removed were the items involved in the compulsive behavior.

In order to identify the types of topographies and social events following compulsive behavior during naturalistic observations, we described these events in detail using narrative records (see Table 7 for examples). A wide range of verbal responses were delivered following target behavior, including assuring the student that he is okay, stating that items should remain as they are (e.g., "That's fine," "All done," "… you don't need to fix it," "we just fixed it"), assuring the student that items will be fixed (e.g., "Ok, I'll fix it. You can read your book."), reprimanding the student verbally (e.g.,"Stop! Christie, stop."), thanking the student, praising the student, or delivering a demand (e.g., "Sit down"). In some cases, descriptive praise specified an alternate behavior (e.g., "Good job having good hands and a quiet voice.") or the teacher complied with the student's request, which occurred in close temporal proximity with the target response (e.g., tickling the student after student requests, "tickle, tickle"). For Adam, each delivery of an edible

occurred while the teacher provided descriptive praise for an alternate behavior. For Elle, an alternate leisure item was delivered following Elle's lining up of puzzle pieces.

Discussion

In order to obtain direct measures of the prevalence and types of social consequences associated with arranging and ordering and other related compulsive behavior, we conducted naturalistic observations with 15 participants. That attention was, by far, the most frequent consequence following target behavior is consistent with previous studies aimed at identifying the prevalence of social consequences (e.g., McKerchar & Thompson, 2004; Thompson & Iwata, 2001).

The fact that escape was observed only once across all participants may suggest that maintenance by social negative reinforcement is unlikely given that it rarely occurs following arranging and ordering or other compulsive behavior under natural conditions. It is possible, however, that arranging and ordering or other compulsive behavior may serve to delay an upcoming event (avoidance). In fact, 13 of the 20 teachers interviewed during phase 2 responded, "seldom" or "half the time" to the question, "Do you ever have to delay or cancel the next activity as a result of [target behavior]?" Despite this possibility, it is difficult to detect an avoidance contingency under naturalistic conditions because it is difficult to know what would have happened if the target behavior had not occurred (e.g., whether a demand would have been delivered or whether the delivery of a demand was delayed). For example, on one occasion, Ross's teacher began walking toward the door after announcing to another teacher that they were headed to "Academics," which is a separate classroom where Ross completes certain academic tasks. Immediately following this announcement, Ross began arranging and ordering materials on the counter, after which his teacher repeatedly called his name until Ross stopped and followed

him. Because a demand was not presented, escape could not be scored; the only events scored in this instance were target behavior and attention. Environmental cues that signal upcoming events (e.g., an announcement to another teacher, the time on a clock, or the termination of an activity that routinely precedes an aversive event) may serve as establishing operations for behavior that serves to prevent or postpone the presentation of an aversive event.

The generality of the prevalence and types of social consequences provided in the present study may be questioned on the grounds that teachers had, at minimum, basic training in behavior analytic principles. It should be noted, however, that training was not provided specifically for the forms of behavior assessed in this study. Further, at the time that naturalistic observations were conducted, only one participant had written behavior management guidelines that addressed arranging and ordering or other compulsive behavior. Ross's guidelines specified that unless disruptive to his or others' routines or unless it involved trash or the property of others', that he "should be granted access to fix [the item] and then encouraged to continue on with his hourly routine" (procedures for interrupting inappropriate forms of compulsive behavior were not specified).

Interestingly, despite being rated as moderately to severely problematic on the RBS-R in phase 1, we did not observe arranging and ordering or other compulsive behavior during observations for five participants (Alice, Anna, Dean, Dex, and Jack). That target behavior was not observed does not necessarily mean that teachers' reports of the prevalence (occurrence) of these topographies during phase 1 were inaccurate (i.e., that the student does not engage in these topographies). First, it should be noted that our observations were relatively brief (40 min); target behavior may have been observed had the length of observation been extended. Second, it is possible that the relevant establishing operations or discriminative stimuli were not present when

we conducted naturalistic observations—despite our attempts to observe during times and settings reported to be problematic. For example, during observations of Dex, whose arranging and ordering consisted of aligning materials against the wall, materials commonly reported to be arranged and ordered such as water bottles or books were already aligned against the wall on his desk when observations began. If some property of the final placement or location of the materials ordered functioned as the reinforcer maintaining Dex's arranging and ordering, then having items already placed by the wall may have functioned as an abolishing operation. The conditions under which Dean's target behavior was reported to occur also suggested that some property of the placement of materials may have functioned as a reinforcer (e.g., teachers reported that he would arrange materials as they were when he first entered a room). Teachers' previous history with the aversive consequences associated with disrupting the arrangement of materials (e.g., vocal perseverations or problem behavior) may have decreased the likelihood that teachers would engage in behavior (e.g., alter the arrangement of items) that may evoke arranging and ordering or other related problem behavior. Because the main purpose of this phase was to describe events as they occur naturally, we did not program any changes in the environment. Such modifications would however, be necessary for identifying the function of behavior within a functional analysis.

PHASE 4: FUNCTIONAL ANALYSIS AND TREATMENT

Functional analyses involve the direct manipulation of environmental events, which allows for the identification of causal relations (Skinner, 1953). This process reveals relations between problem behavior and the environment and can be important to the development of effective interventions (e.g., Iwata, Pace, Cowdery, & Miltenberger, 1994).

Iwata et al. (1982/ 1994) developed the first comprehensive functional analysis for determining the sensitivity of behavior to social positive, social negative, and automatic

reinforcement contingencies. The model involved direct manipulation of antecedents and consequences within test and control conditions. The test conditions included in Iwata et al.'s functional analysis were based on conceptual analyses (e.g., Carr, 1977) and previous literature demonstrating the relation between problem behavior and environmental events such as caregiver attention (e.g., Lovaas, Freitag, Gold, & Kassorla, 1965) and escape from demands (e.g., Carr, Newsom, & Binkoff, 1976, 1980). In the attention and escape test conditions of Iwata et al.'s functional analysis, the relevant motivating operation was arranged (no attention, demands) with the respective consequence (attention, escape) provided contingent on each occurrence of problem behavior. An alone condition was included to test for behavior maintained by automatic reinforcement (i.e., nonsocially mediated reinforcement produced as a direct result of the behavior). Functional relations were then determined by comparing levels of problem behavior in each test condition to levels of problem behavior in a control condition in which contingencies arranged in test conditions were absent.

Functional analyses similar to Iwata et al.'s (1982/ 1994) were originally applied to the assessment and treatment of self-injurious behavior but have since been applied to the study of a wide range of problem behavior such as aggression (e.g., Fisher et al., 1993; Piazza, Fisher et al., 1997), bizarre vocalizations (e.g., Mace & Lalli, 1991), elopement (e.g., Piazza, Hanley, et al., 1997), and pica (e.g., Piazza et al., 1998). Of the topographies included in the restricted and repetitive category of the autism diagnosis, functional analyses have been applied to lower-level repetitive behavior such as motor stereotypy (e.g., hand flapping, body rocking; e.g., Kennedy et al., 2000). Together, these studies demonstrate the generality and flexibility of functional analyses and can inform the assessment and treatment of higher-level repetitive behavior such as arranging and ordering.

In a review of the literature on behavioral assessment and treatment of stereotypy, Rapp and Vollmer (2005) noted that although there is some evidence that stereotypy might be susceptible to social contingencies (e.g., Durand & Carr, 1987; Kennedy et al., 2000), the overwhelming majority of the literature suggests that most stereotypy is maintained by automatic reinforcement.

Because the direct consequences of automatically maintained behavior are often difficult to manipulate, automatic reinforcement is inferred in a functional analysis based on the persistence of behavior in the absence of social contingencies. LeBlanc, Patel, and Carr (2000) noted three patterns of responding in a functional analysis that may be indicative of behavior maintained by automatic reinforcement: (a) high levels of responding in the alone condition and low levels of responding in the attention, escape, and control conditions, (b) high levels of responding across all conditions, or (c) differentially high levels of responding across conditions with low stimulation (e.g., alone, low attention, or escape intervals but not the control [or play] condition). However, because these two latter patterns of responding may also result from behavior maintained by multiple sources of reinforcement, thin intermittent schedules of social reinforcement operating outside of experimental sessions (Vollmer, Iwata, Duncan, & Lerman, 1993), or carry over effects (in a multielement design; Higgins Haines & Baer, 1989), conclusions regarding an automatic function should remain tentative until further evidence can be provided. For example, when levels of responding are undifferentiated or high across all test conditions, stronger evidence of an automatic function is demonstrated when levels of responding maintain across a series of extended or repeated alone (or no-interaction) sessions (e.g., Ringdahl, Vollmer, Marcus, & Roane, 1997; Vollmer Marcus, & LeBlanc, 1994).

High levels of responding across multiple conditions in the functional analysis may also

result from a failure to isolate maintaining variables (Smith, Iwata, Vollmer, & Zarcone, 1993). In such cases, the strategic implementation of function-based treatments may serve to clarify ambiguous results (e.g., Kuhn, DeLeon, Fisher, & Wilke, 1999; Smith et al.; Thompson, Fisher, Piazza, & Kuhn, 1998). In one illustrative example, Kuhn et al. applied matched and mismatched extinction procedures to clarify variables maintaining the self-injurious behavior of a 35-year-old male diagnosed with autism, obsessive-compulsive disorder, and severe mental retardation. High rates of self-injurious behavior were observed in the alone and escape conditions of the initial functional analysis. Although these results suggested that behavior was maintained by automatic and social negative reinforcement, it was possible that responding persisted in the escape condition not because of the escape contingency but because of the low levels of stimulation during escape intervals. To identify whether self-injurious behavior was *also* maintained by escape, Kuhn et al. evaluated the isolated and combined effects of sensory and escape extinction. Rates of self-injurious behavior decreased only in those conditions in which the putative automatic reinforcer was unavailable (i.e., sensory extinction or sensory extinction + escape extinction). Because responding did not persist when self-injurious behavior resulted in escape but not access to the automatic reinforcer (i.e., sensory extinction), an escape function was ruled out. By contrast, because rates of self-injurious behavior maintained at baseline levels only when the automatic reinforcer was available (independent of an escape contingency), the automatic function was confirmed. Thus, despite the fact that self-injurious behavior persisted in the escape condition of the initial functional analysis, subsequent analyses revealed that self-injurious behavior was not maintained by escape but by automatic reinforcement alone. In addition to clarifying maintaining variables, such procedures were beneficial in revealing viable treatment options.

Rapp and Vollmer (2005) outlined four sources of empirical support for behavior maintained by automatic reinforcement that also have implications for treatment: (a) decreased responding when the putative response-reinforcer relation is disrupted or attenuated (also referred to as sensory extinction; e.g., via response blocking or protective equipment; e.g., Kuhn et al., 1999; Rincover, Cook, Peoples, & Packard, 1979), (b) decreased responding when alternate sources of stimulation hypothesized to match the source of automatic reinforcement (i.e., matched stimuli) are available (e.g., Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Piazza et al., 1998; Rincover et al.), (c) increased responding in an alternative response when access to stereotypy is provided contingent on that response (e.g., Charlop, Kurtz, & Casey, 1990; Hanley, Iwata, Thompson, & Lindberg, 2000), and (d) behavior change in accordance with restricted or unlimited prior access to stereotypy, demonstrating sensitivity to motivating operations (e.g., Rapp, 2006).

Among the procedures used to treat automatically maintained behavior, those aimed at disrupting the response-reinforcer relation or providing alternate sources of matched stimuli are most common (Rapp & Vollmer, 2005). One of the advantages of providing access to alternate sources of stimulation as treatment for automatically maintained problem behavior is that it provides an opportunity to engage in an appropriate alternative response. However, simply providing access to alternate stimuli may not be sufficient to decrease automatically maintained problem behavior or increase item engagement (Lindberg, Iwata, & Kahng, 1999; e.g., Hanley et al., 2000; Piazza et al., 1998). In such cases, additional strategies such as prompts, response blocking, or reinforcement may be necessary to increase contact with the alternate source of stimulation or prevent access to the stimulation produced by problem behavior.

General Method

Participants

Three participants, Jim, Ross, and Christie participated in the functional analysis and treatment phase of the study. Participants in this phase were selected based on the frequency and severity of their arranging and ordering and other related compulsive behavior.

Jim was a 15-yr-old male diagnosed with PDD. Jim followed simple instructions and spoke in one- to three-word sentences but with a limited vocabulary. Jim's compulsive behavior included arranging and ordering, completeness, and repeating (see Table 6 for examples). Jim also engaged in high rates of lower level stereotypy including vocal stereotypy and repetitive touching or tapping of items and surfaces. Collectively, his repetitive behavior occurred at such a high rate that his teachers described him as constantly moving or engaging in some form of repetitive behavior. He also engaged in ritualistic behaviors, for example, Jim would engage in a series of motions prior to drinking from the cup (e.g., tapping the cup on the table, pausing, bringing the cup to his mouth, pausing, setting the cup down on the table, picking it up again, bringing the cup to his mouth, pausing, and then taking a sip). Teachers reported that the severity of Jim's compulsive behavior made it difficult to complete academic work with him, was difficult to interrupt or redirect, and that he would sometimes push his teacher out of the way to arrange and order items.

Ross was a 13-yr-old male diagnosed with autism. Ross followed instructions and spoke in one- to three-word sentences. Ross's compulsive behavior included arranging and ordering, completeness, and washing/ cleaning (see Table 6 for examples). Teachers reported that Ross excessively straightened or organized items (e.g., on shelves, closet, or refrigerator) or fixed anything that was out of place (e.g., a loose thread on someone's shirt). His arranging and

ordering often caused delays. For example, when retrieving a drink from the refrigerator during dinner, Ross often arranged items in the refrigerator until someone interrupted him. Ross arranged items in trash bins. His compulsive behavior also extended to other people (e.g., fixing buttons or loose threads on others' clothing), which teachers reported could cause problems if it involved another student (e.g., that student could aggress toward Ross). Ross's picking of loose threads on his own clothing sometimes resulted in large holes in his clothing. In addition, interruption of compulsive behavior sometimes resulted in minor self-injurious behavior, property destruction, tantrums, or verbal perseveration on the item until it was fixed.

Christie was a 15-yr-old female diagnosed with autism. Christie followed simple instructions and spoke using three- to four-word sentences. Christie's compulsive behavior included arranging and ordering of furniture and other items (e.g., magazines or leisure items) as well as arranging and ordering comments (see Table 6 for examples). Teachers reported that interrupting or blocking arranging and ordering of furniture or other items often resulted in aggression or self-injurious behavior. Among the most problematic forms of arranging and ordering was her arranging of large pieces of furniture, which could be dangerous, for example, should the furniture become unstable and fall.

Settings and Materials

Settings and materials varied across participants and were based on information provided in interviews and naturalistic observations. In order to ensure that differences in the initial arrangement of furniture and materials did not confound results (e.g., by varying motivating operations or creating unequal opportunity to engage in targeted behavior), each session of functional analyses and treatment evaluations began with all furniture and materials in the same arrangement. Materials (aside from leisure items in attention and play condition) were also held constant across sessions to ensure equal opportunity to engage in target behavior.

Different-colored discriminative stimuli (S^Ds; i.e., poster board, t-shirt, and/ or tablecloth) were paired with each condition of the functional analysis to facilitate discrimination between contingencies operating in different conditions (Conners et al., 2000).

Response Measurement and Interobserver Agreement

Response definitions and measurement were identical to those used in the naturalistic observation phase, with one exception. Because Jim repeatedly aligned the same object in the same manner in rapid succession (e.g., placing the trash bin in the corner of the room four times in a row within 4 s), measurement of arranging and ordering for Jim was changed from duration in the naturalistic observation to frequency of episodes in the functional analysis and treatment evaluation. The definition of arranging and ordering remained the same; however, a new episode was scored after a 1-s pause from the last episode or contact with a new item.

When applicable during treatment evaluations, data also were collected on item engagement, prompts, response blocking/ interruption, and product replacement. Duration of item engagement was defined differently for each item but generally included item contact plus appropriate manipulation (not including stereotypy). Response blocking/ interruption was scored

when the experimenter placed her hand between the participant and the materials involved in response to the target behavior or attempts, which involved physical contact with the participant. Product replacement was scored when the experimenter replaced materials moved by Christie during session. To accommodate responding during response blocking/ interruption conditions, target response definitions also included attempts.

Sessions were recorded for data collection at a later time. Data during all analyses and treatment evaluations (not including paired-item preference assessments and Christie's single stimulus engagement assessment) were collected using handheld computers. A second observer independently collected data for a minimum of 33% of sessions, distributed equally across conditions. Interobserver agreement was calculated on an interval-by-interval basis (see naturalistic observation for description of calculation). Agreement scores for each participant are listed in Table 7.

For paired-stimulus preference assessments, data on selections were collected using paper and pencil. A second observer collected data for 34% to 100% of trials. Interobserver agreement was calculated by determining the number of trials on which data collectors recorded the same selection (i.e., an agreement), divided by the total number of agreements plus disagreements, and multiplying that number by 100. Mean agreement across participants was 98.61% (range, 95.83% to 100%).

A 5-s momentary-time-sample (MTS; see Powel, Martindale, & Kulp, 1975) was used to record data during Christie's single stimulus engagement assessment. A second observer collected data for 35% of trials. Interobserver agreement was calculated by determining the number of time samples on which data collectors recorded the same selection (i.e., an agreement), divided by the total number of agreements plus disagreements, and multiplying that

number by 100. Item-engagement agreement for Christie's single stimulus engagement assessment was 95.37%.

