

*AN ANALYSIS OF THE REINFORCING PROPERTIES OF
HAND MOUTHING*

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Hand mouthing often has been described as a stereotypic response that is maintained by non-social (automatic) reinforcement; however, data supporting this conclusion can be found in relatively few studies. This series of studies presents an experimental analysis of conditions associated with the maintenance of hand mouthing. In Experiment 1, a functional analysis was conducted for 12 individuals who engaged in chronic hand mouthing to determine whether the behavior is usually maintained independent of social contingencies. Results obtained for 10 subjects were consistent with an automatic reinforcement hypothesis; the remaining 2 subjects' hand mouthing was maintained by social-positive reinforcement. Based on these results, Experiment 2 was designed to identify the specific reinforcing properties of hand mouthing. Each of 4 subjects was provided with a toy that substituted for hand mouthing, and preference for a specific topography of toy manipulation (hand-toy contact or mouth-toy contact) was measured. Results indicated that hand stimulation was the predominant reinforcer for all subjects. Experiment 3 provided an extension of Experiment 2 in that the same responses were measured across a variety of toys presented to each of 5 subjects. Results again indicated that hand stimulation was the predominant reinforcer for all subjects. Implications of these results are discussed with relevance to treatment.

DESCRIPTORS: hand mouthing, functional analysis, automatic reinforcement hypothesis, self-stimulatory behavior, self-injurious behavior, stereotypy

Chronic hand-in-mouth behavior, or hand mouthing as it is typically called, is a repetitive and often rhythmic pattern of behavior that is generally defined as any response that results in getting the hands and face wet due to contact with saliva (Rast & Jack, 1992). Griffin, Williams, Stark, Altmeyer, and Mason (1984) found the prevalence of hand mouthing to be approximately 15% in a state-wide survey of institutionalized individuals who engaged in SIB. Hand mouthing is differentiated from

hand biting in that the former does not result in laceration of the hands caused by the teeth. Tissue damage produced by hand mouthing usually results in skin breakdown and lesions, which subsequently may result in infection (Ball, Campbell, & Barkemeyer, 1980), loss of motor dexterity (Dorsey, Iwata, Ong, & McSween, 1980), and interference with the performance of adaptive skills (Rast & Jack, 1992). In addition, hand mouthing is considered to be socially inappropriate due to its offensive odor and the presence of saliva in areas external to the oral cavity, both of which pose a barrier to social integration (McClure, Moss, McPeters, & Kirkpatrick, 1986).

Several theories have been proposed concerning the etiology of hand mouthing as either stereotypic or self-injurious behavior. One suggests that hand mouthing is maintained by social consequences (Baumeister & Forehand, 1973) in the form of either positive reinforcement (e.g., attention) or negative reinforcement (e.g.,

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escape). A second theory proposes that hand mouthing serves a homeostatic function in maintaining an "optimal" level of stimulation (Lueba, 1955). Guess (1966) examined stereotypic behaviors exhibited by sighted versus non-sighted and ambulatory versus nonambulatory individuals with severe or profound mental retardation and found that nonsighted and nonambulatory individuals engaged in more stereotypic behaviors than their more fully functioning counterparts. On the basis of these data, Guess concluded that stereotypies such as hand mouthing provided *increased* stimulation to those with sensory deficits. By contrast, Baumeister and Forehand (1973) noted that hand mouthing might also *decrease* stimulation by blocking the sensory input produced by noisy or crowded environments. A third theory (Rast & Jack, 1992) views hand mouthing as a "vicious cycle" in which, initially, hand mouthing causes discomfort to the hands due to dryness or chapping. Subsequently, putting hands into the mouth may be soothing; saliva that comes into contact with chapped hands may provide temporary alleviation of discomfort, even though continual hand mouthing will eventually result in further skin breakdown.

A common feature of the above theories is that hand mouthing is viewed as a learned response, and the major difference appears to be the source of reinforcement to which behavioral maintenance is attributed. Attention and escape are social forms of reinforcement, whereas increased (or decreased) sensory stimulation and alleviation of discomfort are nonsocial forms (i.e., they do not involve mediation through the actions of others). As a means of classifying nonsocial contingencies of reinforcement, Vaughan and Michael (1982) proposed the term *automatic reinforcement* to describe situations in which behavior directly produces reinforcing consequences. Thus, theories of hand mouthing as operant behavior seem to be differentiated on the basis of social versus automatic reinforcement as the maintaining contingency.

The prevailing view in the literature has emphasized the self-stimulatory (i.e., automatically reinforced) nature of hand mouthing. As a result, almost all of the research on hand mouthing has focused exclusively on treatment. Of the 39 studies reported to date on hand mouthing, only eight described an attempt to identify the behavior's maintaining contingency. Data from these studies are consistent with the view that most hand mouthing is maintained by automatic reinforcement, but are also indicative of social reinforcement functions. Thus, attempts to eliminate hand mouthing may benefit from identification of the behavior's reinforcers prior to the implementation of treatment: If hand mouthing is maintained by several sources of reinforcement, it is unlikely that any one intervention would produce consistent effects. For example, if hand mouthing was found to be maintained by contingent attention, one option for treatment might be to provide attention for the absence of hand mouthing (i.e., differential reinforcement of other behavior); however, this procedure would be expected to have little effect on hand mouthing that is maintained by access to a different reinforcer.

Because previous studies presented data for few subjects (most were single-case studies), it is unknown if the reported functions represent isolated instances or if the aggregate data reflect the prevalence of automatic reinforcement as a maintaining variable for hand mouthing. Thus, one purpose of the present research (Experiment 1) was to conduct a functional analysis of hand mouthing for a group of individuals to determine if, in fact, hand mouthing is often maintained in the absence of social reinforcement.

