Behavioral Interventions
Behav. Intervent. **15**: 121–133 (2000)

FUNCTIONAL ANALYSIS OF HAIR MANIPULATION: A REPLICATION AND EXTENSION

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In a multi-phase investigation, we assessed the problematic hair manipulation of a four-year-old male diagnosed with autism. In phase 1, a functional analysis of hair manipulation resulted in high levels of responding during a no-interaction condition, while near-zero levels were observed in other conditions. In phase 2, hair manipulation was reduced to near-zero levels during a condition in which Billy wore gloves on his hands to attenuate digital-tactile stimulation. In phase 3, a stimulus preference assessment indicated that object manipulation competed with hair manipulation, and that wearing gloves did not alter the amount of time that Billy manipulated preferred objects. The results are discussed in the context of interventions that achieve their effects via reinforcer substitutability or competition. Copyright © 2000 John Wiley & Sons, Ltd.

Behaviors commonly labeled as "habits" (e.g., thumb or finger sucking, hair pulling) have only recently been subjected to the rigorous analyses often conducted for other problematic behaviors (for a review, see Miltenberger, Fuqua, & Woods, 1998). Consistent with this recent trend, very few studies have conducted extended analyses of behaviors topographically categorized as habits in an attempt to isolate the sensory mechanism(s) maintaining these behaviors. The few studies that have utilized such methods have focused on the behaviors of finger sucking and hair pulling. For example, Ellingson *et al.* (in press) conducted a functional analysis of the finger sucking of two typically developing children and initially observed high levels of the behavior in an alone condition. Thereafter, the authors attempted to attenuate digital-tactile and oral stimulation (the presumed sensory products of finger sucking) by placing adhesive bandages on the target finger of each child. This manipulation produced substantial reductions in both participants' finger sucking, suggesting an

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automatic reinforcement function. The authors subsequently concluded that this behavior was maintained, at least in part, by digital stimulation, oral stimulation, or both.

Rapp, Miltenberger, Galensky, Ellingson, and Lone (1999) conducted a similar analysis with a woman diagnosed with mental retardation who exhibited hair pulling and concomitant hair manipulation (i.e., rubbing pulled hairs between her fingers and against her lips) that occurred primarily during the alone condition of a functional analysis. Because the authors suspected that hair pulling (as the first link in a behavioral chain) was maintained by a sensory consequence of hair manipulation (i.e., hair manipulation always followed hair pulling and lasted five times longer), they conducted a "free hair" condition in which previously pulled or cut hairs were provided noncontingently. In addition, to assess the sensory mechanism maintaining hair manipulation, the participant wore a rubber glove on her hand during both alone and free-hair conditions. The results showed that hair pulling was eliminated during free-hair conditions, but continued to occur at high levels in the alone condition. Conversely, hair manipulation (and hair pulling) was eliminated when the individual wore the glove. Therefore, the authors concluded that hair pulling was maintained by access to hairs that could be manipulated by this individual, and that hair manipulation was maintained primarily by digital-tactile stimulation.

In the present study, we analyzed the persistent hair manipulation of a young boy diagnosed with autism. Hair manipulation was deemed problematic for several reasons. Unlike typical hair pulling or trichotillomania cases, manipulation of hair in this case did not yet result in the removal of hair from the target region (i.e., the top of his scalp). This particular behavior involved touching, stroking, and twisting of hair, which have preceded the pulling of hair in previous investigations (e.g., Rapp, Miltenberger, Long, Elliot, & Lumley, 1998). In addition, because hair manipulation inherently required the use of his hands, this behavior frequently interfered with academic and functional skills training. Likewise, studies have indicated that individuals who exhibit repetitive (habit-like) behaviors receive lower social evaluation ratings from peers (e.g., Friman, McPherson, Warzak, & Evans, 1993; Long, Woods, Fuqua, Miltenberger, & Boudjouk, 1999).

In order to determine the variable(s) maintaining the current participant's hair manipulation, we conducted a functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) using the procedures described by Rapp *et al.* (1999) for assessing hair pulling with concomitant hair manipulation. Subsequently, we conducted a stimulus preference assessment (DeLeon, Iwata, Conners, & Wallace, 1999) to identify objects that might compete with hair manipulation.