Jim

Functional Analysis

Setting. Jim's assessment and treatment sessions were conducted in a 1.5-m by 3-m room equipped with a wide-angle video camera. The room contained a desk, two chairs, a cardboard box, a trash bin, a set of drawers, five notebooks and magazines, two stacks of mismatched cups, a silverware tray with plastic silverware, academic materials (e.g., money, colored cards), and a container of items. On the desk was a pencil holder with pencils and pens, a ruler, two cups, and a water bottle. Items in the session room were intentionally unaligned (e.g., the box was near the wall but placed at an angle and the desk was against the wall but with approximately 3 cm of space between the desk and wall) or "incomplete" (e.g., magazines and notebooks were left open and drawers and the top of the container were left slightly ajar). This was done to allow multiple opportunities to arrange and order or complete items.

Procedures. Functional analysis procedures were similar to those described by Iwata et al. (1982/ 1994). Three test conditions (attention, escape, and no-interaction) and a control condition were alternated in a multielement design. In the attention condition, the experimenter told the participant, "I have some work to do. You can play with your toys." Two low-preference leisure items (selected based on results of a paired-item preference assessment; Fisher et al., 1992) were made available while the experimenter pretended to be occupied reading a magazine. Contingent on target behavior, the experimenter provided attention on a fixed-ratio (FR) 1 schedule. Based on narrative records from Jim's naturalistic observation, attention took the form

of comments about the ordering (e.g., “It’s fine Jim, you don’t need to fix it.”) or reprimands (e.g., “Stop!,” “Leave it.”).

An escape condition was included in order to identify whether the targeted repetitive behavior functioned to delay, postpone, or terminate a non-preferred activity. Demands were selected based on interviews and descriptive data and were delivered using three-step guided compliance (i.e., verbal, gestural/ model, and physical prompt with 5 s between each prompt). Contingent on target behavior, the experimenter turned away from the participant and provided a 30-s break from the task. Demand materials were removed only when those materials were not involved in arranging and ordering. An avoidance contingency was also included, whereby the escape interval was extended by 30 s contingent on target behavior. The inclusion of an avoidance contingency was consistent with naturalistic observations, during which Jim sometimes arranged and ordered or completed items prior to transitioning to a new location and activity, which may have delayed the onset of the next activity. In such cases, stimuli other than an explicit instruction may have signaled the onset of a new activity (e.g., when the teacher asked Jim whether he needs to go to the bathroom and then began walking to the bathroom). A no-interaction condition was included in order to identify whether the target repetitive behavior maintained in the absence of social contingencies. A no-interaction condition was included instead of an alone condition for Jim so that the experimenter could position herself in front of the door to the session room to prevent Jim from repeatedly opening and closing the door or attempting to leave the session room. In the no-interaction condition, the experimenter was in the room but not attending to the participant. Prior to session, the experimenter told the participant that she would not be able to interact with him for 10 min. No differential consequences were provided for target behavior during session.

In the control condition, no demands were presented and attention was delivered every 30 s or contingent on requests for attention (e.g., verbal requests for "tickles"). However, if problem behavior occurred immediately prior to a scheduled attention delivery, attention was delayed for 5 s. In addition, two highly preferred leisure items, selected based on the results of a paired-item preference assessment (Fisher et al., 1992), were continuously available.

Experimental conditions were conducted in a fixed sequence (i.e., no-interaction, attention, control [i.e., play], and escape; e.g., Iwata, Pace, Dorsey, et al., 1994). A series of repeated no-interaction sessions were conducted at the end of the analysis to determine whether responding would persist in the absence of social contingencies, providing further support for an automatic function.

Results. Jim's functional analysis is depicted in Figure 2. Levels of responding were variable across all conditions and persisted across a series of no-interaction sessions, suggesting that Jim's arranging and ordering and completeness were maintained by automatic reinforcement.

Treatment Evaluation

Baseline. The series of no-interaction sessions at the end of Jim's functional analysis served as the baseline for Jim's treatment evaluation.

Leisure Items (LI). Sessions were similar to baseline except that two leisure items were continuously available. Because informal observations during probes suggested that there were few leisure items that Jim engaged with appropriately (i.e., Jim typically banged, ripped, or threw items), a preliminary competing items assessment (e.g., Piazza et al., 2000) was not conducted. Instead, leisure items were selected based on whether they (a) could be arranged in a manner that minimized inappropriate play (e.g., by fastening items to a table) and (b) were likely

to produce automatic reinforcement similar to that produced by arranging and ordering or completeness.

Leisure items included a learning cube and a toy bin. The learning cube (.30 m by .30 m by .30-m) contained rollercoaster beads, a sliding peg maze, an abacus, and a xylophone. The toy bin (.53 m by .46 m by .36 m) contained a variety of leisure items (e.g., monster truck and ball) as well as materials that could be arranged and ordered or completed but on a smaller, more contained scale (e.g., miniature drawers and containers). Because Jim typically engaged inappropriately with leisure items, the learning cube was secured to the table using bungee cords, and items in the bin were attached by strings such that Jim could not throw or destroy them.

Play Skills Training. Because item engagement was low when leisure items were introduced, we conducted separate training sessions to teach Jim appropriate item engagement prior to continuing with the treatment evaluation.

Sessions were 5 min and were conducted in the same room as the functional analysis and treatment evaluation. However, unlike other assessments, materials in the room were restricted to two leisure items (the learning cube and toy bin), a table, and two chairs. In addition, during all play skills training sessions, Jim was allowed to get up from his chair but was blocked from leaving the area of the room containing leisure items. Limiting the materials present in the room as well as Jim's access to other areas of the room allowed for more controlled training conditions.

Baseline. During baseline, leisure items were available and inappropriate play was blocked. No other differential consequences were provided. Although prompts were not delivered during baseline, a voice recorder, which was used to signal 15-s intervals in the prompts condition, also played throughout baseline sessions.

Prompts. This condition was similar to baseline except that prompts were provided every 15 s *unless* Jim was already engaged with one of the leisure items. Thus, the number of prompts per session varied depending on whether Jim was already engaged at the time a prompt was programmed. Specifically, if Jim was not engaged with an item at the end of a 15-s interval, the experimenter delivered a nondirective verbal/ model prompt (e.g., "Let's put all the blue pegs over here" while modeling the action; e.g., Piazza, Contrucci, Hanley, & Fisher, 1997). If Jim did not engage with a leisure item within 2 s of the verbal/ model prompt, the experimenter provided the least amount of physical guidance necessary to initiate item engagement. Jim typically required only brief physical guidance toward the leisure item to initiate item engagement; however, on occasion, Jim strongly resisted physical guidance at which point the experimenter attempted to physically guide him for up to 5 s.

Play skills training data are depicted in the middle panel of Figure 3. After demonstrating experimental control of the effects of prompting on item engagement within separate play skills training, the treatment evaluation was reinitiated and the effects of prompting on arranging and ordering and completeness were evaluated.

LI+ Prompts. This condition was the same as the LI condition except that the prompting procedures used during play skills training were implemented within the treatment evaluation.

LI + Prompts + Response Blocking/ Interruption (RB). A response blocking/ interruption component was added to disrupt the relation between arranging and ordering and completeness and the resulting automatic reinforcer. *Attempts* to engage in target behavior were blocked by placing the experimenter's hand between the participant's hand and the materials involved in arranging and ordering and completeness. If the experimenter could not successfully

block the response, the target behavior was interrupted following initiation of the response and the item ordered or completed was immediately replaced to its original position.

LI + Prompts + RB 2 s. Anecdotal observations during LI + Prompts + RB sessions suggested that Jim was engaging in repeated, successive attempts to arrange and order materials. Thus, the duration of response blocking/ interruption was extended to 2 s in an attempt to more effectively interrupt repeated attempts at the target behavior. Specifically, contingent on attempts to arrange and order or complete items, the experimenter blocked the response and guided Jim's hands to his lap for 2 s. If the experimenter could not successfully block the response, the target behavior was interrupted following initiation of the response, Jim's hand were physically guided to his lap for 2 s, and the item ordered or completed was immediately replaced to its original position.

Teachers. After demonstrating experimental control over the intervention package, two of Jim's teachers (Teachers A and B) implemented the final treatment. All other stimulus conditions (e.g., setting, arrangement of materials, voice recorder) remained constant. Prior to each teacher's first session, the experimenter described the procedures, provided a brief demonstration, and answered questions. During sessions, the experimenter remained in the session room and provided immediate feedback as necessary. Subsequent sessions were preceded by a brief review of the procedures and an opportunity for teachers to ask additional questions.

Results and Discussion. The top panel of Figure 3 shows the results of Jim's treatment evaluation. We began Jim's treatment evaluation with an assessment of the effects of providing access to leisure items amenable to appropriate forms of arranging and ordering and completeness. High rates of compulsive behavior and low levels of item engagement suggested that the automatic reinforcement produced by engaging with leisure items did not compete with

the automatic reinforcement produced by engaging in arranging and ordering and completeness. Because teacher reports and direct observations suggested that Jim lacked appropriate play skills, we conducted separate play skills training (Figure 3, middle panel) in order to teach Jim how to appropriately engage with leisure items and in order to bring Jim's behavior into contact with the putative automatic reinforcement produced by engaging with leisure items. Play skills training produced a small but consistent increase in enagement.

When prompts were introduced into the treatment evaluation (LI + prompts condition), the level and variability of arranging and ordering and completeness decreased and item engagement increased. Although experimental control over the effects of LI + prompts was not demonstrated, and thus it is unknown whether these effects would have been replicated, potential processes responsible for decreased levels of compulsive behavior in this condition are still worth considering. Because prompts were brief and several materials that Jim typically arranged and ordered or completed were within arm's reach of the leisure items, reductions in compulsive behavior cannot be attributed to decreases in the opportunity to engage in compulsive behavior. Prompts may have served to interrupt arranging and ordering and completeness, perhaps by diverting attention, albeit temporarily, away from some of the materials Jim typically arranged and ordered or completed.

Although the rate of compulsive behavior decreased in the LI + prompt condition relative to baseline rates of compulsive behavior, further decreases were desirable. We began by introducing response blocking with the goal of disrupting the response-reinforcer relation between compulsive behavior and the automatic reinforcement it produces, but the rate of arranging and ordering and completeness increased. When the length of response blocking was extended to 2 s, rates of compulsive behavior decreased below those observed in the LI +

prompts condition. Anecdotally, when response blocking/ interruption was first introduced (LI + prompts + RB), Jim engaged in repeated, successive attempts to arrange and order or complete an item. Extending the duration of response blocking/ interruption during the LI + Prompts + RB 2 s condition appeared to interrupt these repeated attempts.

In the final sessions of the treatment evaluation (sessions 45-48), the rate of prompting was on a decreasing trend (Figure 3, bottom panel) and the percentage of item engagement was on an increasing trend. It is possible that, with repeated exposure, engaging with leisure items may have begun to take on automatic reinforcement properties. High levels of item engagement in the absence of prompting would provide further evidence of this possibility. Alternatively, it is possible that item engagement served to avoid prompts (prompts were delivered every 30 s unless Jim was already engaging with leisure items) and that increases in item engagement can be attributed to negative social reinforcement. Additional analyses would be necessary to evaluate the behavioral processes responsible for increased item engagement.

Ross

Functional Analysis

Setting. Ross's functional analysis was conducted in a 1.5-m by 3-m room. One wall was composed of 24 cubbies. Interviews and naturalistic observations informed the types of materials that were present during experimental analyses and their arrangement at the start of sessions. Cubbies contained various items including bins of toys, notebooks, academic materials (e.g., pens, scissors, and rulers), stacks of cups, and a silverware tray. Several items were mismatched (e.g., several Legos® were placed in a bin of wooden blocks), placed outside of their bins, or unaligned (e.g., notebooks were not aligned and one notebook leaned against the others at a 45 degree angle). The rest of the room contained a desk, a set of drawers left slightly

ajar, a plant, an open magazine, and a full trash bin. Because Ross reportedly arranged items in trash bins, we assured that items inside the trash bin were sanitary. Finally, three loose threads were placed on various parts of the experimenter's clothing (e.g., sleeve, shirt, and pant leg).

Procedures. Procedures were identical to Jim's functional analysis; however, antecedent and consequent events were adjusted to accommodate information gathered from interviews and naturalistic observations. Based on narrative records from Ross's naturalistic observation, attention in the attention condition took the form of comments on the behavior (e.g., "It's fine Ross, you don't need to fix it,") or reprimands (e.g., "Stop!," "Leave It."). Interview and descriptive data also suggested that Ross's target behavior may have been associated with transitioning to new locations and activities. For example, during naturalistic observations, approximately 80% of target responses occurred while transitioning (e.g., to retrieve his academic book from the bookshelf across the room). In addition, 5 of 33 target responses occurred within 10 s of a demand; 75% of these demands involved transitioning to retrieve or put away an item and 25% involved a demand to come to the other side of the desk and sit down (escape was not scored because the teacher provided repeated prompts to complete the demand). Thus, demands requiring Ross to get up or move around the room to retrieve items (e.g., "Bring your academic book to the table," "Get the scissors and bring them to the table.") were initially included in the escape condition.

Ross's descriptive data also suggested that compulsive behavior occurred following stimuli other than an explicit instruction (e.g., when a teacher said to another teacher, "We're on our way to the academic classroom."). Because compulsive behavior may have functioned to delay the next activity, we included an avoidance contingency to more closely approximate Ross's experiences in the naturalistic observation.

A no-interaction condition was included instead of an alone condition to provide an opportunity for Ross to pick loose threads from other people's clothing (scored as washing/ cleaning), which teachers reported as problematic. In addition, having the experimenter in the session room assured that the video camera used for data collection could be repositioned, when necessary, to capture target behavior.

In order to determine whether demands that required Ross to move around the room were influencing levels of responding in the escape condition, furniture and materials were rearranged (sessions 21-35) such that Ross no longer had to get up from his chair at the desk to retrieve items.

Results and Discussion. Ross's functional analysis is depicted in Figure 4. Levels of responding were differentially higher in the no-interaction and escape conditions across both environmental arrangements and persisted across a series of repeated no-interaction conditions, suggesting that Ross's arranging and ordering was maintained by automatic reinforcement and escape from demands.

Prior to session 21, levels of arranging and ordering were generally higher in the escape condition. Interestingly, the change in proximity of session materials (sessions 21-35) did not appear to influence levels of responding in the escape condition, suggesting that demands that required Ross to move around the room did not influence levels of arranging and ordering. By contrast, levels of arranging and ordering in the no-interaction condition increased when materials were arranged within arm's reach of the desk. Although it is not clear why this change occurred, based on anecdotal observations, Ross typically began no-interaction sessions sitting in the chair at the desk. Changing the arrangement of the room may have decreased the response

effort associated with target behavior, resulting in a corresponding increase in arranging and ordering.

Completeness and washing/ cleaning are depicted separately (bottom panel of Figure 4) because we used a frequency measure to record their occurrence. Like arranging and ordering, differentially high levels of responding occurred in the no-interaction and escape conditions of the functional analysis. By contrast, when materials were moved within arm's reach, the rate of completeness and washing/ cleaning in the escape condition decreased. These results suggest that completeness and washing/ cleaning were maintained by automatic reinforcement. The reason for the difference in the rate of responding in the escape condition across both experimental arrangements is unknown. Although it is possible that completeness and washing/ cleaning may have been evoked by a particular type of demand (those requiring Ross to move about the room), it is also possible that the establishing operation for these responses had been decreased by inadvertently decreasing the salience of some of the items typically involved in completeness or washing/ cleaning (e.g., items on the floor behind Ross may be less salient when demands provided in the escape condition do not require Ross to get up from his chair). Additional analyses would be necessary to identify the variables responsible for decreased rates of completeness and washing/ cleaning in the escape condition when items were arranged within arm's reach.

Escape Analysis

Elevated levels of responding were observed across no-interaction and escape conditions in the functional analysis, suggesting that arranging and ordering was maintained by both automatic reinforcement and escape from demands. However, it is possible that responding in the escape condition was not due to the avoidance or escape contingency but, instead, to the lack

of alternate stimulation available during avoidance or escape intervals (Kuhn et al., 1999). If so, lower levels of responding may have been observed in the control and attention condition because highly preferred leisure items in the control condition competed with arranging and ordering and verbal comments in the attention condition functioned as punishment. Thus, we conducted an analysis similar to that conducted by Kuhn et al. (1999) to clarify maintaining variables.

Settings. Ross's escape analysis was conducted using a multiple baseline across settings design. The first setting was the same as the within arms reach phase of the functional analysis. The second setting was a classroom equipped with a 1.5-m by 1.5-m table, six chairs, a computer and desk, three bookshelves containing a variety of books and leisure items, a locked toy cabinet, a set of drawers left slightly ajar, a plant, and a trash bin filled with clean items. Like the functional analysis, items were mismatched, placed outside of their bins, or unaligned. In addition, three loose threads were placed on the experimenter's clothing.

No-interaction/ Escape. The no-interaction and escape conditions from the second phase of Ross's functional analysis served as the baseline for the escape analysis in the first setting (top panel, Figure 5). Baseline in the second setting (bottom panel, Figure 5) was similar to the no-interaction condition of the function analysis.