A second purpose was to provide a preliminary analysis of the reinforcing properties of hand mouthing in cases in which the behavior is hypothesized to be maintained by automatic reinforcement. An issue that arises in considering the concept of automatic reinforcement is the fact that the specific reinforcing stimulus may be difficult to identify when it is not me-

Table 1
Subject Characteristics

Subject	Age	Level of MR	Physical deficits	Receptive language	Expressive language
Laura	25	profound	none	follows simple instructions	one-word utterances
Bonnie	40	profound	none	follows simple instructions	repeats simple words
Marty	33	profound	none	follows simple instructions	none
Maria	34	profound	none	minimal	none
Miranda	24	profound	nonambulatory	minimal	none
Anita	68	profound	nonambulatory impaired vision	minimal	none
Lucella	40	profound	impaired hearing	minimal	none
Pierre	39	profound	none	minimal	none
Marcel	25	profound	nonambulatory	minimal	none
Danielle	24	profound	none	minimal	none
Michelle	31	profound	nonambulatory	minimal	none
Monique	34	profound	nonambulatory	minimal	none

diated by another person. Vaughan and Michael (1982) noted that, with respect to automatically reinforced behavior, "it is virtually impossible to sever the behavior from its product, and thus impossible to manipulate the variable of which the behavior is considered a function" (p. 224). An alternative strategy would be to provide access to sources of stimulation similar to that produced by hand mouthing, and to see which source serves as an effective substitute for hand-mouth contact (see Green & Freed, 1993, for a review of reinforcer substitutability). For example, to the extent that an individual who engages in hand mouthing also manipulates objects (toys), it is possible that the topography of manipulation may reveal preference for a given form of stimulation. Relative preference for mouth-toy contact may suggest that stimulation of the mouth is the predominant reinforcer, whereas preference for hand-toy contact may suggest that stimulation of the hand is the predominant reinforcer. In Experiments 2 and 3, individuals whose hand mouthing was not maintained by social reinforcement were given free access to one or more objects to see if they showed preference for mouth versus hand stimulation.

EXPERIMENT 1: FUNCTIONAL ANALYSIS OF HAND MOUTHING

METHOD

Subjects and Setting

Twelve individuals participated. All lived at a state residential facility for persons with developmental disabilities and were referred to a day program for assessment and treatment of SIB. Subject characteristics, including age, level of retardation, physical deficits, and level of expressive and receptive language, are listed in Table 1. None of the subjects received any psychotropic medication during the study. Anita, Monique, Michelle, and Laura received prescribed medications to control seizures.

All sessions were conducted in therapy rooms located at the day program. During sessions, a therapist, an observer, or both were present. Also present in each room were a table and at least one chair, as well as materials specific to various conditions of the experiment.

Response Measurement and Interobserver Agreement

The primary dependent variable was hand mouthing, defined as insertion of the hand or

fingers past the plane of the upper and lower lips, or protrusion of the tongue out of the mouth onto the hand or fingers. Data were also collected on subjects' compliance with instructions, and therapists' delivery of instructions or attention. Subjects' and therapists' behaviors were recorded on a hand-held computer (Assistant, Model AST 102) during continuous 10-s intervals. Because the duration of hand mouthing varied considerably, a partial-interval scoring procedure was used, in which observers marked the occurrence of the behavior if it was observed at any time during a 10-s interval. Data were converted to the percentage of intervals during which responding occurred.

Interobserver agreement was assessed by having a second observer simultaneously but independently collect data with the first observer. Percentage agreement was calculated by dividing the number of intervals containing scoring agreements by the total number of intervals in the session. The percentage of sessions during which agreement was assessed for individual subjects ranged from 15.4% to 57.9%, and mean percentage agreement across subjects ranged from 89.1% to 100%.

Experimental Design and Procedure

The functional analysis procedures used in this experiment were based on those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Subjects were exposed to four or five assessment conditions in a multielement design. To enhance discrimination by subjects, each condition was associated with a unique experimenter for a given subject. Sessions were 15 min in duration, and three to four sessions (one session per condition) were conducted per day for each subject, at least 4 days per week.

Demand. The therapist and subject were in a room containing task materials. During the session, the therapist presented tasks to the subject in discrete trials every 30 s using a three-prompt sequence (instruction, instruction plus demonstration, and instruction plus physical assis-

tance, delivered at 5-s intervals). Praise was delivered for compliance following the initial instruction or demonstration. Contingent on hand mouthing, the therapist ceased all interaction with the subject and removed the task materials until the next trial was scheduled to begin. In essence, a brief time-out or escape was implemented. The purpose of this condition was to assess the possibility that hand mouthing was maintained by social-negative reinforcement in the form of escape from demands.

Attention. The therapist and subject were in a room containing a variety of leisure materials. At the start of the session, the therapist engaged in a solitary activity such as reading. No interaction occurred between the therapist and the subject except that, contingent on hand mouthing, attention in the form of concern and disapproval was delivered (e.g., "Don't do that; stop or you'll hurt your hand"). The purpose of this condition was to assess the possibility that hand mouthing was maintained by social-positive reinforcement in the form of attention.

Alone. The subject was alone in the room, which was empty of all materials. No therapist was present in this condition; thus, no interaction occurred. The purpose of this condition was to assess the possibility that hand mouthing was maintained in the absence of all social consequences.

Materials. A fourth test condition was designed specifically for Laura. Information obtained from interviews with staff on her residence, and subsequently verified during informal observations, suggested that Laura's hand mouthing seemed to occur often when she was denied access to a preferred toy. Therefore, a condition was arranged to test the possibility that hand mouthing was maintained by access to a specific item. Before the start of the session, Laura was allowed access to the preferred toy for 30 s. At the start of the session, the therapist removed the toy. Contingent on hand mouthing, the therapist returned the toy for 30 s.