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PHASE 1: FUNCTIONAL ANALYSIS OF HAIR MANIPULATION

Method

Participant and Target Behavior

Billy was a four-year-old male diagnosed with autism who received one-to-one behavioral intervention for 30 h per week in a university-sponsored program. His hearing and vision were within normal ranges. Billy's expressive and receptive verbal abilities were appropriate for his age and he could read approximately 200 sight words at the time of the study. Billy engaged in the problematic behavior of *hair manipulation*, which was defined as the twirling of scalp hair with fingers of either hand. He exhibited this behavior intermittently during his training sessions in the presence of numerous tutors. This behavior appeared to occur most often when he was alone and not engaged in a formal task. Similarly, Billy occasionally engaged in pulling and stroking of his tutor's hair (exclusively females with long hair). His parents reported that hair manipulation also occurred at home.

Data Collection and Interobserver Agreement

All sessions in this phase were conducted in Billy's therapy room. Data were collected during 20 min sessions (divided into 5 min conditions) using a video camera, which was placed on top of a shelf in Billy's therapy room. Videotaped data were scored using a real-time recording (RTR) procedure (Miltenberger, Rapp, & Long, 1999; Rapp, Carr, Miltenberger, Dozier, & Kellum, in press). RTR involves the second-by-second recording of target behavior(s) and other relevant events by scoring the exact time (from the VCR counter) of onset and offset of the events (e.g., manipulation of a toy). With this method, videotaped sessions were scored on a second-by-second basis for occurrence and non-occurrence of the target behavior using a scoring sheet marked for 300 s for each condition. Two independent observers scored 33% of the videotaped sessions in this phase. The mean interobserver agreement (IOA) scores for occurrences and nonoccurrences of hair manipulation were 96.7% and 100%, respectively.

Experimental Design and Procedures

Using a multielement design, we initially conducted several analogue sessions (in a room where Billy did not typically receive therapy) during which little or no

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hair manipulation was exhibited. Thereafter, we conducted sessions in Billy's therapy room while he was engaged in educational programming. Aside from the addition of a video camera, Billy's room was not altered (i.e., no objects were removed from the room) for any of these sessions. The conditions (described below) were presented during the course of Billy's educational programming in a counterbalanced order. Within a 20 min segment, four 5 min sessions were conducted consecutively during which Billy's tutor provided or withheld consequences as specified for each 5 min period (see example below). During this phase, four 20 min sessions, consisting of four experimental conditions, were conducted across four days.

No interaction. In this condition, Billy independently played with toys and looked at books while a tutor read Billy's program book. The tutor did not interact with Billy (i.e., no consequences were provided for hair manipulation). This condition assessed operant levels of hair manipulation in the absence of social consequences.

Attention. During this condition, Billy was seated across from a tutor and was engaged in his usual academic training. Following an instance of hair manipulation, the tutor provided brief attention (using a neutral tone) in the form of a verbal statement (e.g., "Billy, put your hand down please.") and then continued the training task. During the course of training, brief verbal praise (e.g., "good job", "smart boy") was provided for correct responses, while other behavior (e.g., whining) was ignored. This condition evaluated socially mediated positive reinforcement as a potential variable maintaining hair manipulation.

Demand. In this condition, a tutor presented Billy with a nonpreferred academic training task (i.e., one that was frequently correlated with problematic behavior). These tasks typically required a combination of a verbal response and the manipulation of an object (which could be completed with one hand). Contingent on each instance of hair manipulation, the tutor withdrew training materials, looked away from Billy, and withheld prompts for 20 s. Following the break period, the tutor re-initiated the task. Correct responses were followed by brief verbal praise, while other behavior was ignored. This condition evaluated whether socially mediated negative reinforcement, in the form of escape from potentially aversive academic demands, was a maintaining variable for hair manipulation.

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Control. In this condition, Billy was provided access to the toys in his room, as well as continuous social interaction with the tutor. The purpose of this condition was to evaluate levels of hair manipulation when Billy had access to preferred toys and a dense schedule of attention. This condition served as a methodological control and was used as a comparison for the other conditions.

As previously indicated, the 5 min conditions were provided in succession during 20 min periods. An example of a 20 min assessment period is as follows: (a) the tutor provided Billy attention contingent on hair manipulation during a training segment (attention), (b) the tutor played with Billy and provided a rich schedule of attention (control), (c) the tutor provided brief escape from a nonpreferred program contingent on hair manipulation (demand), and (d) the tutor instructed Billy to "go play", and, thereafter, withheld social interaction (no interaction).