Automatic Extinction (Auto Ext)/ Auto Ext + Escape. To determine whether target behavior was also maintained by escape, the automatic reinforcer was eliminated across both no-interaction and escape conditions (e.g., Kuhn et al., 1999). If target behavior was also maintained by escape from demands, responding would persist in the escape condition when attempts to engage in target behavior resulted in escape but not access to the automatic reinforcer.

Alternatively, if responding was not maintained by escape, then responding would decrease in the escape condition when the automatic reinforcer was eliminated.

Auto Ext. During Auto Ext, the experimenter blocked attempts to engage in target behavior (i.e., response blocking) or interrupted target behavior following initiation of the response (i.e., response interruption) preventing access to the automatic reinforcer. If Ross successfully displaced an item (which occurred rarely), the item was immediately replaced to its previous position. For example, if Ross adjusted the couch cushion, the experimenter immediately interrupted the response and replaced the couch cushion to the position it was in prior to Ross's ordering.

Auto Ext + Escape. This condition was similar to the escape condition of the functional analysis except that Ross was prevented from accessing the automatic reinforcer for target behavior. In other words, *attempts* continued to result in a 30-s break from demands or a 30-s delay to the onset of the next demand and target behavior was blocked.

Results and Discussion. Because arranging and ordering in the escape condition may have been due to the lack of alternate stimulation available during avoidance or escape intervals rather than the contingency programmed in the escape condition of the functional analysis (Kuhn et al., 1999), we conducted an additional escape analysis in order to clarify maintaining variables.

Figure 5 shows the results of Ross's escape analysis. When the automatic reinforcer was eliminated, levels of arranging and ordering decreased across both Auto Ext and Auto Ext + escape conditions. That is, responding did not maintain when escape was provided as a reinforcer, suggesting that arranging and ordering was maintained by automatic reinforcement alone.

An alternate explanation is that Ross's original functional analysis was accurate and that response blocking in the escape analysis functioned as a punisher. The fact that responding gradually decreased when response blocking was introduced in the auto ext and auto ext + escape conditions, which is similar to patterns of responding when extinction is introduced (extinction curve), suggests that automatic extinction and not punishment was responsible for decreased responding during the escape analysis.

Additional support for or against maintenance by escape when responding is differentially higher in the no-interaction and escape conditions of the functional analysis may be provided by analyzing within-session patterns of responding during the escape interval of the escape condition (Kuhn et al., 1999); high levels of responding during the escape intervals when no demands are being placed on the individual may suggest that behavior is maintained by automatic reinforcement. Because naturalistic observations suggested that Ross's arranging and ordering, completeness, and washing/ cleaning may serve to delay the onset of demands under naturally occurring conditions, we programmed an avoidance contingency within the escape condition of the functional analysis. Differential consequences (i.e., delay) programmed contingent on behavior during escape intervals, precluded the ability to use within session patterns as evidence for or against an escape function. Nevertheless, the escape analysis served as a more convincing demonstration that escape was not a maintaining variable.

Treatment Evaluation

Although the escape analysis suggested that response blocking was sufficient for decreasing target behavior, we conducted a separate treatment evaluation to determine (a) the influence of competing items on target behavior and item engagement and (b) whether the effects of response blocking would persist under less than optimal procedural integrity.

Setting. Due to the limited availability of settings used during the functional analysis and automatic versus escape analysis, Ross's treatment evaluation was conducted in a third setting, the basement of his residence. The basement contained a TV cabinet, a couch, a set of drawers left slightly ajar, a table with two chairs, two toy bins, a tall metal cabinet, two treadmills, an exercise bicycle, and a trash bin filled with clean items. Like previous analyses, materials were mismatched, placed outside of their bins, or unaligned. Instead of loose threads on the experimenter's clothing, four small pieces of paper were scattered across the floor (picking up trash from floor was scored as washing/ cleaning). Unlike previous analyses, a plant was not present in the room.

Competing items assessment sessions were conducted in a 1.5-m by 3-m room that contained items that could be arranged and ordered, completed, or washed/ cleaned (e.g., containers of items, notebooks, full trash bin, and plant).

Competing Items Assessment. We conducted a separate competing items assessment (Piazza et al., 2000) to identify leisure items to be included in the competing items condition of the treatment evaluation. Eight stimuli amenable to appropriate forms of arranging and ordering (e.g., Lite Brite®) were presented singularly during 5-min sessions. Each item was presented twice and in a random order. In addition, two sessions during which no leisure items were present were included as a control.

Data were collected on duration of item engagement, duration of arranging and ordering, and frequency of completeness and washing/cleaning. Percentage of item engagement and arranging and ordering for each session was calculated by dividing the duration of the target response by the total duration of session (5 min). Mean percentage of item engagement and arranging and ordering are depicted in Figure 6. Completeness and washing/cleaning (not

depicted in this figure) occurred only a total of five times across control sessions, twice across Legos® sessions, and once across shuffle puzzle sessions.

Stimuli associated with high levels of item engagement and low levels of target behavior (Lite Brite®, basketball pinball, and maze; see Figure 6) were evaluated within the competing items condition of the treatment evaluation.

Baseline. Baseline was similar to the no-interaction condition of the functional analysis. Sessions were 10 min.

Competing Items (CI). The competing items condition of the treatment evaluation was similar to baseline except that the three competing items identified from the competing items assessment were continuously available throughout session.

Intermittent Response Blocking (INT RB). Because levels of responding did not recover when response blocking was removed in the return to no-interaction and escape conditions in the escape analysis (top panel, Figure 5), we hypothesized that responding would maintain at low levels even when response blocking was implemented intermittently. If effective, intermittent response blocking would serve as a practical alternative to response blocking on an FR 1, particularly because Ross typically had a 1:2 teacher-to-student ratio. Sessions were identical to the competing items condition except that the experimenter blocked the first three out of every four attempts to engage in target behavior (e.g., see Lerman & Iwata, 1996$_a$; Smith, Russo, & Le, 1999). Because arranging and ordering was measured as duration, we developed criteria for initiating response blocking during (or following) the fourth attempt, during which Ross was allowed to arrange and order. The three-out-of-four sequence of response blocking was reinitiated following (a) 10 s of arranging and ordering, (b) a 3-s pause between target behavior

(criteria for turning off the duration key during data collection for arranging and ordering was 3 s), or (c) an attempt to arrange and order, complete, or wash/clean a new item.

Results and Discussion. The top panel of Figure 7 shows results from Ross's treatment evaluation. Like Jim, we began Ross's treatment evaluation with an assessment of the effects of providing Ross with access to leisure items that were amenable to arranging and ordering in order to evaluate the effects of providing Ross with the opportunity to arrange and order more appropriate materials on inappropriate forms of arranging and ordering, completeness, and washing/cleaning. Decreased levels of arranging and ordering were observed when competing items were first introduced; however, these effects were not replicated when competing items were reintroduced following a reversal to baseline, suggesting that the availability of leisure items did not influence target responding. Further, with the exception of two sessions, Ross did not engage with leisure items during the CI condition. Despite the fact that leisure items did not influence target behavior, leisure items continued to be made available in order to provide Ross with an appropriate alternate activity during sessions. The second CI condition also served as a baseline from which to evaluate the effects of intermittent response blocking (CI + INT RB condition).

Results from Ross's escape analysis demonstrated that response blocking decreased compulsive behavior to zero or near-zero levels of responding (although not shown in Figure 5 zero to near-zero levels of responding were also observed for completeness and washing/ cleaning during response blocking). Because Ross typically had a 1:2 teacher-to-student ratio, intermittent response blocking was evaluated in order to determine whether treatment effects would persist when response blocking was implemented with less than perfect procedural integrity. Functional control over intermittent response blocking was demonstrated with

arranging and ordering and the effects of CI + INT RB persisted when implemented by Ross's teachers. Perhaps most notable is that the frequency with which the experimenter had to block Ross's compulsive behavior decreased and maintained at low levels by the end of the treatment evaluation.

The effectiveness of intermittent response blocking appears to be at odds with Ross's escape analysis, in which gradual decreases in arranging and ordering during Auto Ext and Auto Ext + escape conditions suggest that response blocking functioned to disrupt the response-reinforcer relation (i.e., extinction). Lerman and Iwata (1996_a) suggested that the processes (automatic extinction versus punishment) responsible for decreased responding can be determined by manipulating the schedule of consequences (response blocking). If extinction is responsible for decreased responding when response blocking is implemented on a continuous schedule, automatically maintained behavior would be expected to increase when response blocking is implemented intermittently. In other words, responding would presumably be contacting reinforcement on an intermittent schedule. By contrast, responding would be expected to remain low if punishment is in effect. This logic, however, presumes that each instance of behavior contacts automatic reinforcement (i.e., FR 1). If Ross's arranging and ordering, completeness, or washing/ cleaning were reinforced, for example, by an orderly environment, then the orderly environment may have not been contacted even when responding was not blocked. For example, Ross often arranged the dates velcroed onto the calendar such that they were aligned and in order. If the reinforcer was to obtain an orderly calendar, then aligning or ordering only several of the dates of the calendar may have not been sufficient to bring Ross's behavior in contact with reinforcement. In other words, extinction may have been in effect even when response blocking was intermittent. Nevertheless, results from Ross's treatment evaluation

suggest that the effects of response blocking will persist even when implemented with less than optimal procedural integrity.

Christie

Setting

Sessions were conducted in the living room of Christie's residence. The area of the room opposite the entrance contained a locked TV cabinet (with TV and VCR), a couch, a loveseat, an end table, four magazines on the floor, a 1.8 m by 2.5 m area carpet, and a .61-m by 1.83-m table with various items (e.g., magazines, action figures, and Barbies®) on top of the table. The rest of the living room contained a wooden desk and chair, two bookshelves, a locked armoire, a locked toy cabinet, a treadmill, a trash bin, a basket of toys, and a large bouncy ball. Videos were left on during all sessions to approximate conditions under which arranging and ordering occurred during Christie's naturalistic observation.

No other students were present during session. In addition, in order to minimize distractions from the rest of the household, a tablecloth was hung across the entranceway of the living room. Different-colored tablecloths, poster boards (placed at about eye level on the wall opposite the TV) and t-shirts (worn by the experimenter) were associated with each condition of the functional analysis to facilitate discrimination.

Functional Analysis. A functional analysis was conducted to determine the influence of attention, escape, and automatic reinforcement on Christie's arranging and ordering. Arranging and ordering in the functional analysis included both ordering of furniture and other items such as books, magazines, and toys. However, because of the difference in the severity of the problem across topographies, arranging and ordering of furniture was recorded separately from arranging and ordering of other items for all subsequent analyses.

Procedures were similar to Jim's functional analysis; however, materials and consequences were adjusted to accommodate information gathered from interviews and naturalistic observations. Based on narrative records from Christie's naturalistic observation, the experimenter delivered verbal reprimands (e.g., "Christie, stop!") and statements of concern (e.g., "Careful, it could fall on you. You could hurt yourself.") contingent on arranging and ordering in the attention condition. Unlike Jim and Ross, interviews and descriptive data for Christie did not appear to suggest that arranging and ordering occurred in the context of demands. However, because escape is the most common maintaining variable for other problem behavior in individuals with developmental disabilities and related disorders (e.g., Iwata, Pace, Dorsey et al., 1994), we included a demand condition to test whether arranging and ordering was sensitive to escape from demands. In order to assure that there was an opportunity to arrange and order furniture, demands that allowed Christie to move about the room such as physical education programs (e.g., jumping jacks, skipping) and clean up tasks (e.g., wiping windows, dusting shelves) were included. An avoidance contingency was not included within the escape condition for Christie because, unlike Jim and Ross, naturalistic observations did not suggest that arranging and ordering may serve to delay the onset of demands.

A no-interaction condition was included instead of an alone condition so that the experimenter could intervene to remedy unsafe situations that may result from moving large, heavy pieces of furniture. In addition, having the experimenter in the session room assured that the video camera used for data collection could be repositioned, when necessary, to capture arranging and ordering.

Results. Christie's functional analysis data are depicted in Figure 8. Levels of responding were variable across all conditions, except the escape condition, which was relatively low and

stable. In addition, responding persisted across both series of no-interaction sessions, suggesting that Christie's arranging and ordering was maintained by automatic reinforcement.

Process versus Product Analysis

The purpose of this assessment was to identify the nature of the automatic reinforcer maintaining Christie's arranging and ordering of furniture. Based on anecdotal observations during naturalistic observations and functional analysis sessions, there appeared to be consistencies in the direction in which furniture was moved and, in some cases, its placement by the end of session. Thus, we hypothesized that arranging and ordering of furniture may be maintained by some property of the final placement of furniture (i.e., the product of arranging and ordering) rather than the *opportunity* to arrange and order materials (i.e., the process of arranging and ordering).

If the final placement of the furniture (i.e., the product of arranging and ordering) functioned as a reinforcer, then treatment could involve at least one of two alternatives: (a) an antecedent manipulation whereby furniture remained in a preferred placement, eliminating the establishing operation or (b) an extinction procedure whereby furniture was replaced to its original arrangement contingent on arranging and ordering, disrupting the response-reinforcer relation. On the other hand, if Christie's arranging of furniture was maintained by the opportunity to move furniture (i.e., the *process* of arranging and ordering), then teaching Christie to arrange and order other, more acceptable materials may serve as a viable substitute for the reinforcement directly produced by moving furniture.

Procedures. The process versus product analysis involved a comparison of two antecedent manipulations: furniture arranged according to the original arrangement used in all previous sessions (original arrangement condition) or furniture arranged according to a preferred

arrangement (preferred product condition). No differential consequences were provided contingent on arranging and ordering across both conditions.

Preferred product probes. In order to identify how to arrange furniture during the preferred product condition, five, 50-min probes were conducted prior to beginning the product versus process analysis. During probes, no differential consequences were provided for arranging and ordering and all requests for others to arrange and order were honored (i.e., the experimenter helped Christie move furniture). The furniture arrangement at the end of probes was documented such that consistencies could be noted and incorporated into the preferred product condition of the process versus product analysis.

Original arrangement. This condition served as the comparison (or control) condition and was similar to the no-interaction condition of the functional analysis. In addition, the furniture arrangement at the start of session was the same as the functional analysis (see setting description).

Preferred product placement. The preferred product condition served as the test condition. If arranging and ordering was maintained by access to a *product*, then little to no arranging and ordering should occur when furniture was pre-arranged according to Christie's preferred product. On the other hand, if arranging and ordering was maintained by the *process* of arranging and ordering, then levels of arranging and ordering would be similar to levels in the original arrangement condition.

Prior to preferred product sessions, furniture was arranged according to information provided by the 50-min probes. In addition, before each session, Christie was provided with three, 15-s opportunities to request adjustments. This was done in order to accommodate small adjustments (e.g., aligning the corners of the couches) as well as to detect large changes in

preference prior to the start of session. Specifically, the experimenter asked Christie, "Where would you like the furniture?" and pointed to several pieces of furniture while asking, "Stay here or move?" If Christie requested that something be moved, one of her teachers waited with Christie in another room while the experimenter arranged the furniture according to Christie's request. This was done in the event that *watching* furniture being moved was reinforcing, which may function as an abolishing operation, influencing levels of responding during session. If Christie requested large changes to the arrangement of the furniture (e.g., moving the TV cabinet from one side of the living room to the other), sessions were terminated and a 50-min preferred product probe was conducted. This occurred once prior to session 15. Process versus product sessions were never conducted following preferred product probes in case providing 50 min access to the opportunity to, or the product of, arranging and ordering served as an abolishing operation.

Results and Discussion. Figure 9 shows the results from Christie's process versus product analysis. Differential levels of arranging and ordering occurred in original arrangement and preferred product placement conditions and were replicated within a reversal design. Because this analysis involved antecedent manipulations, the nature of the automatic reinforcer could be inferred based on levels of responding that would be expected in the presence and absence of an establishing operation for access to a final product. If the process of ordering was the maintaining variable, then similar levels of arranging and ordering would have been observed across both conditions because the opportunity to arrange and order was present across both conditions. However, the fact that Christie did not arrange furniture in the preferred product condition suggests that, by having furniture arranged according to a preferred product at the

beginning of session, the establishing operation for arranging and ordering furniture had been eliminated.

Treatment Evaluation

Baseline. Baseline was identical to the no-interaction condition of the functional analysis.

Leisure Items (LI). Sessions were similar to baseline except that leisure items were continuously available.In an attempt to provide materials that could be arranged and ordered but on a smaller, more contained scale, we began by including a diorama of a living room with miniature dollhouse furniture. However, because the dollhouse furniture did not appear to compete with arranging and ordering, we added three leisure items (session 12) based on results of a *single stimulus engagement preference assessment* (SSE; e.g., DeLeon, Iwata, Conners, & Wallace, 1999; Hagopian, Rush, Lewin, & Long, 2001). Because levels of arranging and ordering were variable in previous assessments, a representative sample of Christie's arranging and ordering in the presence of different leisure items would likely require extended and repeated sessions with each item. Thus, rather than conduct a separate competing items assessment, we conducted an SSE assessment to identify leisure items associated with high levels of item engagement, the effects of which could be assessed within treatment evaluation sessions.