Play. In this condition, the therapist and subject were in a room containing a variety of lei-

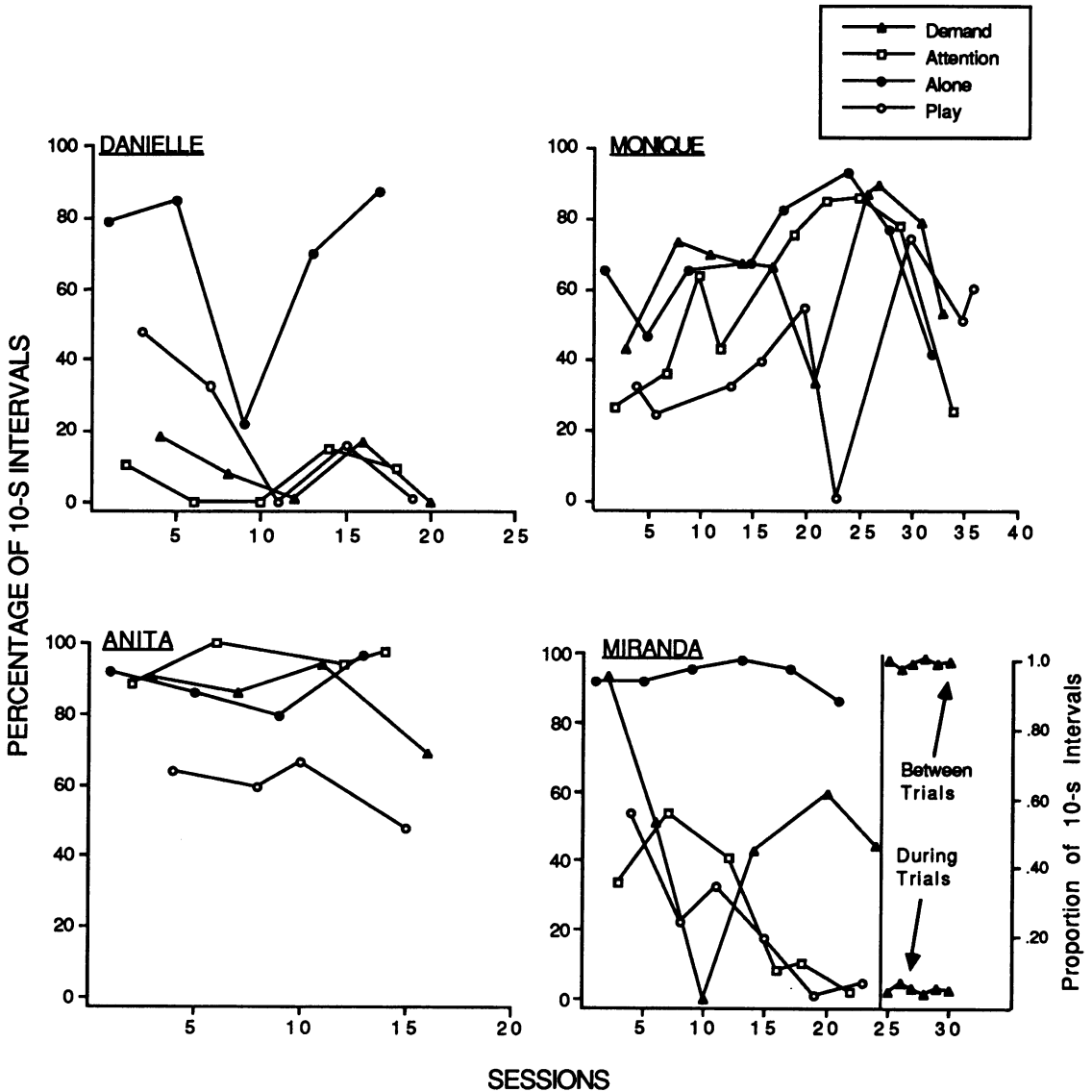


Figure 1. Percentage of intervals of hand mouthing across assessment conditions during Experiment 1 for Danielle, Monique, Anita, and Miranda.

sure materials, as in the attention condition. On a fixed-time (FT) 30-s schedule, interaction in the form of praise, toys, or pats on the back was delivered independent of hand mouthing. The play condition served as a control for the other conditions.

RESULTS AND DISCUSSION

Data for the 12 subjects tended to reflect several common patterns of responding; therefore,

four typical and two atypical data sets were selected for graphic presentation. Figure 1 shows the results obtained for Danielle, Monique, Anita, and Miranda. Danielle's hand mouthing was highest during the alone condition, suggesting that the behavior was not maintained by social contingencies. Monique's hand mouthing was relatively high in all conditions, but it was somewhat lower during the play condition. Anita demonstrated an undifferentiated response

pattern during the demand, attention, and alone conditions, whereas hand mouthing was much lower during play. Both Monique and Anita spent much of the play condition engaged in toy manipulation. Because differentially high levels of responding were not observed during either the attention or demand conditions, the data do not suggest that hand mouthing was maintained by social reinforcement. Instead, hand mouthing was hypothesized to be maintained by automatic reinforcement. Miranda's hand mouthing occurred almost continuously during the alone condition, but a considerable amount of hand mouthing also occurred during the demand condition, suggesting that her hand mouthing was maintained by both automatic reinforcement and social reinforcement in the form of escape (see Smith, Iwata, Vollmer, & Zarcone, 1993, for an extensive discussion of multiply controlled SIB). Additional demand sessions were conducted in order to examine more closely the relationship between hand mouthing and escape, and observers differentially scored hand mouthing that occurred during trials and hand mouthing that occurred during time-out (between trials). Results indicated that a much higher proportion of hand mouthing occurred between trials (.972) compared to during trials (.028), indicating that most of Miranda's hand mouthing during the demand condition occurred when she was functionally alone. These results suggest that her hand mouthing was not maintained by negative reinforcement (escape).

Figure 2 shows data for Bonnie and Laura. Bonnie's hand mouthing was highest during the attention condition, suggesting that her behavior was maintained primarily by positive reinforcement in the form of attention. Laura's hand mouthing was highest during the materials condition, indicating that her behavior was maintained by access to an object.