Results and Discussion

Figure 1 shows that hair manipulation occurred for the greatest percentage of time during the no-interaction condition (M = 35.9%), followed by the demand (M = 5.2%), attention (M = 1.4%), and control (M = 0.2%) conditions. Although escape from the educational task was obtained for hair manipulation

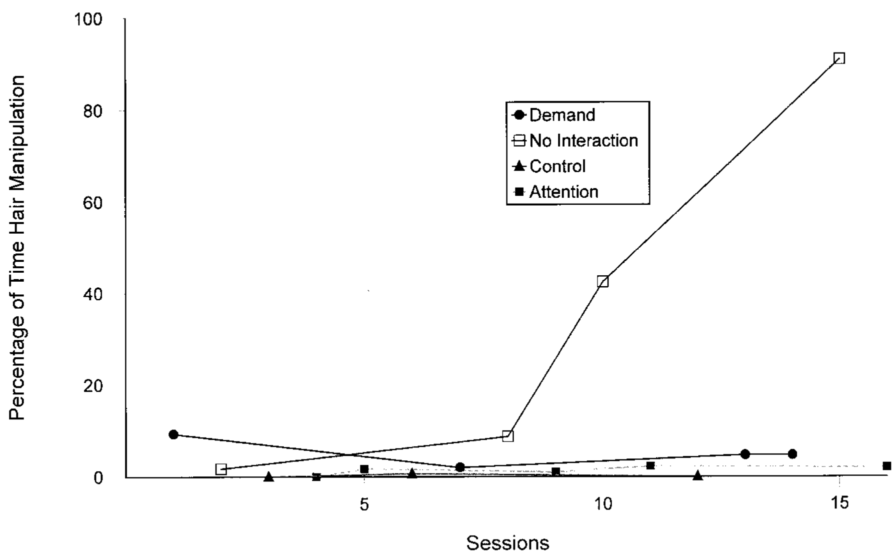

Figure 1. The percentage of time Billy engaged in hair manipulation during no-interaction, attention, demand, and control conditions.

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in the demand condition, within-session analysis of these sessions showed that hair manipulation was exhibited for the greatest duration during the contingent break periods, rather than during the task. It should also be noted that although Billy manipulated his hair during the contingent breaks provided in the demand condition, he never left his seat (where his educational programming was conducted), whereas he always did so during the no-interaction condition. Overall, the functional analysis suggests that hair manipulation was likely maintained by some form of automatic reinforcement.

PHASE 2: SENSORY ASSESSMENT OF HAIR MANIPULATION

A number of studies have conducted extended analyses of aberrant behavior when traditional functional analyses (Iwata *et al.*, 1982/1994) yielded undifferentiated responding across conditions or high levels of behavior during a no-interaction/alone condition. Such results are typically interpreted as evidence for an automatic reinforcement function. One approach that has been utilized to further analyze the operation function in such cases is to alter the sensory product of the target behavior. The following analysis was an attempt to replicate the results obtained by Rapp *et al.* (1999) by using gloves to attenuate digital-tactile stimulation. Likewise, objects with properties similar to that of hair (e.g., hairy or furry toys) were available to Billy to evaluate whether the stimulation produced by these objects would complete with (e.g., Favell, McGimsey, & Schell, 1982) or substitute for the stimulation produced by hair manipulation.

Method

Target Behaviors

The operational definition for hair manipulation was the same as in phase 1. *Object manipulation* was defined as contact of either hand with an object.

Data Collection and Interobserver Agreement

Data collection and scoring were the same as in phase 1. Likewise, IOA was calculated in the same manner as in phase 1. A second observer scored 30% of the sessions in this phase. The mean IOA scores for occurrences and non-occurrences of hair manipulation were 98.5% and 99.8%, respectively. The

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mean IOA score for nonoccurrences of object manipulation (hairy/furry toys) was 100%. Agreement for occurrences is not reported because Billy did not manipulate any of these objects during sessions.

Experimental Design and Procedures

In this phase, we evaluated levels of hair manipulation across three experimental conditions within a multielement design. As in the previous phase, 5 min sessions were conducted in Billy's therapy room during the course of his normal training sessions. Each condition was presented as a variant of the no-interaction condition during contingent break periods that followed 5 min of his typical training (as in phase 1). For example, a tutor would engage Billy in an educational training task (data on hair manipulation were not collected during this period) after which a no-interaction session (or the specified variant) was begun (data on hair manipulation were collected during these segments). Prior to conducting the formal assessment, Billy was given access to each object (used in the hairy/furry toys condition) separately, at least three times for periods of 10 min. Similarly, Billy wore the gloves several times for periods up to 10 min prior to wearing them during the sessions. Three to four of these 5 min sessions were conducted per day.