The SSE included eight leisure items amenable to arranging and ordering. Leisure items were presented singularly for 1 min, and each item was presented twice in a random order. Data were collected on duration of item engagement using a 5-s MTS. Percentage of item engagement was calculated by dividing the duration of the item engagement by the total duration of session (1 min). Mean percentage of item engagement are depicted in Figure 10. Circus set, garden stringing beads, Beauty and the Beast© magnet board, and dollhouse furniture were associated with the highest levels of item engagement. These items were included in the remainder of the

leisure items condition (session 12-15) to evaluate their effect on arranging and ordering of furniture.

LI + Prompts. This condition was similar to the leisure items condition except that nondirective verbal and model prompts (e.g., Piazza et al., 1997) to engage with leisure items were provided every 30 s. This was done to identify whether prompts would be sufficient to promote contact with the automatic reinforcement provided via item engagement. Specifically, the experimenter modeled appropriate item engagement while describing her actions (e.g., "I'm setting up the couches in front of the TV like a movie theater" while the experimenter manipulated the dollhouse furniture) or following a predetermined play script (e.g., "First up we have Pablo on the trapeze!" while the experimenter placed the circus character on the trapeze).

LI + Prompts + Product extinction (Ext). This condition was similar to the leisure items + prompts condition except that the automatic reinforcer associated with arranging and ordering furniture was eliminated (i.e., extinction).

Based on the results of the product versus process analysis, which showed that the resulting product and not the process of moving furniture maintained Christie's arranging and ordering, extinction involved immediately replacing furniture to its original arrangement contingent on arranging and ordering (hereafter referred to as product extinction). As such, no physical contact or blocking was necessary. This was important because teachers expressed hesitance in physically blocking Christie from engaging in a response because it reportedly evoked or elicited aggression.

On one occasion (session 36), Christie moved the TV cabinet and then wedged herself between the TV cabinet and the wall such that the experimenter was not able to replace the TV cabinet to its original position. In this situation, the experimenter prevented Christie from

moving the TV cabinet any further by placing herself on the other side of the cabinet and replaced the TV cabinet to its original location once Christie moved from behind the TV cabinet, which occurred at the end of session. As a more conservative measure of the effects of product extinction, the time during which Christie physically prevented the experimenter from replacing the TV cabinet was scored as arranging and ordering.

Play Skills Training. Although product extinction was effective in decreasing arranging and ordering of furniture, we conducted a separate play skills training assessment to provide Christie with an appropriate alternative to arranging and ordering furniture. Sessions were 5 min and conducted in the same room as all previous assessments.

Baseline. Baseline was similar to the leisure items condition of the treatment evaluation except that furniture was replaced contingent on arranging and ordering (Product Ext). In addition, unlike previous assessments, videos were not on throughout session.

***Prompts + Sr*$^{+}$.** Prompts and reinforcement were added to teach appropriate item engagement. Nondirective verbal and model prompts were provided (a) at the start of session, (b) every 30 s without item engagement, and (c) immediately following termination of the reinforcement period.

Contingent on item engagement for the required duration, Christie was provided access to a video containing a collection of preferred scenes. Teachers had reported that Christie typically watched videos during her free time and repeatedly requested to watch particular movie scenes in succession. Based on this information and prior to beginning play skills training, the experimenter provided Christie with access to a remote control during videos and recorded the scenes most frequently played. A collection of Christie's preferred movie scenes were then combined onto a DVD and used as the reinforcer during play skills training.

In order to increase the probability that Christie would contact reinforcement, the duration of cumulative item engagement required to obtain the reinforcer was initially 5 s. Once Christie was engaging with leisure items for at least 20% of session, the required duration increased to 10 s. Thereafter, Christie was required to have engaged with items for at least 40% of session before increasing the required cumulative duration. Christie received 30-s access to the preferred video when the required duration was between 5 and 30 s, 60-s access when the required duration was 45 or 60 s, and 120-s access when the required duration was 90 or 120 s. An audible timer was used to track Christie's cumulative item engagement. The timer beeped once when started or stopped engaging with items and multiple times when the required duration of item engagement elapsed, after which the preferred video was immediately started. Data collection was suspended during reinforcement intervals.

LI + Prompts + Product Ext + Sr^{+}. Following play skills training, procedures used during play skills training were added to the treatment evaluation to determine their effect on item engagement and arranging and ordering within 10 min sessions. Like previous treatment evaluation conditions, videos were on throughout session; however, contingent on 120 s of cumulative item engagement, Christie was provided 120-s access to her video containing a collection of her preferred movie scenes. Data collection was not suspended during reinforcement intervals during the treatment evaluation.

Results and Discussion. The top panel of Figure 11 shows the results of Christie's treatment evaluation. Levels of arranging and ordering of furniture in the initial baseline (the repeated no-interaction condition of the functional analysis) were variable, with the last three data points ranging between 38.33% and 44.33%. The addition of leisure items (LI condition) and prompts (LI + Prompts) did not influence levels of arranging and ordering; product

extinction was necessary for maintaining low levels of arranging and ordering. The effects of the final intervention package LI + Prompts + Product Ext + Sr+ for Eng. maintained when implemented by Christie's teachers.

Because prompts and reinforcement (i.e., access to preferred video scenes) were necessary for maintaining item engagement, it seems unlikely that leisure items had taken on automatically reinforcing properties. Even when leisure items are not integral to maintaining treatment outcomes, it may still be desirable to provide an opportunity to arrange and order more appropriate materials and teach appropriate play skills such that item engagement, perhaps over repeated exposure, may come into contact with new sources of automatic reinforcement.

Results from the process versus product analysis were incorporated into Christie's treatment evaluation by assuring that furniture was immediately replaced to its original position contingent on arranging and ordering. Although response blocking should serve to disrupt the response-reinforcer relation regardless of whether the automatic reinforcer maintaining arranging and ordering or other compulsive behavior is the opportunity to order items or the final placement of those items, the ability to program an alternate form of extinction (furniture replacement) was particularly desirable for Christie because teachers had expressed hesitance with implementing procedures that required physical contact, which was reported to evoke or elicit aggression and self-injury and may have ultimately compromised procedural integrity if Christie's aggression or self-injury functioned as a punisher for teachers' physical contact.

General Functional Analysis and Treatment Discussion

Research suggests that extinction may be integral to ensuring treatment success (e.g., Iwata, Pace, Cowdery, et al., 1994). In our study, treatment components aimed at disrupting the response-reinforcer relation (response blocking or product extinction) were necessary for

obtaining desirable treatment outcomes for all participants. Simply providing access to stimuli amenable to appropriate forms of arranging and ordering, completeness, or washing/ cleaning (matched stimuli; e.g., Piazza et al., 1998; Piazza et al., 2000) did not reduce target behavior for any of the participants. Further, prompting or prompting plus supplemental reinforcement were necessary to maintain engagement with leisure items for two participants (Jim and Christie), suggesting that these items did not function as competing reinforcers.

Though extinction was sufficient to reduce compulsive behavior to desirable levels, it is often considered best practice to provide an alternate means of accessing the functional reinforcer, for example, by programming its availability via differential reinforcement of an alternative behavior (DRA), differential reinforcement of other behavior (DRO), or noncontingent reinforcement (NCR; Lerman & Iwata, 1996_b; Van Houten et al., 1988). In addition to providing the individual with the opportunity to access personally relevant reinforcers, such procedures may enhance the effects of treatment by addressing the motivating operation. Because leisure items did not appear to compete with the automatic reinforcement produced by compulsive behavior in our study, it seems unlikely that the motivating operation was addressed. Other forms of addressing the motivating operation such as providing an opportunity to engage in compulsive behavior following a functional communication response were not appropriate for these participants given that compulsive behavior, itself, was undesirable (particular forms that were considered dangerous such as arranging large pieces of furniture or trash in trash bins). Future research might explore acceptable methods of addressing the motivating operation when automatically maintained behavior is undesirable (e.g., by allowing appropriate forms of compulsive behavior).

An additional analysis was conducted with Christie in order to identify whether arranging and ordering was maintained by the process or product of ordering. Consistencies in the arrangement of furniture during Christie's naturalistic observation and functional analysis had suggested that Christie's arranging and ordering may have been maintained by some property of the final placement of items and might therefore be treated by preventing access to that final placement. We did not attempt to identify the nature of the automatic reinforcer for Jim and Ross, in part because consistencies in the arrangement of items could not be easily identified for all topographies but also because response blocking, which prevents access to the opportunity to arrange and order items, also prevents access to a final product placement. Unlike Christie, aggression or self-injurious behavior was not reported to be associated with physical contact for Jim or Ross. Further, response blocking had already been shown to be effective for Ross during his escape analysis.

The procedures used to identify whether the final placement of items functioned as a reinforcer for Christie's arranging and ordering required that the putative preferred product be identified prior to conducting the process versus product analysis. Such antecedent conditions may be difficult to arrange if consistencies in the arrangement (or final placement) of items cannot be identified (e.g., there was no apparent pattern to Ross's arranging of trash in trash bins) or the establishing operation for product as a reinforcer is subtle or difficult to control (e.g., Jim might dart across the room to close a drawer that was only slightly ajar). As noted by Ross's teacher in phase 2, it would be difficult to avoid or prevent compulsive behavior altogether, "[teachers] couldn't possibly control everything…there is always going to be something on the floor somewhere or something like a book on a shelf that is not facing the correct way."

An alternative means of identifying whether the final placement of items functions as a reinforcer that would accommodate the difficulties of identifying potential preferred products *a priori* would be to assess the effects of product extinction. In other words, as is suggested by the results of Ross's escape analysis and the results of several other studies that have used similar procedures (e.g., Kuhn et al., 1999; Smith et al., 1993; Thompson et al., 1998), function-based treatments can be used to clarify functional relations. Should arranging and ordering persist when items are immediately replaced to their original position contingent on arranging and ordering, then the *process* of arranging and ordering rather than the final placement of items is likely to be the variable maintaining this behavior.

SUMMARY AND CONCLUSIONS

Given the paucity of research on higher-level repetitive behavior, we sought to provide a comprehensive description of one form of higher-level repetitive behavior, arranging and ordering, that was considered to be problematic for a relatively large percentage of individuals in our sample. The RBS-R scale used in phase 1 assisted in identifying the topography of interest for further study as well as the students for which this topography was considered to be moderately to severely problematic. Interviews and naturalistic observations in phases 2 and 3 were useful in gathering qualitatively rich information regarding this largely understudied behavior.

Information gathered from the second and third phases of our study (interviews and naturalistic observations) was also useful for arranging experimental conditions in phase 4. The types of antecedent and consequent events programmed in the test conditions of the functional analysis and the materials included in experimental sessions were based on information gathered from interviews and narrative records. Thus, although interviews and descriptive assessments do

not determine functional relations (Thompson & Iwata, 2007; Zarcone et al., 1991), they may be useful in that they can inform the arrangement of functional analyses (e.g., see Bowman, Fisher, Thompson, & Piazza, 1997; Fisher, Lindauer, Alterson, & Thompson, 1998; Thompson et al., 1998). Arranging functional analyses such that they include events typically encountered by the individual under natural conditions also increases the ecological validity of experimental results (Hanley et al., 2003).

We have stressed the role of functional analyses in developing treatments, but results from functional analyses also contribute to our understanding of common maintaining variables. In their review of the literature on assessment and treatment of stereotypy, Rapp and Vollmer (2005) noted that the overwhelming majority of the literature suggests that most stereotypy is maintained by automatic reinforcement. It is possible that, like lower-level repetitive behavior, higher-level repetitive behavior is most commonly maintained by automatic reinforcement. Nevertheless, because the second and third phases of our study did identify some social events associated with arranging and ordering and other related compulsive behavior, additional research is needed to determine the extent to which higher-level repetitive behavior in autism is susceptible to social contingencies.

Compulsive behavior in individuals diagnosed with obsessive compulsive disorder (OCD) is presumed to be maintained by automatic negative reinforcement (Maltby & Tolin, 2003). That is, compulsive behavior is thought to prevent or reduce anxiety associated with aversive stimuli (Matlby & Tolin). Although items listed in the compulsive behavior subscale of the RBS-R (e.g., arranging and ordering, completeness, and washing/ cleaning) share topographical similarities with the behavior of individuals diagnosed with OCD, it remains unknown whether they also share functional similarities. Interestingly, exposure response

prevention (ERP), which is commonly used to treat compulsions in OCD, also shares topographical similarities with the treatment components found to be effective in the present study (e.g., response blocking). ERP relies on two main principles: (a) respondent extinction (or habituation), which occurs over repeated exposure to a conditioned stimulus in the absence of the unconditioned stimulus and (b) operant extinction, which occurs by preventing the response that produces access to the automatic reinforcer (Maltby & Tolin). Research suggests that exposure to aversive stimuli under controlled conditions may enhance treatment effects (e.g., Abramowitz, 1996). Should problem behavior be found to be maintained by automatic negative reinforcement, then planned and therapist-controlled exposure to aversive stimuli may enhance the effects of treatment. Future research might evaluate whether the conditions under which "compulsive behavior" occurs are aversive for individuals with autism. Other potential sources of automatic reinforcement such as "sameness" (e.g., Green et al., 2006; Prior & MacMillan, 1973) might also be explored.

The present study represents one of the first known attempts at providing a comprehensive description of arranging and ordering and related environmental events. Further, although several hypotheses as to the function of higher-level repetitive behavior have been proposed (e.g., see brief review by Flannery & Horner, 1994; Green et al., 2006), that we know of, phase 4 of the present study represents the first attempt to identify the function of higher-level repetitive behavior using experimental analyses. Results from our study suggest that functional analysis methodology, which has been used to assess and treat lower-level repetitive behavior, may be useful for assessing and treating higher-level repetitive behavior. Arranging and ordering and other compulsive behavior were amenable to common function-based treatment components for all three participants in phase 4. Experimental analyses similar to those used in this study

may inform treatment of problematic forms of arranging and ordering or other compulsive behavior.

References

Abramowitz, J. S. (1996). Variants of exposure and response prevention in the treatment of obsessive-compulsive disorder: A meta-analysis. *Behavior Therapy, 27,* 583–600.

Ahearn, W. H., Clark, K., MacDonald, R., & Chung, B. I. (2007). Assessing and treating vocal stereotypy in children with autism. *Journal of Applied Behavior Analysis, 40,* 263–275.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

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

Bodfish, J. W. (2004). Treating the core features of autism: Are we there yet? *Mental Retardation and Developmental Disabilities, 10,* 318–326.

Bodfish, J. W., Symons, F. W., & Lewis, M. H. (1999). The Repetitive Behavior Scale. *Western Carolina Center Research Reports.*

Bodfish, J. W., Symons, F. J., Parker, D. E., & Lewis, M. H. (2000). Varieties of repetitive behavior in autism: Comparisons to mental retardation. *Journal of Autism and Developmental Disabilties, 30,* 237–243.

Bourreau, Y., Roux, S., Gomot, M., Bonnet-Brilhault, F., & Barthelemy, C. (2009). Validation of the repetitive and restricted behaviour scale in autism spectrum disorders. *European Child and Adolescent Psychiatry, 18,* 675–682.

Bowman, L. G., Fisher, W. W., Thompson, R. H., & Piazza, C. C. (1997). On the relation of mands and the function of destructive behavior. *Journal of Applied Behavior Analysis,*

30, 251–265.

Campbell, M., Locascio J., Choroco, M. C., Spencer, E. K., Malone, R. P., Kafantaris, V., & Overall, J. E. (1990). Stereotypies and tardive dyskinesia: Abnormal movements in autistic children. *Psychopharmacology Bulletin, 26,* 260–266.

Carr, E. G. (1977). The motivation of self-injurious behavior: A review of some hypotheses. *Psychological Bulletin, 84,* 800–816.

Carr, E. G., Newsom, C. D., & Binkoff, J. A. (1976). Stimulus control of self-destructive behavior in a psychotic child. *Journal of Abnormal Child Psychology, 4,* 139–153.

Carr, E. G., Newsom, C. D., & Binkoff, J. A. (1980). Escape as a factor in the aggressive behavior of two retarded children. *Journal of Applied Behavior Analysis, 13,* 101–117.

Charlop, M. H., Kurtz, P. F., & Casey, F. G. (1990). Using aberrant behaviors as reinforcers for autistic children. *Journal of Applied Behavior Analysis, 23,* 163–181.

Conners, J., Iwata, B. A., Kahng, S., Hanley, G. P., Worsdell, A. S., & Thompson, R. H. (2000). Differential responding in the presence and absence of discriminative stimuli during multielement functional analysis. *Journal of Applied Behavior Analysis, 33,* 299–308.

Cuccaro, M. L., Shao, Y., Grubber, J., Slifer, M., Wolpert, C. M., Donnelly, S. L., ...Pericak-Vance, M. A. (2003). Factor analysis of restricted and repetitive behaviors in autism using the autism diagnostic interview–R. *Child Psychiatry and Human Development, 34,* 3–17.

DeLeon, I. G., Iwata, B. A., Conners, J., & Wallace, M. D. (1999). Examination of ambiguous stimulus preferences with duration-based measures. *Journal of Applied Behavior Analysis, 32,* 111–114.

Dunlap, G., Dyer, K., & Koegel, R. L. (1983). Autistic self-stimulation and intertribal interval duration. *American Journal of Mental Retardation, 88,* 194–202.

Durand, V. M., & Carr, E. G. (1987). Social influences on "self-stimulatory" behavior: Analysis and treatment application. *Journal of Applied Behavior Analysis, 20,* 119–132.