Results for all 12 subjects are listed as condition means in Table 2. For the 6 subjects whose results were not presented individually, hand mouthing was high in the alone condition

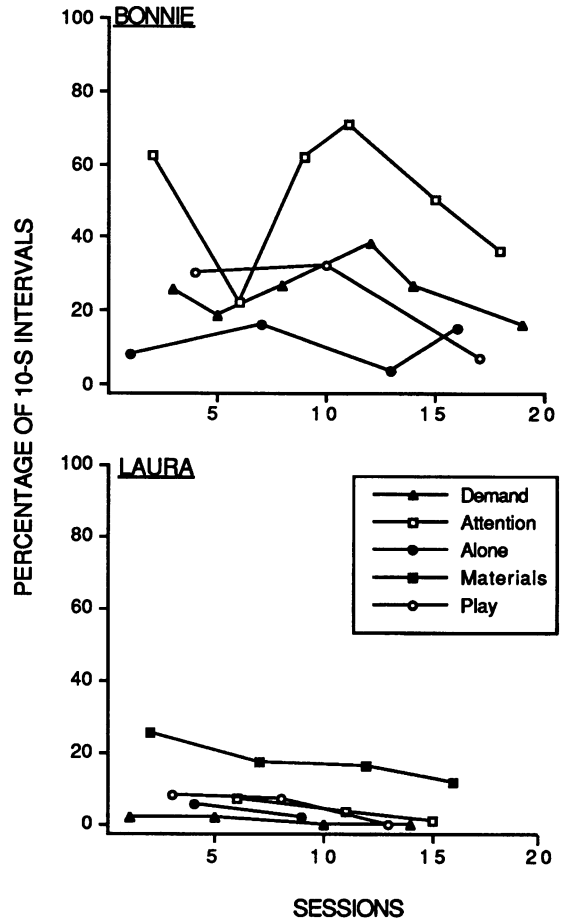


Figure 2. Percentage of intervals of hand mouthing across assessment conditions during Experiment 1 for Bonnie and Laura.

(Pierre), high in the alone and other conditions (Maria and Lucella), moderately low in all conditions (Marty and Marcel), and high in both the demand and alone conditions (Michelle). Results of the additional demand assessment for Michelle indicated that a higher proportion of her hand mouthing (.822) occurred between trials, when she was functionally alone. Thus, results for the remaining 6 subjects suggest that their hand mouthing was not maintained by social reinforcement.

In summary, hand mouthing for 10 of the 12 subjects appeared to be maintained independent of social reinforcement. Thus, data obtained for the majority of subjects were consis-

Table 2
Mean Percentage of 10-s Intervals of Hand Mouthing
Per Condition During Experiment 1

Subject	Condition				Between demand trials*
	De- mand	Atten- tion	Alone	Play	
Laura	1.1	3.9	4.1	7.5	17.7
Bonnie	25.4	50.5	10.7	23.1	
Marty	6.7	11.3	12.2	4.4	
Maria	67.1	23.5	53.0	44.1	
Miranda	48.5	24.8	93.1	21.9	.972
Anita	84.9	95.1	88.5	59.3	
Lucella	10.7	24.9	38.4	43.0	
Pierre	1.8	5.2	74.4	11.6	
Marcel	11.0	5.2	11.0	11.7	
Danielle	9.0	6.9	68.6	19.6	
Michelle	67.7	4.3	25.7	4.2	.822
Monique	66.3	57.7	67.3	41.2	

* Indicates the proportion of hand mouthing that occurred between demand trials (i.e., during time-out) versus during trials.

tent with the general view that hand mouthing is a form of self-stimulation that is hypothesized to be maintained by automatic reinforcement. However, the hand mouthing of 2 subjects was maintained by social-positive reinforcement, one in the form of attention (Bonnie), and the other in the form of access to materials (Laura). These data suggest that hand mouthing can be sensitive to social contingencies.

Of particular interest are the different patterns of responding exhibited by subjects whose hand mouthing was hypothesized to be maintained by automatic reinforcement, reflected in the session-by-session data for Danielle, Monique, Anita, and Miranda (see Figure 1). Anita's hand mouthing was lowest during the play condition, suggesting that access to toys during that condition may have competed somewhat with hand mouthing. Results for Danielle and Miranda suggest that a variety of activities (play materials during the play and attention conditions and tasks during the demand condition) competed with hand mouthing. By contrast, Monique's hand mouthing was relatively high across all conditions, suggesting that activities available during these conditions did not compete effectively with hand mouthing. Thus, the

extent to which access to a particular activity in a given assessment condition provided reinforcement that competed with that produced by hand mouthing may explain the different data patterns obtained for these subjects. Nevertheless, the common feature of these different patterns is the fact that hand mouthing was not clearly maintained by social reinforcement.

A noteworthy result of Experiment 1 was the finding that hand mouthing was highest in both the demand and alone conditions for Michelle and Miranda. The differentiation in scoring procedures during additional demand sessions provides an extension of functional analysis methodology. Without these data, a tentative conclusion of multiple control would have been reached. However, results of the additional demand sessions indicated that both subjects' hand mouthing occurred almost exclusively during time-out, suggesting that the behavior was not maintained by escape.

Although data for the majority of subjects suggested that their hand mouthing was insensitive to social contingencies, it is always possible that a highly unusual form of socially mediated reinforcement (i.e., escape from a specific task, access to a specific item) maintained hand mouthing but was not isolated during assessment. In previous research, we have used a variety of strategies to identify idiosyncratic sources of reinforcement (e.g., see Iwata et al., 1994) and, in fact, found one for Laura in the present study. Thus, although unlikely, the possibility remains that the functional analyses conducted in this study simply failed to identify the source of social reinforcement that was maintaining some subjects' hand mouthing.

For the 2 subjects whose hand mouthing was maintained by social-positive reinforcement, the specific nature of reinforcement (attention for Bonnie and toys for Laura) was identified in the functional analysis. However, for the 10 subjects whose hand mouthing was not maintained by social reinforcement, it is not clear if the source of reinforcement was primarily stimulation to the hand or the mouth. Thus, Experi-

ment 2 was an attempt to identify relative preference for hand or mouth stimulation.