No interaction. This condition was the same as in phase 1 and was used as a comparison for the other conditions.

Gloves. This condition was identical to the no-interaction condition, with the exception that Billy wore thin, cotton woven gloves on his hands. This condition was used to evaluate levels of hair manipulation when digital-tactile stimulation was attenuated.

Hairy/furry toys. In this condition, Billy was provided continuous access to hairy and/or furry toys to assess whether he would manipulate these objects instead of his own hair. The objects included in this condition were a Kooshball®, a doll's hair, a Troll® doll (with long hair), and a toy mouse. These objects were selected because they appeared to possess stimulus qualities similar to hair. Thus, this condition was intended to evaluate whether these objects produced stimulation that substituted for or competed with hair manipulation.

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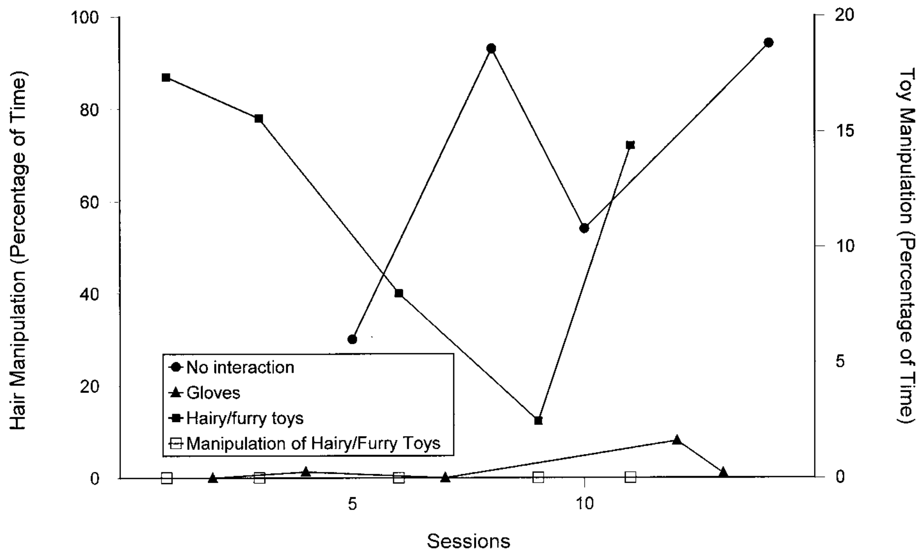

Figure 2. The percentage of time Billy engaged in hair manipulation during no-interaction, glove, and hairy/furry toys conditions (on the primary y-axis). The percentage of time Billy manipulated objects during the hairy/furry toys condition is depicted on the secondary y-axis.

Results and Discussion

Figure 2 shows that the highest level of hair manipulation was observed during the no-interaction condition ($M = 67.8\%$), followed by the hairy/furry toys ($M = 57.9\%$) and gloves ($M = 2.2\%$) conditions. Figure 2 also shows that Billy did not manipulate the objects during the hairy/furry toys condition. In contrast, hair manipulation was reduced to near-zero levels for four of the five sessions when Billy wore the gloves. Billy did not exhibit any novel behavior while wearing the gloves with the exception of indicating that he was "hot" toward the end of two sessions.

Interestingly, during session 11, Billy exhibited what appeared to be an extinction burst (see Lerman, Iwata, & Wallace, 1999). Within-session (second-by-second) analysis of hair manipulation during this session indicated that the first instance of hair manipulation occurred at 0:01 and lasted 6 s, the second response occurred at 2:20 and lasted 4 s, the third response occurred at 3:34 and lasted 11 s, and the fourth response occurred at 3:53 and lasted 5 s. When compared to the no-interaction condition, in which a single instance of hair manipulation typically occurred for up to several minutes, this pattern of responding suggests that the glove may have produced sensory extinction

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(Rincover, Cook, Peoples, & Packard, 1979) of digital-tactile stimulation produced by hair manipulation.