Durand, V. M., & Crimmins, D. B. (1988). Identifying the variables maintaining self-injurious behavior. *Journal of Autism and Developmental Disorders, 18,* 99–117.

Fisher, W. W., Lindauer, S. E., Alterson, C. J., & Thompson, R. H. (1998). Assessment and treatment of destructive behavior maintained by stereotypic object manipulation. *Journal of Applied Behavior Analysis, 31,* 513–527.

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

Fisher, W. W., Piazza, C., Cataldo, M., Harrell, R., Jefferson, G., & Conner, R. (1993). Functional communication training with and without extinction and punishment. . *Journal of Applied Behavior Analysis, 26,* 23–36.

Flannery, K. B., & Horner, R. H. (1994). The relationship between predictability and problem behavior for students with severe disabilities. *Journal of Behavioral Education, 4,* 157–176.

Gabriels, R. L., Cuccaro, M. L., Hill, D. E., Ivers, B. J., & Goldson, E. (2005). Repetitive behaviors in autism: Relationships with associated clinical features. *Research in Developmental Disabilties, 26,* 169–181.

Green, V. A., Sigafoos, J., Pituch, K. A., Itchon, J., O'Reilly, M. O., & Lancioni, G. E. (2006).

Assessing behavioral flexibility in individuals with developmental disabilities. *Focus on Autism and Other Developmental Disabilities, 21*, 230–236.

Groden, G. (1989). A guide for conducting a comprehensive behavioral analysis of a target behavior. *Journal of Behavior Therapy and Experimental Psychiatry, 20*, 163–169.

Hagopian, L. P., Rush, K. S., Lewin A. B., & Long, E. S. (2001). Evaluating the predictive validity of single stimulus engagement preference assessment. *Journal of Applied Behavior Analysis, 34***,** 475–485.

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.

Hanley, G. P., Iwata, B. A., Thompson, R. H., & Lindberg, J. S. (2000). A component analysis of "stereotypy as reinforcement" for alternative behavior. *Journal of Applied Behavior Analysis, 33,* 285–297.

Hausman, N., Kahng, S., Farrell, E., & Mongeon, C. (2009). Idiosyncratic functions: Severe problem behavior maintained by access to ritualistic behaviors. *Education and Treatment of Children, 32,* 77–87.

Higgins Hains, A. H., & Baer, D. M. (1989). Interaction effects in multielement designs: Inevitable, desirable, and ignorable. *Journal of Applied Behavior Analysis, 22,* 57–69.

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

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.

Jones, R. S. P., Wint, D., & Ellis, N. C. (1990). The social effects of stereotyped behavior. *Journal of Mental Deficiency Research, 34,* 261–268.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217–250.

Kennedy, C. H., Meyer, K. A., Knowles, T., & Shukla, S. (2000). Analyzing the multiple functions of stereotypical behavior for students with autism: Implications for assessment and treatment. *Journal of Applied Behavior Analysis, 33,* 559–571.

Kuhn, D. E., DeLeon, I. G., Fisher, W. W., & Wilke, A. E. (1999). Clarifying an ambiguous functional analysis with matched and mismatched extinction procedures. *Journal of Applied Behavior Analysis, 32,* 99–102.

Kuhn, D. E., Hardesty, S. L., & Sweeney, N. M. (2009). Assessment and treatment of excessive straightening and destructive behavior in an adolescent diagnosed with autism. *Journal of Applied Behavior Analysis, 42,* 355–360.

Lam, K. S. L., & Aman, M. G. (2007). The Repetitive Behavior Scale-Revised: Independent validation in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37,* 855–866.

LeBlanc, L. A., Patel, M. R., & Carr, J. E. (2000). Recent advances in the assessment of aberrant behavior maintained by automatic reinforcement in individuals with developmental disabilities. *Journal of Behavior Therapy and Experimental Psychiatry, 31,* 137–154.

Leekam, S., Tandos, J., McConachie, H., Meins, E., Parkinson, K., Wright, C., ...Couteur, A. L. (2007). Repetitive behaviours in typically developing 2-year-olds. *Journal of Child Psychology and Psychiatry, 48,* 1131–1138.

Lerman, D. C., & Iwata, B. A. (1996$_a$). A methodology for distinguishing between extinction and punishment effects associated with response blocking. *Journal of Applied Behavior Analysis, 29,* 231–233.

Lerman, D. C., & Iwata, B. A. (1996$_b$). Developing a technology for the use of operant extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29,* 345-382.

Lewis, M. H., & Bodfish, J. W. (1998). Repetitive behavior disorders in autism. *Mental retardation and developmental disabilities research reviews, 4,* 80–89.

Lindberg, J. S., Iwata, B. A., & Kahng, S. W. (1999). On the relation between object manipulation and stereotypic self-injurious behavior. *Journal of Applied Behavior Analysis, 32,* 51–62.

Lovaas, O. I., Freitag, G., Gold, V. J., & Kassorla, I. C. (1965). Experimental studies in childhood schizophrenia: Analysis of self-destructive behavior. *Journal of Experimental Child Psychology, 2,* 67–84.

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.

Maltby, N., & Tolin, D. F. (2003). Overview of treatments for obsessive-compulsive disorder and spectrum conditions: Conceptualization, theory, and practice. *Brief Treatment and Crisis Intervention, 3,* 127-144.

McDougle, C. J., Kresch, L. E., Goodman, W. K., Naylor, S. T., Volkmar, F. R., Cohen, D. J., &

Price, L. H. (1995). A case–controlled study of repetitive thoughts and behavior in adults with autistic disorder and obsessive-compulsive disorder. *American Journal of Psychiatry, 152*, 772–777.

McKerchar, P. M., & Thompson, R. H. (2004). A descriptive analysis of potential reinforcement contingencies in the preschool classroom. *Journal of Applied Behavior Analysis, 37*, 431–443.

Militerni, R., Bravaccio, C., Falco, C., Fico, C., & Palermo, M. T. (2002). Repetitive behaviors in autistic disorder. *European Child and Adolescent Psychiatry, 11*, 210–218.

Murphy, G., Macdonald, S., Hall, S., & Oliver, C. (2000). Aggression and the termination of "rituals": A new variant of the escape function for challenging behavior? *Research in Developmental Disabilities, 21*, 43–59.

O'Neill, R. E., Horner, R. H., Albin, R. W., Storey, K., & Sprague, J. R., & Newton, J. S. (1997). *Functional Assessment and Program Development for Problem Behavior: A Practical Handbook*. Pacific Grove, CA: Brooks/Cole Publishing Company.

Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 33*, 13–27.

Piazza, C. C., Contrucci, S. A., Hanley, G. P., & Fisher, W. W. (1997). Nondirective prompting and noncontingent reinforcement in the treatment of destructive behavior during hygiene routines. *Journal of Applied Behavior Analysis, 30*, 705–708.

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

Piazza, C. C., Fisher, W. W, Hanley, G. P., Remick, M. A., Contrucci, S. A., & Aitken, T. (1997). The use of positive and negative reinforcement in the treatment of escape-maintained destructive behavior, *Journal of Applied Behavior Analysis, 30,* 279–297.

Piazza, C. C., Hanley, G. P., Bowman, L. G., Ruyter, J. M., Lindauer, S. E., & Saiontz, D. M. (1997). Functional analysis and treatment of elopement. *Journal of Applied Behavior Analysis, 30,* 653–672.

Powell, J., Martindale, A., & Kulp, S. (1975). An evaluation of time-sample measures of behavior. *Journal of Applied Behavior Analysis, 8,* 463–469.

Prior, M., & MacMillan, M. B. (1973). Maintenance of sameness in children with Kanner's syndrome. *Journal of Autism and Childhood Schizophrenia, 3,* 154–167.

Rapp, J. T. (2006). Toward an empirical method for identifying matched stimulation for automatically reinforced behavior: A preliminary investigation. *Journal of Applied Behavior Analysis, 39,* 137–140.

Rapp, J. T. & Vollmer, T. R. (2005). Stereotypy I: A review of behavioral assessment and treatment. *Research in Developmental Disabilities, 26,* 527–547.

Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis, 12,* 221–233.

Ringdahl, J. E., Vollmer, T. R., Marcus, B. A., & Roane, H. S. (1997) An analogous evaluation of environmental enrichment: The role of stimulus preference. *Journal of Applied Behavior Analysis, 30,* 203–216.

Shapiro, E. S., & Kratochwill, T. T. (Eds.). (2000). *Behavioral Assessment in Schools* (2nd edn). New York: Guilford Press.

Skinner, B. F. (1953). *Science and Human Behavior*. New York: Macmillan.

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.

Smith, R. G., Russo, L., & Le, D. D. (1999). Distinguishing between extinction and punishment effects of response blocking: A replication. *Journal of Applied Behavior Analysis, 32,* 367–370.

South, M., Ozonoff, S., & McMahon, W. M. (2005). Repetitive behavior profiles in asperger syndrome and high-functioning autism. *Journal of Autism and Developmental Disorders, 35,* 145–158.

Thompson, R. H., Fisher, W. W., Piazza, C. C., & Kuhn, D. E. (1998). The evaluation and treatment of aggression maintained by attention and automatic reinforcement. *Journal of Applied Behavior Analysis, 31,* 103–116.

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

Thompson, R. H., & Iwata, B. A. (2007). A comparison of outcomes from descriptive and functional analyses of problem behavior. *Journal of Applied Behavior Analysis, 40,* 333–338.

Turner, M. (1999). Repetitive behaviour in autism: A review of psychological research. *Journal of Child Psychology and Psychiatry, 40,* 839–849.

Van Houten, R., Axelrod, S., Bailey, J. S., Favell, J. E., Foxx, R. N., Iwata, B. A., & Lovaas, O. I. (1988). The right to effective behavioral treatment. *Journal of Applied Behavior Analysis, 21,* 381–384.

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

Vollmer, T. R., Iwata, B. A., Duncan, B. A., & Lerman, D. C. (1993). Extensions of multielement functional analysis using reversal-type designs. *Journal of Developmental and Physical Disabilities, 5,* 311–325.

Vollmer, T. R., Marcus, B. A., & LeBlanc, L. (1994). Treatment of self-injury and hand mouthing following inconclusive functional analyses. *Journal of Applied Behavior Analysis, 27,* 331–344.

Zarcone, J. R., Rodgers, T. A., Iwata, B. A., Rourke, D. A., & Dorsey, M. F. (1991). Reliability analysis of the motivation assessment scale: A failure to replicate. *Research in Developmental Disabilities, 12,* 349–360.

Footnotes

[1]The terms *compulsions* and *compulsive behavior* will be used to refer to responses that share topographical similarities with the behavior of individuals diagnosed with obsessive compulsive disorder and for the purposes of maintaining consistency with the terminology used in the scale from phase 1. In particular, *compulsive behavior* will be used when referring to any one or more of the responses included in the compulsive behavior subscale of this scale.

[2]We remind the reader that vocal stereotypy and echolalia were added to the RBS-R scale in our study. Lam and Aman (2007) did not include these items.

[3]The terms *completeness* or *complete items* will be used to refer to responses outlined in this operational definition. Turning off lights (but not repeatedly) is included in this definition for phase 3.

Appendix A

REPETITIVE BEHAVIOR SCALE – Revised (RBS-R)

Student's Name: _____ **Today's Date**: ____/ ____/ _____

Gender: Female Male **Date of Birth**: ____/ ____/ _____

Informant's Name: _____ **Relation**: _____

How long have you known this person? _____ years _____ months

Instructions:

*Please rate this person's behavior by reading each of the items listed and then choosing the score that best describes how much of a problem the item is for the person. Be sure to read and score all items listed. Make your ratings based on **your** observations and interactions with the person **over the last 3 months**. Please complete the questionnaire independently, without consulting others.*

Use the definitions in the box given below to score each item.

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

When deciding on a score for each item, consider: (a) how frequently the behavior occurs (e.g., weekly versus hourly), (b) how difficult it is to interrupt the behavior (e.g., can be easily redirected versus becomes distressed if interrupted) and (c) how much the behavior interferes with ongoing events (e.g., easy to ignore versus very disruptive).

I. Stereotyped Behavior Subscale

(DEFINITION: apparently purposeless movements or actions that are repeated in a similar manner)

1	WHOLE BODY (Body rocking, Body swaying)	0	1	2	3
2	HEAD (Rolls head, Nods head, Turns head)	0	1	2	3
3	HAND/ FINGER (Flaps hands, Wiggles or flicks fingers, claps hands, Waves or shakes hand or arm)	0	1	2	3
4	LOCOMOTION (Turns in circles, Whirls, Jumps, Bounces)	0	1	2	3
5	OBJECT USAGE (spins or twirls objects, Twiddles or slaps or throws objects, Lets objects fall out of hands)	0	1	2	3
6	SENSORY (Covers eyes, Looks closely or gazes at hands or objects, Covers ears, Smells or sniffs items, Rubs surfaces)	0	1	2	3

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

II. Self-injurious Behavior Subscale

(DEFINITION: movement or actions that have the potential to cause redness, bruising, or other injury to the body, and that are repeated in a similar manner)

7	HITS SELF WITH BODY PART (Hits or slaps head, face, or other body area)	0	1	2	3
8	HITS SELF AGAINST SURFACE OR OBJECT (Hits or bangs head or other body part on table, floor or other surface)	0	1	2	3
9	HITS SELF WITH OBJECT (Hits or bangs head or other body area with objects)	0	1	2	3
10	BITES SELF (Bites hand, wrist, arm, lips, or tongue)	0	1	2	3
11	PULLS (Pulls hair or skin)	0	1	2	3
12	RUBS OR SCRATCHES SELF (Rubs or scratches marks on arms, leg, face, or torso)	0	1	2	3
13	INSERTS FINGER OR OBJECT (Eye-poking, Ear-poking)	0	1	2	3
14	SKIN PICKING (Picks at skin on face, hands, arms, legs, or torso)	0	1	2	3

III. Compulsive Behavior Subscale

(DEFINITION: behavior that is repeated and is performed according to a rule, or involves things being done in a particular way)

15	ARRANGING/ ORDERING (Arranges certain objects in a particular pattern or place; Need for things to be even or symmetrical)	0	1	2	3
16	COMPLETENESS (Must have doors opened or closed; Takes all items out of a container or area)	0	1	2	3
17	WASHING/ CLEANING (Excessively cleans certain body parts; Picks at lint or loose threads)	0	1	2	3
18	CHECKING (Repeatedly check doors, windows, drawers, appliances, clocks, locks, etc.)	0	1	2	3
19	COUNTING (Counts items or objects; Counts to a certain number or in a certain way)	0	1	2	3
20	HOARDING/ SAVING (Collects, hoards or hides specific items)	0	1	2	3
21	REPEATING (Need to repeat routine events; In/ out door, up/ down from chair, clothing on/ off)	0	1	2	3
22	TOUCH/ TAP (Need to touch, tap, or rub items, surfaces, or people)	0	1	2	3

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

IV. Ritualistic Behavior Subscale

(DEFINITION: performing activities of daily living in a similar manner)

23	EATING/ MEALTIME (Strongly prefers/ insists on eating/ drinking only certain things; Eats or drinks items in a set order; Insists that meal related items are arranged in a certain way)	0	1	2	3
24	SLEEPING/ BEDTIME (Insists on certain pre-bedtime routines; Arrange items in room in "just so" prior to bedtime; Insists that certain items be present with him/ her during sleep; Insists that another person be present prior to or during sleep)	0	1	2	3
25	SELF-CARE- BATHROOM AND DRESSING (Insists on specific order of activities or tasks related to using the bathroom, to washing, showering, bathing, or dressing; Arranges items in a certain way in the bathroom or insists that bathroom items not be moved; Insists on wearing certain clothing items)	0	1	2	3
26	TRAVEL/ TRANSPORTATION (Insists on taking certain routes/ paths; Must sit in specific location in vehicles; Insists that certain items be present during travel, e.g., toy or material; Insists on seeing or touching things or places during travel such as a sign or store)	0	1	2	3
27	PLAY/ LEISURE (Insists on certain play activities; Follows rigid routine during play/ leisure; Insists that certain items be present/ available during play/ leisure; Insists that other persons do certain things during play)	0	1	2	3
28	COMMUNICATION/ SOCIAL INTERACTIONS (Repeats same topic(s) during social interactions; Repetitive questioning; Insists on certain topics of conversation; Insists that others say certain things or respond in certain way during interactions)	0	1	2	3

V. Restricted Behavior Subscale

(DEFINITION: limited range of focus, interest, or activity)

29	Fascination, preoccupation with one subject or activity (e.g., trains, computers, weather, dinosaurs)	0	1	2	3
30	Strongly attached to one specific subject	0	1	2	3
31	Preoccupation with part(s) of object rather than the whole object (e.g., buttons on clothes, wheels on toys cars)	0	1	2	3
32	Fascination, preoccupation with movement/ things that move (e.g., fans, clocks)	0	1	2	3

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

VI. Sameness Behavior Subscale

(DEFINITION: resistance to change, insisting that things stay the same)

33	Insists that things remain in the same place(s) (e.g., toys, supplies, furniture, pictures, etc.)	0	1	2	3
34	Objects to visiting new places	0	1	2	3
35	Becomes upset if interrupted in what he/she is doing	0	1	2	3
36	Insists on walking in a particular pattern (e.g., straight line)	0	1	2	3
37	Insists on sitting at the same place	0	1	2	3
38	Dislikes changes in appearance or behavior of the people around him/ her	0	1	2	3
39	Insists on using a particular door	0	1	2	3
40	Likes the same CD, tape, record, or piece of music played continually; Likes same movie/ video or part of movie/ video	0	1	2	3
41	Resists changing activities; Difficulty with transitions	0	1	2	3
42	Insists on same routine, household, school, or work schedule everyday	0	1	2	3
43	Insists that specific things take place at specific times	0	1	2	3

VII. Vocal Behavior Subscale

44	Vocal stereotypy - vocal responses that have no apparent function and are not teacher-directed (e.g., non-contextual laughing or giggling, non-contextual words or phrases, repetitive grunts or squeals)	0	1	2	3
45	Immediate echolalia – repeats or echoes part or all of what was just said (e.g., repeats the last part of your question back to you)	0	1	2	3

Appendix B

Description of Behavior and Related Environmental Events Interview (DBREE)

Student: _____ DOB: _____ Sex (M/ F)
Informant's Name: _____ Date of Interview: _____
Informant's relation to student (e.g., teacher, parent): _____
Interviewer's Name: _____
Topography: _____

I. DESCRIPTION OF BEHAVIOR(S)

(a) What does _____ look like (i.e., topography)?