EXPERIMENT 2: IDENTIFYING THE REINFORCING PROPERTIES OF HAND MOUTHING

Only one study to date has presented data suggesting a specific source of reinforcement for hand-mouthing behavior. Favell, McGimsey, and Schell (1982) examined the effects of access to alternative reinforcers on the stereotypic behaviors of 3 subjects, one of whom engaged in hand mouthing. During baseline, when toys and social interaction were not available, the subject engaged in high levels of hand mouthing. During one condition of the study, hand mouthing decreased when preferred toys were made available to the subject. In addition, toy mouthing was observed to occur at a high level, whereas toy play (with the hand) occurred less frequently. In Experiment 2, a methodology similar to that described by Favell *et al.* was used to identify possible sources of automatic reinforcement for hand mouthing. To the extent that a subject engages in some topography of toy manipulation (either hand-toy or mouth-toy contact), relative preference for mouth-toy contact may suggest that stimulation of the mouth is the predominant reinforcer, whereas relative preference for hand-toy contact may suggest that stimulation of the hand is the predominant reinforcer.

METHOD

Subjects and Setting

Four of the subjects from Experiment 1, whose hand mouthing was hypothesized to be maintained by automatic reinforcement, participated (Maria, Miranda, Anita, and Lucella). Sessions were conducted at the same location as in Experiment 1.

Response Measurement and Interobserver Agreement

Data were collected on hand mouthing, hand-toy contact, and mouth-toy contact.

Hand mouthing was defined as in Experiment 1. Hand-toy contact was defined as a hand touching a toy except when the subject brought the toy into contact with the mouth. Mouth-toy contact was defined as insertion of the toy past the plane of the upper and lower lips or protrusion of the tongue out of the mouth onto the toy. Procedures for scoring data and calculating interobserver agreement were the same as in Experiment 1. The percentage of sessions during which reliability was assessed ranged from 30% to 50% across subjects. Mean interobserver agreement percentages were as follows: hand-mouth contact, 94.8% (range, 91.0% to 97.1%); hand-toy contact, 85.3% (range, 76.1% to 93.3%); mouth-toy contact, 95.9% (range, 92.1% to 99.1%).

Experimental Design and Procedure

During repeated 15-min sessions, subjects were provided free access to an object they had been observed to manipulate during informal probes conducted prior to the study. These objects included a stuffed animal (Anita), plastic stacking rings (Maria), plastic toy keys attached to a plastic key ring (Miranda), and a toy mirror with straps (Lucella). Data on hand mouthing, hand-toy contact, and mouth-toy contact were taken when subjects had continuous access to toys. Thus, hand mouthing, mouth-toy contact, and hand-toy contact could all occur freely.

RESULTS AND DISCUSSION

Figure 3 shows data on hand mouthing, hand-toy contact, and mouth-toy contact for the 4 subjects. Results for Maria, Miranda, and Lucella show high levels of hand-toy contact relative to hand-mouth contact, suggesting that access to toys substituted effectively for hand mouthing; hand-toy contact was also much higher than mouth-toy contact for all 3 subjects, suggesting a relative preference for hand-toy contact. Anita's data show almost equal levels of hand-toy and hand-mouth contact, suggesting that the stuffed toy did not substitute