PHASE 3: STIMULUS PREFERENCE ASSESSMENT

DeLeon *et al.* (1999) recently suggested that a duration measure of stimulus preference is better suited to evaluate preference for objects that are intended to compete with, or substitute for, behavior maintained by automatic reinforcement. Hence, in the final phase of this study, we presented several items to Billy that could be manipulated when hair manipulation was simultaneously available.

Method

Target Behavior

The definition of hair manipulation was the same as in the previous two phases. Object manipulation was defined as any contact of Billy's hands or feet with a particular object (i.e., he could simultaneously manipulate multiple objects).

Data Collection and Interobserver Agreement

Data were collected during four, 10 min sessions using the same data collection and scoring methods described in the previous phases. A second observer scored 50% of the sessions in this phase. Mean IOA scores for occurrences and nonoccurrences of hair manipulation were 94.3% and 100%, respectively. The mean IOA scores for occurrences and nonoccurrences of object manipulation were 99.6% and 100%, respectively.

Procedure

The stimulus preference assessment was conducted in a context similar to the no-interaction condition. That is, the tutor displayed objects (see Figure 3) on the floor in Billy's therapy room and subsequently allowed him to interact with the items of his choosing. To further examine whether a preferred object produced stimulation similar to that of manipulating hair, Billy also wore gloves (as in phase 2) during one additional session. It was assumed that if object

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manipulation was maintained by digital-tactile stimulation, then attenuating that sensation would produce a reduction in the percentage of time the preferred object was manipulated relative to periods when this sensation was not attenuated. If such an effect was observed, it would provide support for a reinforcer substitution explanation for the reduction of hair manipulation during object manipulation. If levels of object manipulation were unchanged when Billy wore gloves, this would support a reinforcer competition explanation.

Results and Discussion

Figure 3 shows the percentage of time in which Billy manipulated objects and hair across the four sessions (including one session in which Billy wore gloves). The figurine ($M = 43.5\%$) was manipulated for the most extensive period, followed by the ball ($M = 21\%$), and jump rope ($M = 10.6\%$). Hair manipulation ($M = 2.2\%$) was consistently low and slowly decreased to zero across the three sessions. The session in which Billy wore gloves resulted in no relative change in stimulus preference or levels of object manipulation. Thus, this assessment not only demonstrated that Billy would manipulate the figurine, the

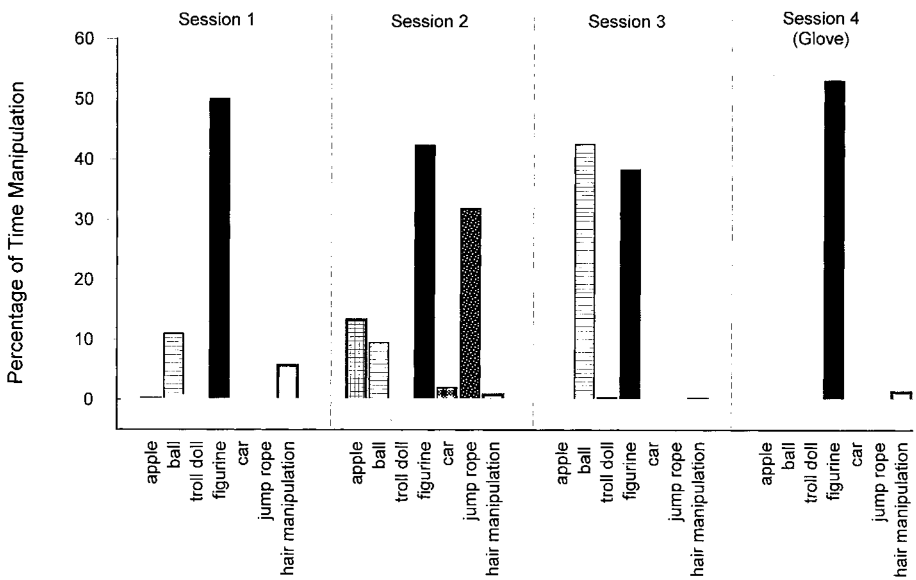

Figure 3. The percentage of time Billy engaged in object and hair manipulation during the stimulus preference assessment.

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ball, or both for extended periods of time, but also that these objects successfully competed with, but likely did not substitute for, hair manipulation.