(b) Describe an episode of _____.

(c) How often does _____ occur? (hourly/ daily/ weekly/ monthly/ less often)

(d) How long does _____ last when it occurs? (< 1 min, 1-5 min per event/ 6-10 min per event/ >10 min)

(e) What is the magnitude or intensity of _____? (low, medium, high) Please describe.

(f) Does it involve any particular objects or materials? Which ones?

II. DESCRIPTION OF PROBLEM

(a) Is _____ a problem? Why?

(b) How much does _____ interfere with ongoing events? (easy to ignore/ fairly easy to ignore/ moderately disruptive/ very disruptive)

(c) How difficult is it to interrupt _____? (easy to interrupt/ fairly easy to interrupt / moderately difficult to interrupt / very difficult to interrupt)

(d) What happens when you interrupt _____?

- For example, does _____ lead to other problem behavior? (yes/ no)
- If so, what kind of problem behavior? (aggression, self-injurious behavior, property destruction)

(e) How long has _____ been a problem? (< 1 month, 1-6 months/ 7-12 months/ longer)

- How long have you known (name)?

(f) What reactions do you get in public when (name) engages _____?

III. SETTING EVENT FACTORS

(a) Are there any *settings* in which _____ is most likely to occur (e.g., home, school, community)? What is the likelihood of _____ occurring given this setting? (never/ seldom/ half the time/ usually/ always)

__ Home (never/ seldom/ half the time/ usually/ always)

__ School (never/ seldom/ half the time/ usually/ always)

__ Community (never/ seldom/ half the time/ usually/ always)

__ Other(s): _____ (never/ seldom/ half the time/ usually/ always)

(b) Does _____ occur during certain times of the day (e.g., morning, afternoon, evening)? What is the likelihood of _____ occurring during this time of day? (seldom/ half the time/ usually/ always)

__ Morning (never/ seldom/ half the time/ usually/ always)

__ Afternoon (never/ seldom/ half the time/ usually/ always)

__ Evenings (never/ seldom/ half the time/ usually/ always)

(c) With whom is _____ most likely? Least likely? (e.g., parents, specific teachers, etc.) Equally probable across people?

(d) Does _____ occur when routines are interrupted? (never/ seldom/ half the time/ usually/ always)

(e) Are there any other behaviors that reliably precede _____?

IV. ANTECEDENTS

(a) Are there any *situations* in which _____ is most likely to occur (e.g., meals, bathroom, academics, play, change in routine)? What is the likelihood of _____ occurring given this situation? (seldom/ half the time/ usually/ always)

__ Meals (never/ seldom/ half the time/ usually/ always)

__ Bathroom (never/ seldom/ half the time/ usually/ always)

__ Academics (never/ seldom/ half the time/ usually/ always)

__ Play (never/ seldom/ half the time/ usually/ always)

__ Change in routine (never/ seldom/ half the time/ usually/ always)

__ Other(s): _____ (never/ seldom/ half the time/ usually/ always)

(b) Would _____ occur repeatedly, in the same way, for long periods of time if (name) was alone (e.g., rocking back and forth for over an hour)? (yes/ no)

(c) Does _____ occur when any request is made of (name)? (never/ seldom/ half the time/ usually/ always) If so, are there any specific requests that seem to be associated with _____?

(d) Does _____ seem to occur in response to your talking to other persons in the room/ area? (never/ seldom/ half the time/ usually/ always)

(e) Does _____ occur whenever you stop attending to (name)? (never/ seldom/ half the time/ usually/ always)

(f) Does (name) seem to _____ to upset or annoy you when you are not paying attention to him/ her (e.g., you are in another room or interacting with another person)? (never/ seldom/ half the time/ usually/ always)

(g) Does _____ occur when you take away or deny a favorite food, toy, or activity? (never/ seldom/ half the time/ usually/ always)

(h) Does _____ stop occurring shortly after you give (name) food, toy, or requested activity? (never/ seldom/ half the time/ usually/ always)

(i) Is _____ (more/ less/ equally) likely to occur if you are within 3 feet of (name)?

V. CONSEQUENCES

(a) Can _____ be easily redirected? (yes/ no)

- How (e.g., block, change activity)?
- How often does this strategy work? (sometimes/ half the time/ usually/ always)

(b) What can you do to avoid or prevent _____?

- How often does this strategy work? (sometimes/ half the time/ usually/ always)

(c) Can you do anything to calm (name) down or stop _____?

- How often does this strategy work? (sometimes/ half the time/ usually/ always)

(d) Do you participate in _____? If so, why? What happens?

(e) Do you ever have to delay or cancel the next activity as a result of _____? (never/ seldom/ half the time/ usually/ always) Any activities in particular?

Why do you think it happens?

*When name *arranges or orders*, do you leave the items that way?

Table 1

Percentage Interrater Agreement Across RBS-R Subscales

	Exact		Occurrence/ nonoccurrence		Severity/ rating of 3	
	M	Range	*M*	Range	*M*	Range
Stereotyped behavior	43	36-49	74	60-80	78	69-89
Self-injurious behavior	60	49-73	76	64-86	88	80-94
Compulsive behavior	70	58-86	79	71-86	91	85-97
Ritualistic behavior	60	47-71	72	63-76	90	81-96
Restricted behavior	52	38-67	69	63-73	88	82-98
Sameness behavior	64	41-89	75	61-89	91	82-99

Table 2
Percentage of Endorsements for Occurrence and Ratings 1, 2, and, 3 for Each Item on RBS-R

Item	Occurrence		Rating		
	Primary	Secondary	1	2	3
Stereotypy subscale	*92*	*98*			
Hand/ finger movements	80	77	30	32	18
Sensory	76	77	32	28	16
Whole body movements	68	70	45	17	6
Locomotion	67	71	36	24	7
Object usage	58	59	23	18	18
Head movements	48	44	34	9	5
Self-injurious subscale	*90*	*93*			
Hits w/body	45	49	23	22	25
Rubs/scratches self	45	49	25	9	8
Hits w/object	41	48	23	7	6
Picks skin	41	48	16	9	11
Hits against surface	35	38	19	16	28
Pulls hair/skin	35	42	19	10	7
Inserts finger or object	35	38	9	6	5
Bites self	20	26	15	16	15
Sameness Subscale	*86*	*80*			
No interruption	**68**	**58**	36	20	12
Likes same music/ movie	**53**	**58**	19	22	**13**
Difficulty with transitions	49	**54**	23	19	8
Placement of objects	41	38	21	14	7
Insists on same routine	34	28	23	3	9
Insists on time	29	28	14	7	9
No new places	25	25	18	5	2
Sits certain place	22	22	16	5	1
Walks particular pattern	19	17	11	5	3
Appearance/behavior of others	18	21	9	5	4
Uses particular door	7	8	5	2	0
Ritualistic Subscale	*78*	*79*			
Eating/mealtime	**52**	47	25	14	**13**
Communication	50	46	19	15	**17**
Play/leisure routine	47	40	24	12	12
Self care routine	30	26	18	7	6
Transportation routine	27	28	16	9	3
Sleeping/bedtime	25	25	15	5	6
Compulsive subscale	*76*	*77*			
Needs to touch/tap	40	42	19	9	**13**
Completeness	40	35	19	11	11
Arranging and ordering	38	44	13	12	**14**
Hoarding/ saving	33	30	15	12	7
Washing/ cleaning	26	25	16	6	5
Repeating	19	28	9	4	6
Checking	17	17	11	1	5
Counting	10	12	4	4	2
Restricted Subscale	*75*	*75*			
Preoccupation with one subject	**64**	**60**	25	26	**13**
Attached to specific subject	**56**	46	24	19	**14**
Preoccupation with part of object	34	35	17	10	8
Preoccupation with movement	28	21	16	11	2
*Vocal stereotypy	83	89	22	30	31
*Echolalia	44	48	26	12	6

Note. Italics indicate the % of participants engaging in at least one item in that subscale. Boldface indicate higher-level items at least one *SD* > *M* for occurrence and rating of 3 (based on higher-level subscales only).

Table 3

Participant Characteristics and Outline of Participation in Phases 2-4

	CA	MA	Sex	Diagnosis	Phase		CA	MA	Sex	Diagnosis	Phase
Jon	9	2	M	autism	2	Jack	14	2	M	PDD	2, 3[a]
Elle	10	2	F	autism	2, 3	Christie	15	< 3	F	autism	2-4
Al	11	6	M	autism	2	Jim	16	-	M	PDD	2-4
Joe	12	4	M	autism	2, 3	Anna	16	< 3	F	autism	2, 3[a]
Dex	13	2	M	autism	2, 3[a]	Adam	17	3	M	autism	2, 3
Sara	13	4	F	autism	2	Mike	17	3	M	autism	2, 3
Amy	13	6	F	PDD	2	Alice	17	3	F	autism	2, 3[a]
May	13	3	F	autism	2	Alex	19	< 3	M	PDD	2, 3
Ross	13	5	M	autism	2-4	Dean	20	-	M	autism	2, 3[a]
Nic	14	< 3	M	autism	2, 3	Dom	20	4	M	PDD	2, 3

Note. CA = chronological age; MA = mental age. The numbers 2, 3, and 4 under phase correspond to the interview, naturalistic observation, and functional analysis and treatment, respectively.

[a]Target responses were not observed during naturalistic observation.

Table 4

Descriptions of Compulsive Behavior Based on Questions a, b, and f of the Description of Behavior(s) Category of the Interview

*Placement of items is specific and consistent (Adam, Alex, **Christie**, Dean, Jack, Joe, Mike)*	
Protective equipment and curtains (Joe)	Doors, clocks, and others' clothes (Jack)
Napkin during mealtime;	Items should remain where they were when first
Loose hairs (e.g., replaced on head; **Christie)**	entered room (includes others' hats and glasses; Dean)
Furniture replaced (e.g., chair pushed back in; Mike)	Certain places for certain items (e.g., books, notebooks; Adam, Alex)
	Animals drawn in a particular order (Mike)
*A&O includes placement or organization, not otherwise specified (Al[a], Alex[a], Alice, Amy, **Christie**, Jon[a], Mike, Nic, **Ross**[a], Sara[a])*	
Furniture and leisure items (**Christie**)	Trash in trash bin (**Ross**)
People's limbs (Jon, Sara)	Academic materials (Amy)
Placement of people in room (Jon)	Blocks (orders, messes order up, and repeats; Mike)
Tokens (Alice, **Christie**, Nic)	
Stacks and lines up items in rows and patterns (Adam, Anna[a], Elle, Nic)	
Leisure items (Elle)	Puzzle pieces (stacked; Adam)
CDs and videos (Nic)	
*Aligns items against other objects or surfaces (Amy, Dex[a], Dom, **Jim**[a], **Ross**[a])*	
Shoes and other items (if not in order, requests/ places in trash; Dom)	Pictures and papers; Repeatedly realigns photos in album (Amy)
Completeness (Adam, Alice, May, Mike, Nic)	
Doors and lights closed (May, Mike, Nic)	Puzzles (does so repeatedly; Adam)
Containers emptied (e.g., remaining juice; Alice)	
*Washing/ Cleaning (Alex, **Ross**)*	
Loose threads and hairs off (**Ross**)	Trash on floor must be placed in trash bin (Alex)

Note. Students who participated in phase 4 are in boldface.

[a]Items involved were not specific (general). [b]Reported to change form.

Table 5

Reported Frequency and Description of Problem for Compulsive Behavior

	Frequency	Interferes with Events	Hard to Interrupt	Types of PB related to Interruption	Other
Joe	Hourly	3	3	Agg	Elopes to arrange and order
Jim	Hourly	3	3	Agg	
Al	Hourly	2	2	Agg, ED, Yells	Perseverates vocally
Ross	Hourly	2	2	SIB, ED, Tantrum	Intrusive
Christie	Hourly	2	1	Agg, SIB	Dangerous
Alice	Hourly	2	1	Agg, Cries	Elopes to arrange and order
Dex	Hourly	2	1	Agg, SIB	Pushes to gain access to materials
Anna	Hourly	2	1	Screams	
Alex	Hourly	1	1		
Jack	Hourly	1	0		
Adam	Hourly	0	1	Yells	
Elle	Hourly	0	0		Lack of leisure skills
Nic	Hourly	0	0		
Dom	Daily	3	3	Agg, SIB	
Mike	Daily	2	2,3	Agg, SIB, ED	
Jon	Daily	2	2	Agg, SIB, ED	Intrusive, perseverates vocally
Dean	Daily	2	2	Agg	Perseverates vocally
May	Daily	2	2	SIB	
Sara	Daily	1	1	Agg, SIB, ED	
Amy	Daily	0	0		

Note. Numbers correspond to ratings (range, 0 to 3); 0 = not problematic; 3 = very problematic. PB = problem behavior; Agg = aggression; SIB = self injury; ED = environmental destruction. Students who participated in phase 4 are in boldface.

Table 6

Summary of Strategies Reported to be Used to Redirect or Prevent Compulsive Behavior

	Consequent-based (Redirect)								Antecedent-based (Prevent)		
	Vocal or physical redirection	Rule-reminders	Prompts to problem solve	Prompts to request A&O	Physical blocking	Removal of materials	Prompts to take a break		Removal of materials typically ordered	Keep items "in their place"	Preemptive rule-reminders
Adam	X								X		
Al		X	X			X	X				X
Alex	X				X					X	
Alice					X					X	
Amy						X			X		
Anna	X										
Christie	X										
Dean				X	X					X	
Dex	X				X				X	X	
Dom	X	X							X		
Elle	X								X		
Jack				X					X		
Jim	X				X						
Joe	X										
Jon											
May		X									
Mike	X				X	X			X		
Nic						X					X
Ross	X					X	X				
Sara	X	X									
Total *n*	12	4	1	2	6	5	2		7	4	2

Note. Cells with Xs indicate those participants (rows) for which a particular strategy was reported (columns).

Table 7

Examples of Topographies and Consequences Recorded During Naturalistic Observations

	Topography	Teacher's Response
Adam	Putting together puzzles repeatedly and insistently	"Good job having good hands and a quiet voice." Delivers small edible.
Alex	Academic book is disorganized, Alex attempts to fix it and then signs, "help"	"Help with what? Oh, you want me to fix your kidbook? … Ok, I'll fix it. You can read your book. I'll fix it right now. . . Read your book I'm fixing it for you."
	Stacks blocks that had just been used for counting during academics and then hands stacked blocks to teacher	"Thank you" Takes stacked blocks from him and puts in a pouch in academic notebook.
Christie	Lifts one side of couch, moves table, gets underneath table adjusts leg of table.	"Christie!," "No thank you.," "Stop! Christie, stop. No thank you. It's going to fall on you."
	"Fix it," "help" while pointing to furniture	"Don't touch it. It's going to fall on you. I don't know how to fix it. We just fixed it. It's fine."
Elle	Lining up and stacking tiles	"Nice job, Elle."
	Lining up puzzle pieces (as opposed to placing pieces on puzzle board)	"Elle, do you want to play with something different?" Repeats question while presenting a second leisure item.
Jim	Moves chair and aligns table against wall	"You're ok. Put your hands down. You need to keep good hands. Sit down."
	Closes academic notebook while teacher prepares materials for academic session	Opens notebook, removes notebook from Jim's desk, and then places it on table behind her.
Joe	Moves toy bins, then says "tickle, tickle"	Stops talking to the other teacher in room, approaches Joe, and tickles him under arms and around shoulders.
Mike	"Light off, lights off, I want lights off please."	"I can't understand you…Oh, sure. Nice job asking." Turns off light and room becomes dark
Ross	Arranges notebooks on bookshelf [a]	"Did you find your book? [Blocks arranging]. Alright, then we are all done."
	Arranges items on bookshelf [a]	"All done." Blocks arranging.
	Fixes loose paper on shelf [a]	"Do you need help?" Takes paper from Ross and puts it back. "No thanks. We are going to leave this here"
	Moves box on floor [a]	"That's fine, Ross."
	Arranges plant stems and dirt	Approaches and blocks arranging. "Wash your hands."
	"Fix" while pointing at calendar	"The calendar? You don't need to fix it. All done."