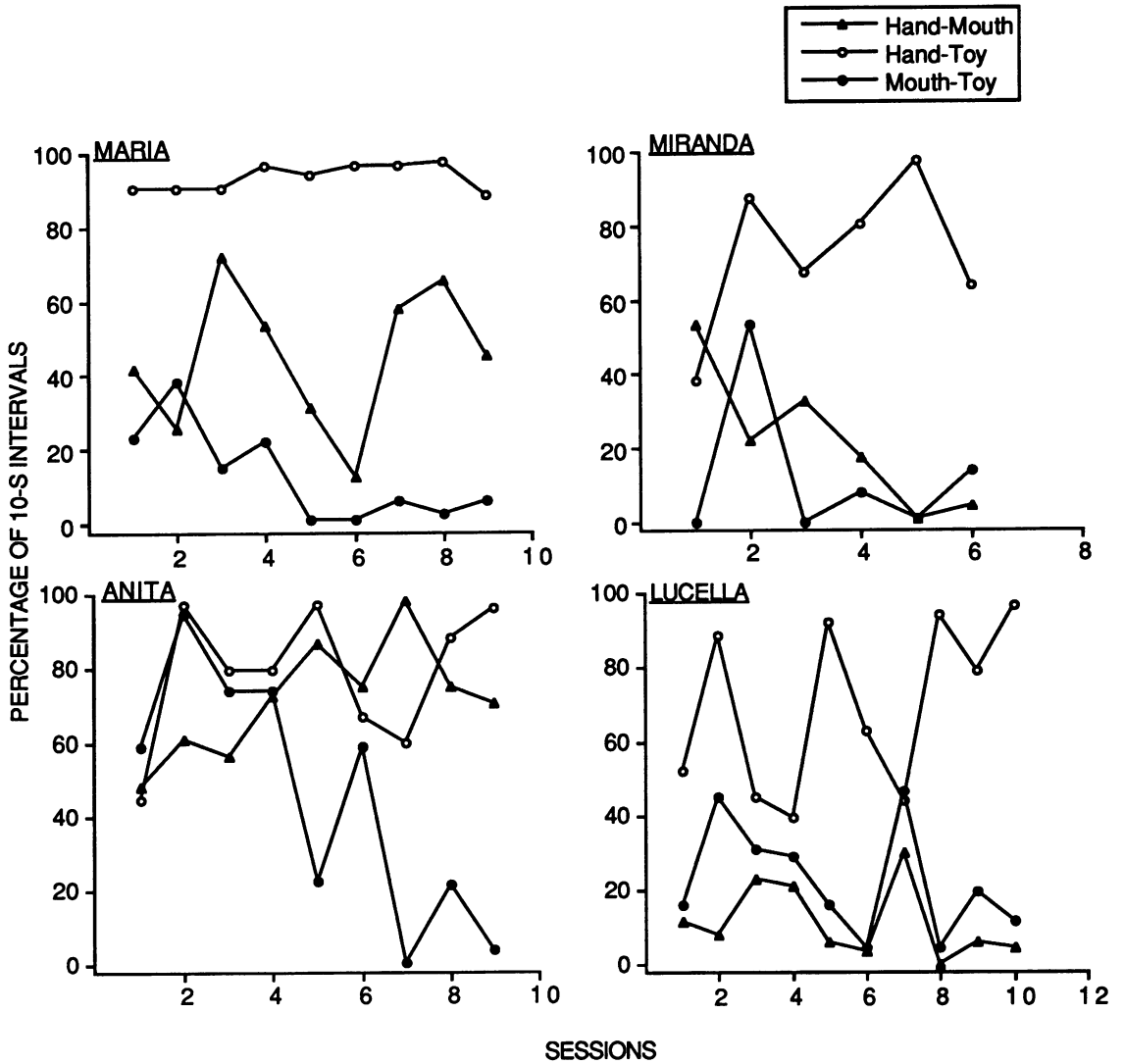


Figure 3. Percentage of intervals of hand-mouth contact, hand-toy contact, and mouth-toy contact during Experiment 2 for Maria, Miranda, Anita, and Lucella.

for hand mouthing. Her data also indicate that hand-toy and mouth-toy contact both occurred at high levels for the first four sessions. Thereafter, hand-toy contact remained high, whereas mouth-toy contact decreased, suggesting a relative preference for hand-toy contact.

Results obtained for all 4 subjects suggest that hand stimulation was the predominant reinforcer for hand mouthing; however, this conclusion should be made with caution. Substitutability of hand-toy contact for hand mouth-

ing does not necessarily indicate that the reinforcer for hand mouthing is stimulation to the hand rather than the mouth. Preference for one topography over another may be a function of specific stimulus properties. That is, perhaps the subjects engaged in more hand-toy contact than mouth-toy contact when presented with an object simply because they preferred handling (rather than mouthing) that specific toy. When provided with an object having different stimulus properties, a subject might exhibit a pref-

erence for mouth-toy contact. Thus, conclusions about reinforcement effects in this study would have been stronger following replications to determine whether subjects' preferences remained consistent across a range of stimuli; Experiment 3 was conducted to provide such an analysis. Subjects were given free access to a variety of toys to determine whether preference for either hand-toy contact or mouth-toy contact would be maintained across stimuli that varied in texture. If a subject consistently engages in one topography of toy manipulation with a variety of toys, perhaps a more tenable conclusion regarding the predominant reinforcer can be made.

EXPERIMENT 3: CONSISTENCY OF PREFERENCE FOR HAND-TOY VERSUS MOUTH-TOY CONTACT

METHOD

Subjects and Setting

Five of the subjects from Experiment 1, whose hand mouthing was hypothesized to be maintained by automatic reinforcement, participated (Pierre, Marcel, Danielle, Michelle, and Monique). Sessions were conducted at the same location as in Experiment 1.

Response Measurement and Interobserver Agreement

Data were collected on hand mouthing, hand-toy contact, and mouth-toy contact, defined as in Experiment 2. In addition, the definition of mouth-toy contact was modified for Pierre and Danielle to include contact between a hand-held foot massager and the cheeks and lips because the toy was too large to insert past the lips. Consequently, contact between the massager and the lips or cheeks was assumed to provide stimulation to the mouth. Procedures for scoring data and calculating interobserver agreement were the same as in Experiment 1. The percentage of sessions during which reliability was assessed ranged from 24.3% to

41.7% across subjects. Mean interobserver agreement percentages were as follows: hand-mouth contact, 96.0% (range, 89.1% to 100%); hand-toy contact, 93.0% (range, 81.5% to 99.3%); mouth-toy contact, 96.8% (range, 90.9% to 100%).

Experimental Design and Procedure

A two-phase assessment procedure was used. During an initial set of probes, subjects were given free access to a large variety of toys, presented singly for 5 min each. Toys that occasioned either hand-toy contact or mouth-toy contact during at least 30% of the intervals were selected for a more extended assessment of preference. In all, 19 different toys were assessed in this second phase (six for Marcel, Danielle, and Monique; seven for Michelle; and nine for Pierre). Each toy was presented singly to a subject for a varied number of 5-min sessions (range, five to nine). No therapist was present during sessions, and data on hand mouthing, hand-toy contact, and mouth-toy contact were taken when subjects had continuous access to a toy; thus, the three responses could all occur freely.

RESULTS AND DISCUSSION

Continued occurrence of high levels of hand mouthing when a toy was available would indicate that access to the toy did not substitute for or compete with reinforcement produced by hand mouthing; in this case, data on hand-toy or mouth-toy contact would be of little interest. Therefore, in the final data analysis, only those toys that occasioned either hand-toy or mouth-toy contact at least twice as often as hand mouthing were included.

Figure 4 shows the total proportion of intervals during which subjects engaged in hand-mouth, hand-toy, and mouth-toy contact in the presence of each toy that served as an effective substitute for hand mouthing. The data for Pierre, Marcel, and Danielle indicate consistent preference for hand-toy over mouth-toy contact