GENERAL DISCUSSION

The results of the present investigation replicate and extend previous findings (Rapp *et al.*, 1999) obtained in the analysis of hair pulling and concomitant hair manipulation. In this investigation, the hair manipulation of a young male with autism occurred at high levels during a no-interaction context (i.e., no social consequences). This behavior was substantially reduced when gloves were worn on his hands to attenuate digital-tactile stimulation. Subsequently, manipulation of preferred toys was shown to compete with manipulation of hair during a free-operant stimulus preference assessment. Because the figurine (the most preferred object), unlike Billy's hair, could provide visual stimulation as well as digital-tactile stimulation, and a visual discrimination was necessary to select this object, it may have been unreasonable to assume that manipulation of this object would decrease when Billy wore gloves. Hence, the percentage of time during which Billy manipulated this and other objects was essentially unchanged when he wore the gloves. In light of this finding, it appears that reinforcer competition, rather than reinforcer substitution, was the mechanism responsible for reducing hair manipulation. To address this behavior in Billy's natural environment, the preferred objects were made continuously available during periods when Billy played independently (i.e., no social interaction).

The present investigation contributes to the assessment and treatment literature for behavior maintained by automatic reinforcement in several ways. First, this study is among the few that provides evidence that pulling and/or manipulation of hair can be maintained by automatic positive reinforcement in the form of digital-tactile stimulation, rather than automatic negative reinforcement in the form of tension reduction (e.g., Christenson, Mackenzie, & Mitchell, 1991; Stanley, Borden, Mouton, & Breckenridge, 1995). Despite the notable absence of experimental data, the former explanation has dominated the hair-pulling literature (Miltenberger *et al.*, 1998). Second, when analogue functional analysis sessions did not evoke the target behavior, we utilized a method for conducting consecutive naturalistic experimental conditions to maximize time efficiency and produce reliable results. Given specific stimulus contexts, this method may represent a cost-effective and valid alternative to analogue analyses. Finally, to our knowledge, this is the first study to attempt to reduce an alternative behavior (i.e., object manipulation) by attenuating a postulated sensory product of that behavior. In this case, the analysis was conducted to

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determine whether reinforcer substitution or competition was responsible for reductions in hair manipulation.

Some limitations of this study need to be recognized. First, although we demonstrated that the objects competed with hair manipulation during analogue sessions (conducted in his therapy room), we did not experimentally assess the long-term effectiveness of this intervention. Second, the results of phase 2 may appear somewhat counterintuitive with regard to the concept of reinforcer competition/substitution. That is, if stimulation produced by manipulating hair maintained Billy's behavior, then it would seem logical that at least some of his responding would have been allocated to the hairy/furry toys. Interestingly, during the later hairy/furry toy sessions, Billy made comments such as "no mouse", suggesting that he did not want this object. Thus, Billy's verbal behavior might have indicated that the hairy mouse was an aversive stimulus that elicited emotional responses that were incompatible with object manipulation. However, Billy neither made negative comments about the other objects nor exhibited overt "avoidance" behavior of the house (e.g., sitting far away from the object). Furthermore, he did manipulate his own hair during these sessions (a response he often engaged in while lying next to the mouse and was not correlated with fear or anxiety for Billy). Thus, it seems unlikely that the absence of object manipulation in this condition could be attributed to aversive properties of one object. Conversely, it is more parsimonious to assume that the objects did not produce the same quality of sensory reinforcement as manipulation of scalp hair.

A final limitation is that we did not evaluate the possibility that (proprioceptive) stimulation produced by movement of the arm to the head (during hair manipulation) contributed to the maintenance of this hand-to-head behavior. However, because both arm movement to the head and hair manipulation (touching scalp hair) subsided during the gloves condition (the glove would not affect stimulation produced by arm movement), it seems unlikely that this arm movement was a factor in the maintenance of hair manipulation.

The results of this investigation provide several avenues for future research on the assessment and treatment of behavior maintained by automatic reinforcement. Because the identification of sensory mechanism(s) that maintain a behavior can enable the clinician to implement either sensory extinction or reinforcer substitution/competition procedures to reduce the target behavior, future research might focus on developing new methods for evaluating these mechanisms. Similarly, researchers could focus on generating further support for phenomena such as sensory extinction, which presumably is the operant mechanism responsible for behavior reduction under conditions of sensory attenuation. Such support might accrue with the continued use of within-session

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analysis of data obtained via RTR methods. Finally, researchers should continue to explore new approaches for applying functional analysis methods. Striking a balance between experimental control and naturalistic representation will likely enhance the utility of this assessment method.

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