Note. Students who participated in phase 4 are in boldface.

[a]Occurred following teacher's request to retrieve academic materials; escape was not scored because teacher redelivered prompt.

Table 7
Agreement Scores for Each Participant Across All Experimental Analyses

	Jim		Ross		Christie	
	M	Range	*M*	Range	*M*	Range
A&O	93	67-100	90	67-100	94[b]	76-100
Completeness	97	89-100	99.5	95-100		
Washing/ Cleaning			97	72-100		
A&O Comments					98	84-100
Item Engagement [a]	82	68-92	98	85-100	95	83-100
Prompts [a]	94	87-100			92	77-100
Response Blocking [a]	97	93-100	99	97-100		
Product Replacement [a]					99	85-100

Note. A&O = arranging and ordering.

[a]Applicable for treatment evaluation and play skills training only. [b]Includes A&O of furniture only except for functional analysis, during which furniture and items were not separated.

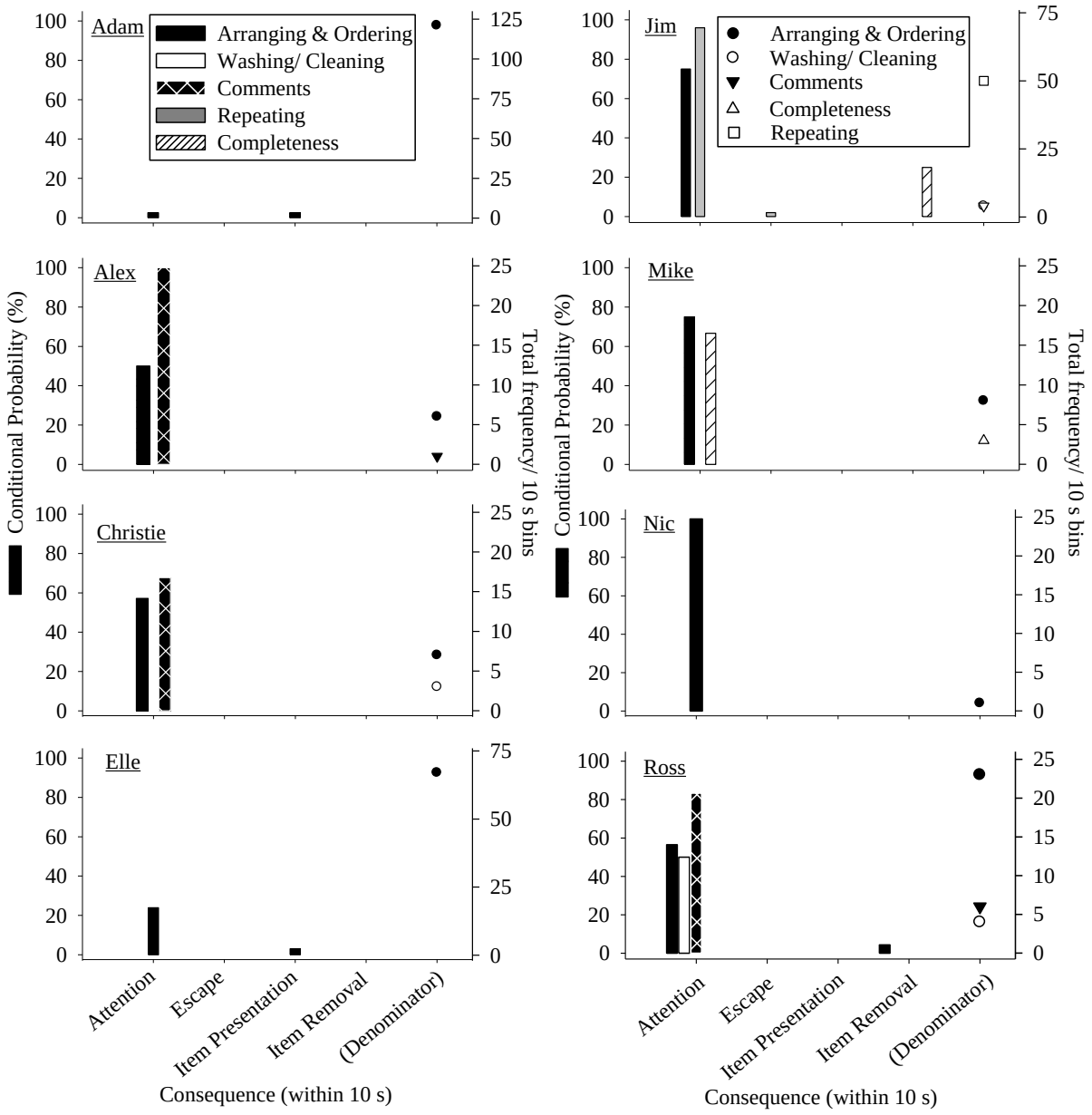

Figure 1. Descriptive data are depicted for those responses and participants for which at least one target response was followed by at least one type of consequence. Bars represent the conditional probability of attention, escape, item presentation, and item removal within 10 s of each target response (primary y axis). Symbols represent the total number of responses or 10 s bins (for duration measures) for each target response.

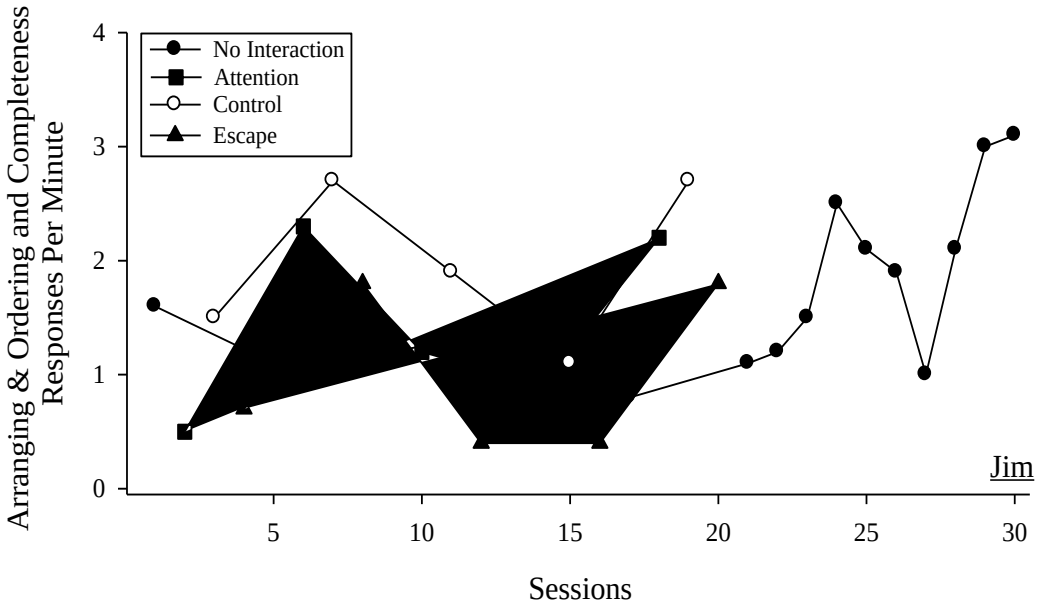

Figure 2. Arranging and ordering and completeness responses per minute across no-interaction, attention, control (play), and escape conditions for Jim's functional analysis.

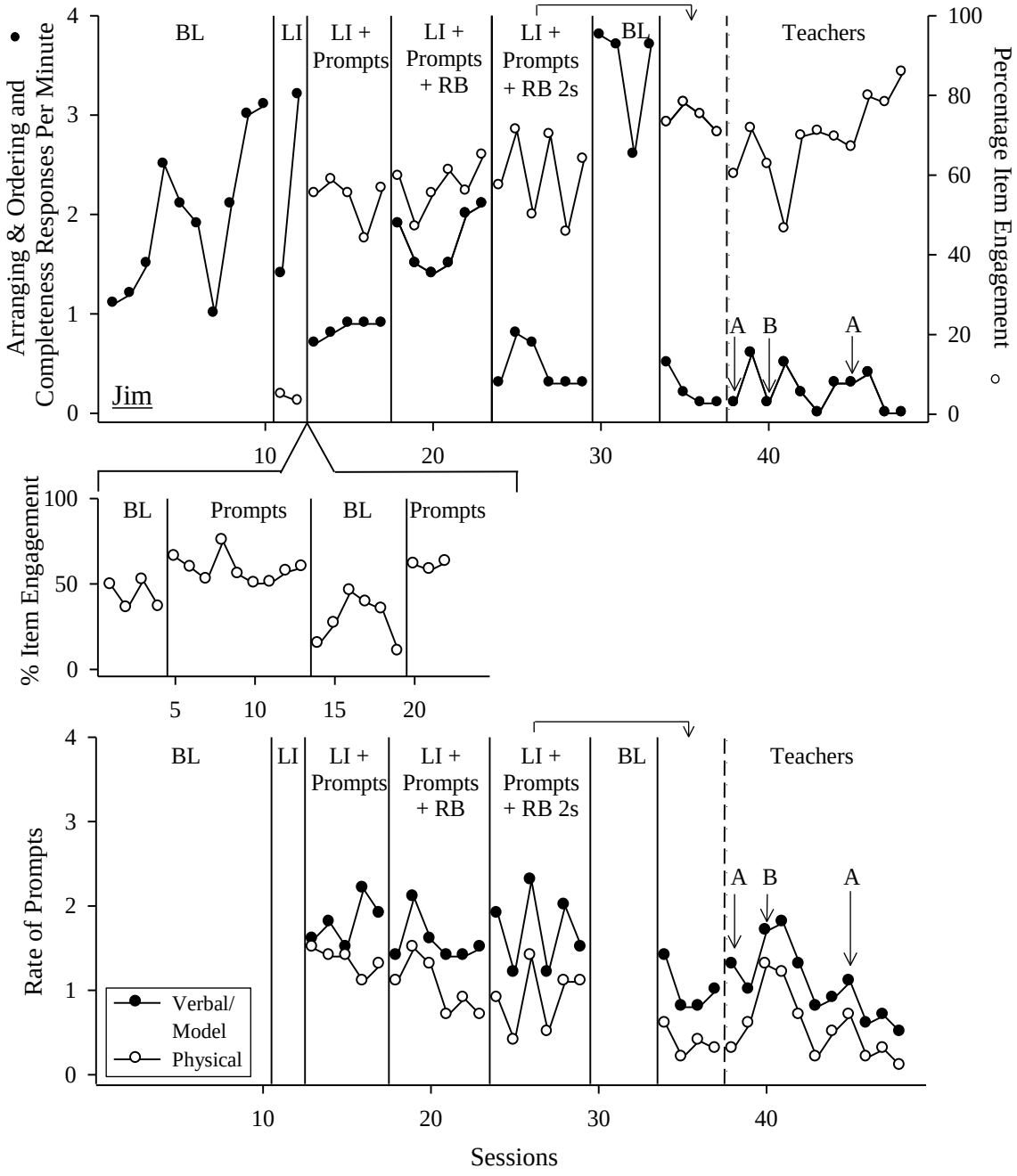

Figure 3. The top panel shows combined arranging and ordering and completeness responses per minute (closed circles, primary y axis) and the percentage of item engagement (open circle, secondary y axis) during Jim's treatment evaluation. The middle panel shows the percentage of item engagement during Jim's play skills training, which was implemented between sessions 12 and 13 of the treatment evaluation. The bottom panel shows the rate of verbal/ model (closed circles) and physical (open circles) prompts during Jim's treatment evaluation. Letters in the teachers phase of the treatment evaluation represent sessions conducted by different teachers (teacher A and teacher B).

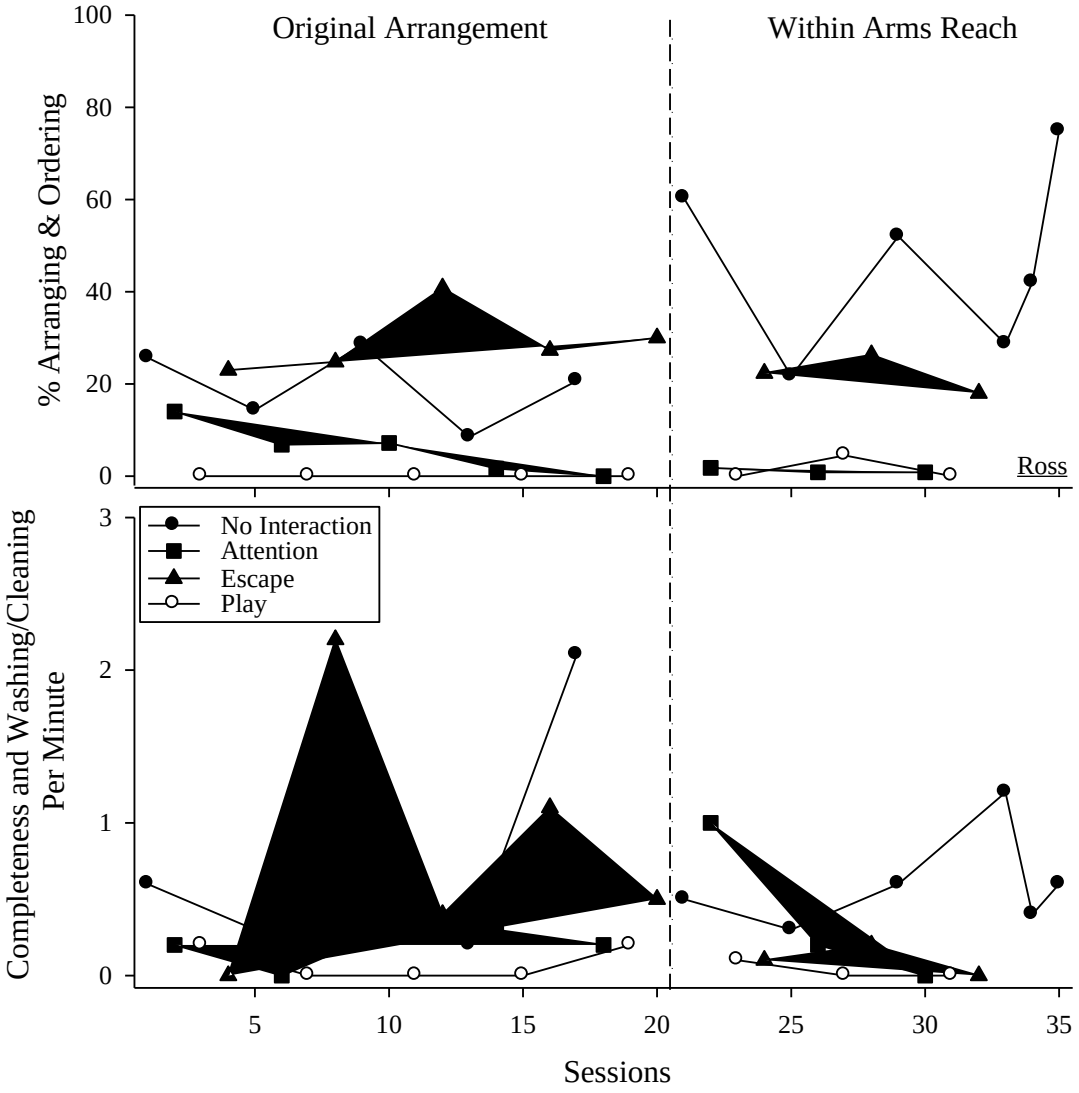

Figure 4. The percentage of arranging and ordering (top panel) and combined completeness and washing/ cleaning responses per minute (bottom panel) across no-interaction, attention, control (play), and escape conditions for Ross's functional analysis. In the second phase of the functional analysis materials typically involved in target responses were rearranged such that they were all within arm's reach of Ross.