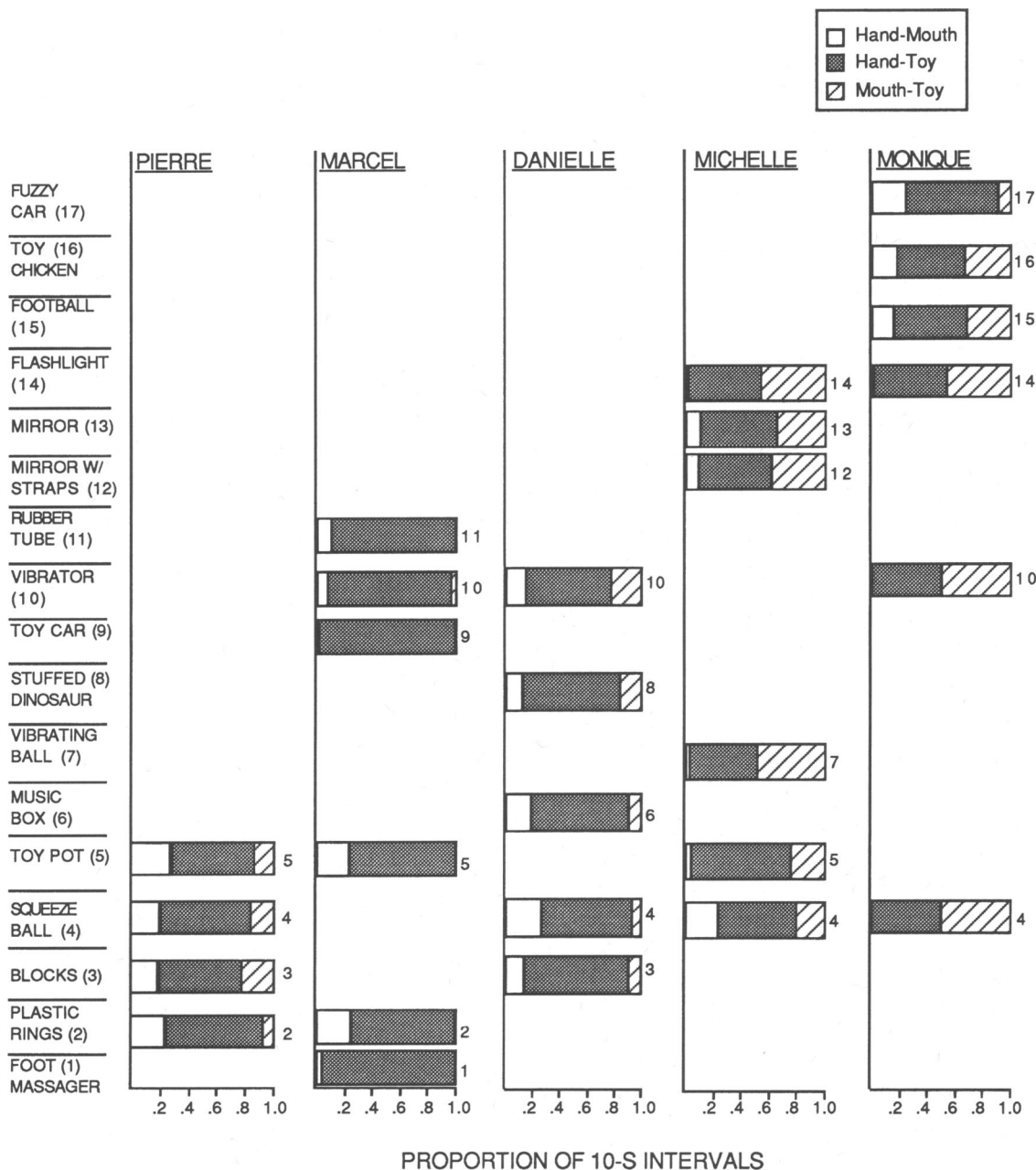


Figure 4. Mean proportion of intervals of hand-mouth contact, hand-toy contact, and mouth-toy contact per toy during Experiment 3 for Pierre, Marcel, Danielle, Michelle, and Monique.

across a wide range of stimuli. For Pierre, much higher levels of hand-toy contact occurred with plastic rings, blocks, squeeze ball, and toy pot, whereas much lower levels of mouth-toy contact occurred with these items. Marcel engaged in hand-toy contact almost exclusively across

toys (foot massager, plastic rings, toy pot, toy car, vibrator, and rubber tube). Specifically, no mouth-toy contact occurred with the toy pot, foot massager, and rubber tube; and mouth-toy contact occurred at extremely low proportions for rings, toy car, and vibrator (.011, .012, and

.034, respectively). Danielle's data are similar to Pierre's, showing much higher levels of hand-toy contact across all toys (blocks, squeeze ball, music box, stuffed dinosaur, and vibrator). Thus, the data for Pierre, Marcel, and Danielle indicate strong and consistent preference for hand-toy contact, and suggest that hand stimulation was the predominant reinforcer that maintained their hand mouthing.

Michelle showed almost equal levels of hand-toy and mouth-toy contact with the vibrating ball (the proportions of intervals in which hand-toy and mouth-toy contact occurred were .484 and .489, respectively), suggesting no preference for hand-toy or mouth-toy contact. Her hand-toy contact was slightly higher with the flashlight (the proportions of intervals in which hand-toy and mouth-toy contact occurred were .519 and .466, respectively). Data for the remaining four toys (mirror, mirror with straps, toy pot, and squeeze ball) indicate that higher levels of hand-toy contact occurred. Thus, Michelle's data indicate a moderate preference for hand-toy contact over mouth-toy contact, although both behaviors occurred to a noticeable degree.

Monique showed almost equal levels of hand-toy and mouth-toy contact with the squeeze ball and vibrator (the proportions of intervals in which hand-toy and mouth-toy contact occurred for the squeeze ball were .497 and .503, respectively, and for the vibrator were .50 and .50, respectively). Data obtained with the flashlight, football, toy chicken, and fuzzy car indicated that higher levels of hand-toy contact occurred, suggesting a preference for hand-toy contact. Thus, as was the case with Michelle, Monique showed a moderate preference for hand stimulation.