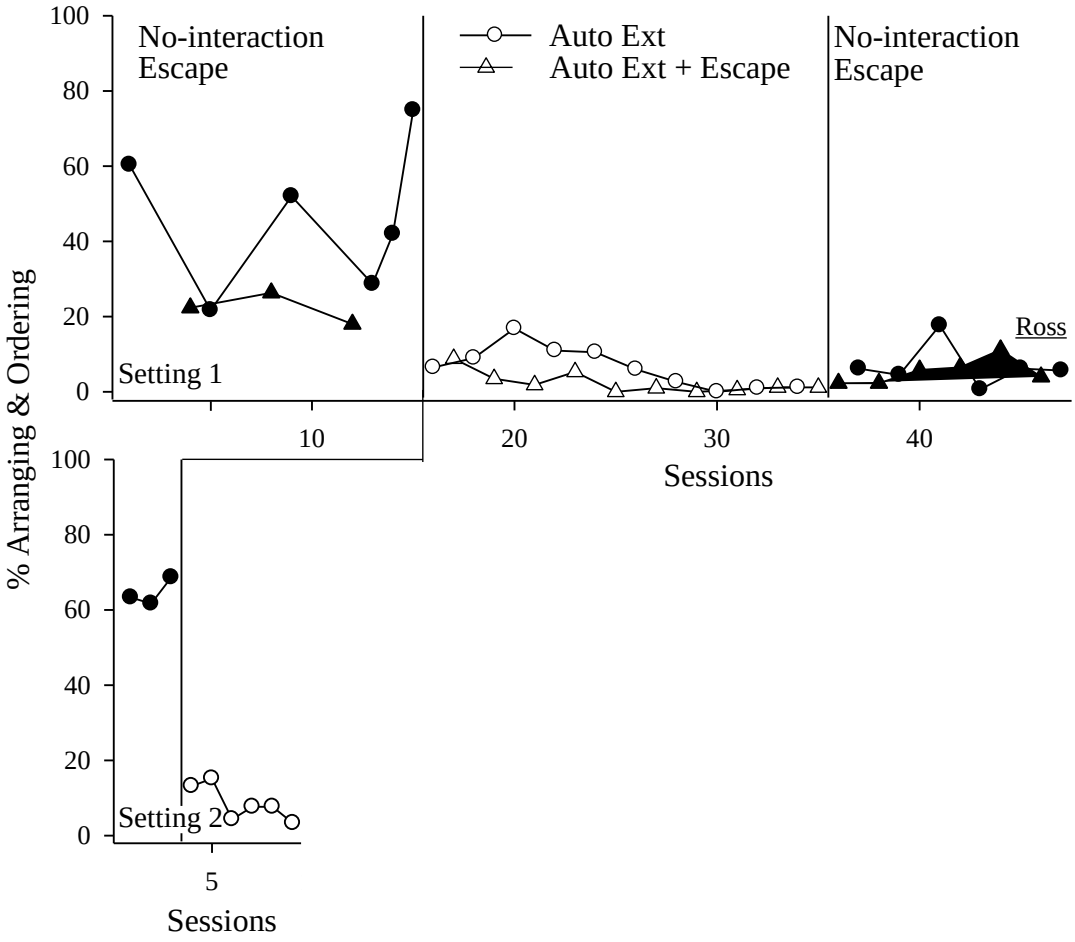

Figure 5. The percentage of arranging and ordering during Ross's escape analysis. Data from the within arms reach phase of Ross's functional analysis were used as the initial phase of the escape analysis in setting 1 (top panel). Closed circles represent the no-interaction condition and closed triangles represent the escape condition. Open symbols represent conditions during which target responses were blocked (Auto Ext). The percentage of arranging and ordering within setting 2 are depicted in the bottom panel.

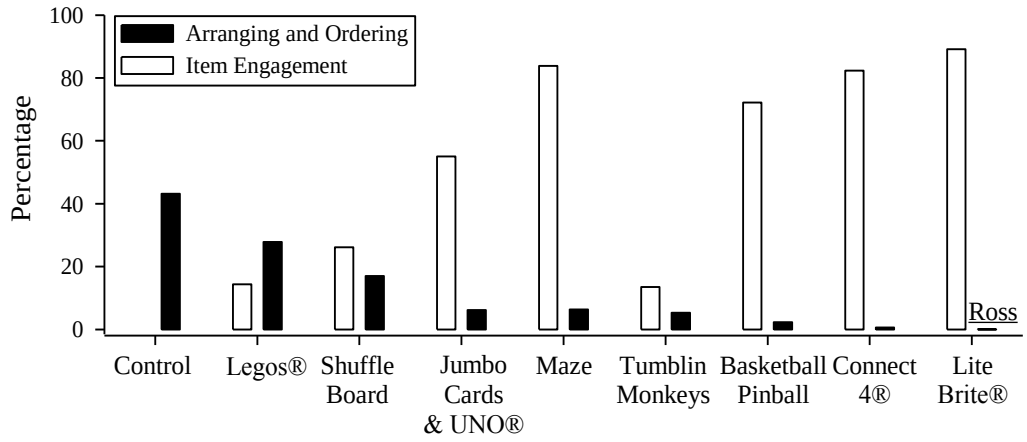

Figure 6. The percentage of arranging and ordering (black bars) and item engagement (white bars) during Ross's competing items assessment.

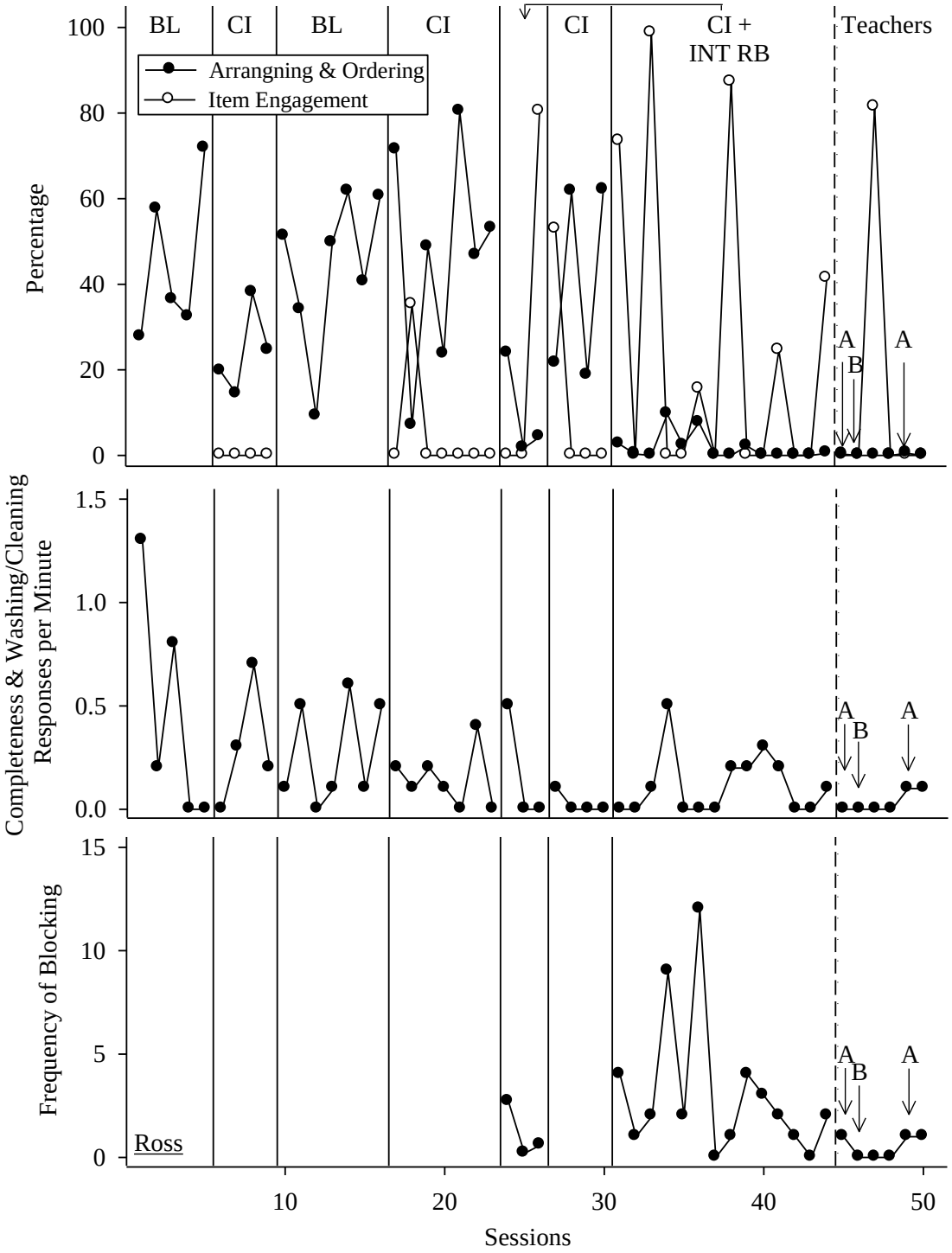

Figure 7. Percentage of arranging and ordering and item engagement (top panel; closed circles and open circles, respectively), completeness and washing/ cleaning responses per minute (middle panel), and frequency of experimenter blocking target responses (bottom panel) during Ross's treatment evaluation. Letters in the teachers phase of the treatment evaluation represent sessions conducted by different teachers (teacher A and teacher B).

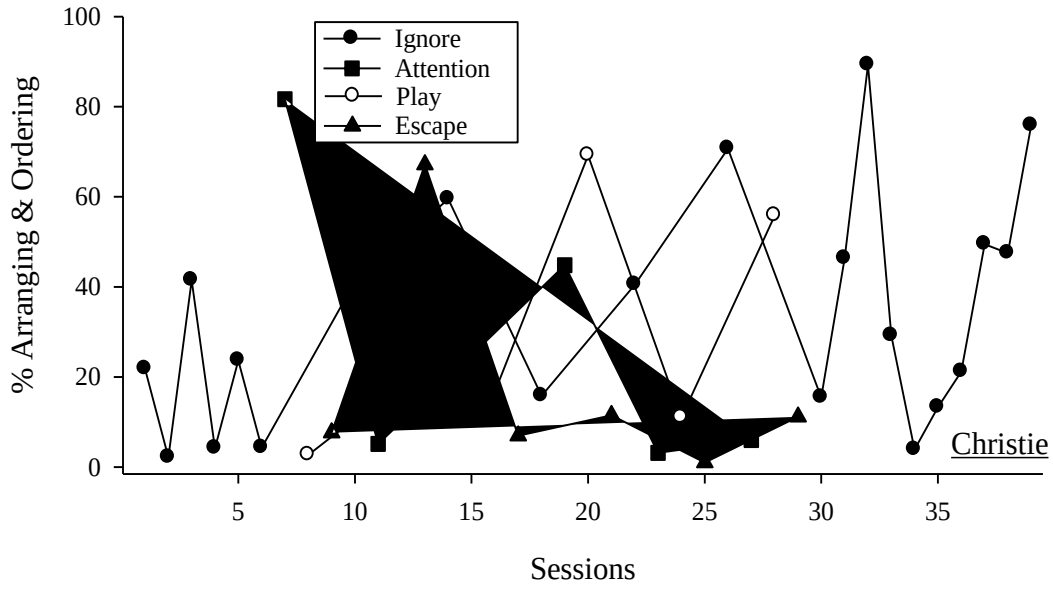

Figure 8. Percentage of arranging and ordering across no-interaction, attention, control (play), and escape conditions for Christie's functional analysis.

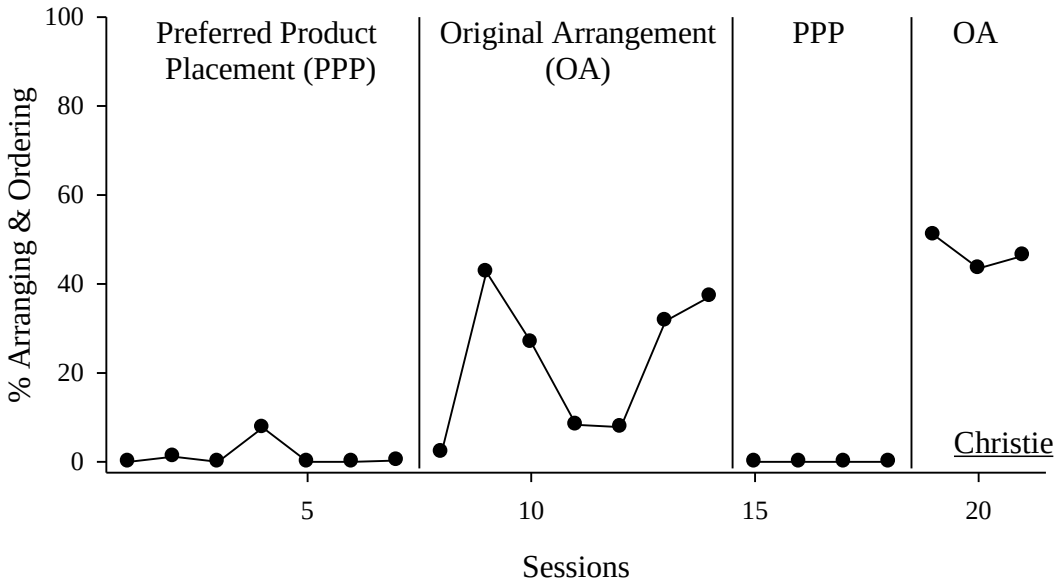

Figure 9. Percentage of arranging and ordering of furniture across preferred product placement (PPP) and original arrangement (OA) conditions for Christie's process versus product analysis.

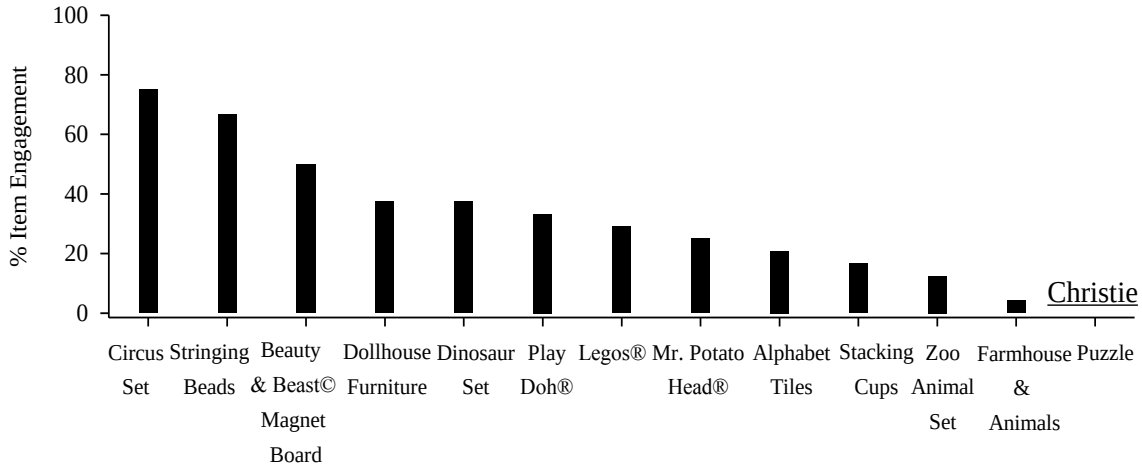

Figure 10. Percentage of item engagement during Christie's single stimulus engagement assessment.

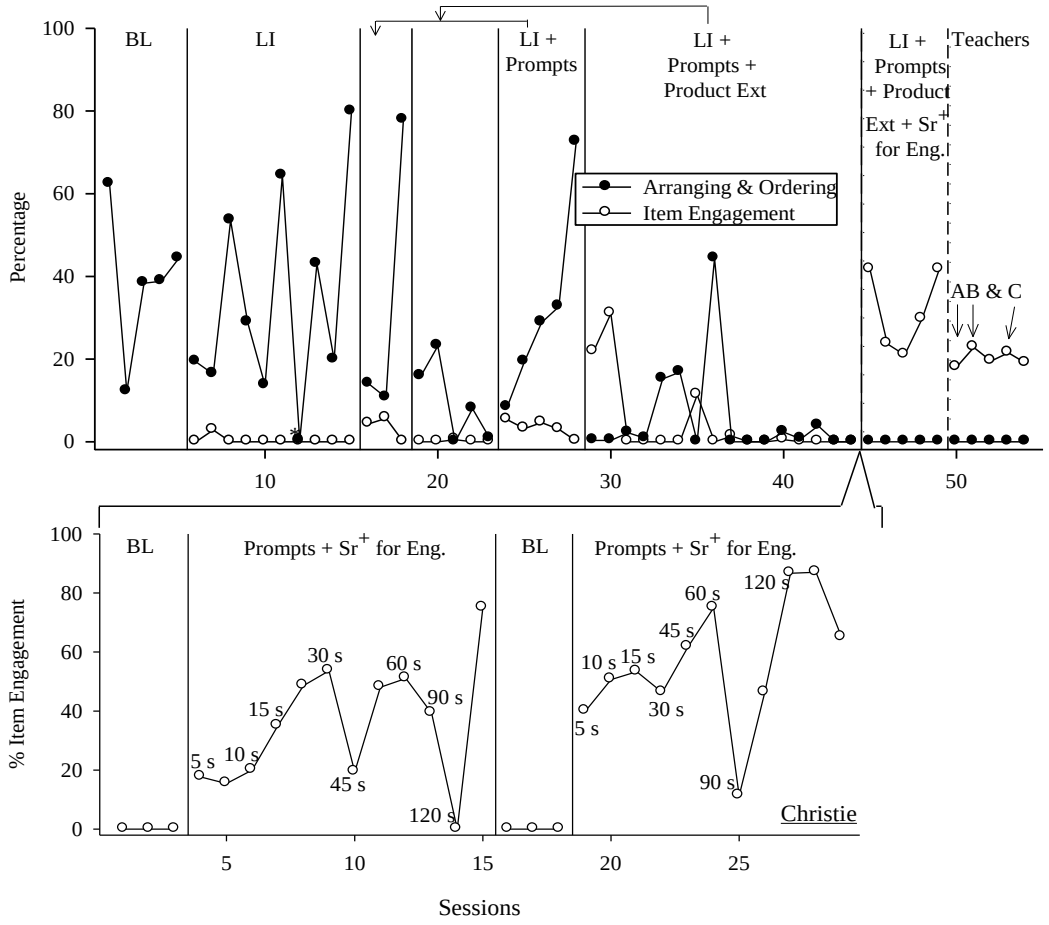

Figure 11. The top panel shows the percentage of arranging and ordering of furniture (closed circles) and the percentage of item engagement (open circles) during Christie's treatment evaluation. Letters in the teachers phase of the treatment evaluation represent sessions conducted by different teachers (teacher A, teacher B, and teacher C). The bottom panel shows the percentage of item engagement during Christie's play skills training, which was implemented between sessions 44and 45 of the treatment evaluation. Numbers next to data points represent changes in cumulative item engagement criteria for reinforcement.