The methodology used in Experiment 3 extended the procedures of Experiment 2 as well as those described by Favell *et al.* (1982). Results generally showed a preference for hand stimulation across all 5 subjects (a strong preference by Pierre, Marcel, and Danielle and a moderate preference by Michelle and Mo-

nique). Results also showed no clear evidence of preference for mouth stimulation. This is a surprising result, because hand mouthing produces stimulation to the mouth; otherwise, the hand would not come into contact with the mouth, and the subject would engage in a different topography of hand stereotypy (if stimulation to the hand were the only source of reinforcement). Although highly speculative, one possible explanation for these results is that hand-mouth contact may be more reinforcing than other forms of hand stereotypies (e.g., hand flapping or finger twirling) except when objects whose manipulation provides either similar or competing stimulation are available.

Because the current methodology represents an initial attempt to identify the reinforcing properties of hand mouthing, future research should continue to focus both on the use of objects that substitute effectively for hand mouthing and on better control of stimulus properties. In Experiment 3, different toys were used, but the manipulation of one specific stimulus property (e.g., texture, shape, size, or color) while holding other properties constant was not done. It is possible that the data may have been less variable had such a manipulation been undertaken. For example, although Michelle's overall results suggested preference for hand stimulation, there was no preference for hand-toy or mouth-toy stimulation with the vibrating ball; similarly, Monique's overall results suggested preference for hand stimulation, but no preference was observed with the squeeze ball or the vibrator. Thus, perhaps a procedure that involved availability of toys that varied only on one specific stimulus property would yield even more consistent results with respect to preference.

Comments on Treatment

Following the conclusion of the studies, all subjects but Anita, who was withdrawn from participation at the end of Experiment 1 due to an age-related illness, received treatment to reduce hand mouthing. Intervention for subjects

whose hand mouthing was maintained by social reinforcement consisted of noncontingent reinforcement (Bonnie) and differential reinforcement (Laura). For all other subjects (Marty, Maria, Miranda, Lucella, Pierre, Marcel, Danielle, Michelle, and Monique) treatment consisted of providing access to toys noncontingently, supplemented for some subjects with either removal of toys contingent on hand mouthing (Pierre and Michelle) or placement of mitts on the hands for brief periods contingent on hand mouthing (Maria and Marty). These interventions were effective in reducing hand mouthing to near-zero levels.

GENERAL DISCUSSION

In Experiment 1, the self-injurious hand mouthing of 12 individuals was examined by way of a functional analysis. Results for 10 subjects were consistent with a conclusion that hand mouthing was not maintained by social reinforcement, thus providing empirical support for an assumption that is common throughout most of the treatment literature. However, data obtained for 2 subjects indicated that hand mouthing also may be maintained by social contingencies. Thus, an a priori assumption that hand mouthing in a given individual is a self-stimulatory response may be incorrect and could have detrimental effects on treatment. For example, an effective intervention for Bonnie or Laura, whose hand mouthing was maintained by social reinforcement, might be to discontinue access to attention or materials for hand mouthing (i.e., extinction) while providing these consequences independent of hand mouthing (noncontingent reinforcement), contingent on the nonoccurrence of hand mouthing (differential reinforcement of other behavior), or contingent on the occurrence of a different behavior (differential reinforcement of alternative behavior). By contrast, interventions based on sensory extinction (Rincover, 1978; Rincover, Cook, Peoples, & Packard, 1979) or on providing access to alternative sources of

stimulation (Favell et al., 1982) would not be effective for these individuals if hand mouthing continued to produce social reinforcement.

In Experiments 2 and 3, we attempted to identify the reinforcing properties of hand mouthing through a determination of reinforcer substitutability when subjects had free access to one or more toys. Results of both experiments indicated a preference for hand stimulation, suggesting that alternative forms of stimulation should be those easily held or manipulated with the fingers. Had preference been shown for mouth stimulation, alternative sources of reinforcement would be derived from objects that could be placed safely into the mouth. In either case, results indicative of substitutability would enable one to reduce hand mouthing without implementing any specific therapeutic contingencies (i.e., by merely providing subjects with objects that they would manipulate).

Although the replacement topography for hand mouthing may still be viewed as socially inappropriate, as in the case of toy mouthing or even manipulating objects that are not considered normative from the standpoint of chronological age, it would produce less tissue damage than hand mouthing and thus would pose fewer health risks. It is also possible that the replacement topography could itself be subsequently modified through the use of additional reinforcement contingencies. For example, in the Favell et al. (1982) study, hand mouthing decreased relative to baseline when toys were available, but toy mouthing occurred at a much higher level than toy play, suggesting that mouth-toy contact, rather than hand-toy contact, substituted for hand mouthing. In a later condition, hand-toy contact increased when this topography was specifically reinforced. An alternative procedure, commonly used in research on substitutability effects, involves placing a "cost" (i.e., a contingency) on access to mouth-toy contact while access to hand-toy contact remained freely available. Under such conditions, one might observe a shift in preference from the former to the latter topography. Thus, it is pos-

sible that access to toys combined with several types of reinforcement contingencies may eventually result in a complete replacement of hand mouthing with hand-toy contact.

Finally, it must be noted that the methodology used in Experiments 2 and 3 was an indirect one. Although a demonstration of substitutability shows that one reinforcer competes with another under certain conditions, substitutability is not necessarily based on any shared characteristics among reinforcers. For example, if subjects in the present studies were given the opportunity to hear music by holding down the button on a tape recorder, and if this response competed with hand mouthing, substitutability would have been demonstrated, yet few would conclude that auditory stimulation (the competing reinforcer) maintained hand mouthing. This type of problem did not arise in Experiments 2 and 3 because the subjects determined the manner in which objects were manipulated, and both topographies of manipulation (contact with hand or mouth) closely resembled that of hand mouthing. Thus, when attempting to identify the nature of automatically reinforcing stimuli via substitutability, caution should be taken in selecting alternative (competing) sources of stimulation.

In summary, the present experiments exemplify an integration of research on functional analysis methodologies and reinforcer substitutability to identify both contingencies of reinforcement and specific reinforcing stimuli that contribute to the maintenance of behavior disorders. In particular, the examination of substitutability among response-reinforcer relationships may yield new techniques for assessing and treating a wide range of behaviors that are maintained by nonsocial (automatic) reinforcement.

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