

*ANALYSIS AND TREATMENT OF  
FINGER SUCKING*

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We analyzed and treated the finger sucking of 2 developmentally typical children aged 7 and 10 years. The functional analysis revealed that the finger sucking of both children was exhibited primarily during alone conditions, suggesting that the behavior was maintained by automatic reinforcement. An extended analysis provided support for this hypothesis and demonstrated that attenuation of stimulation produced by the finger sucking resulted in behavior reductions for both children. Treatment consisted of having each child wear a glove on the relevant hand during periods when he or she was alone. Use of the glove produced zero levels of finger sucking for 1 participant, whereas only moderate reductions were obtained for the other. Subsequently, an awareness enhancement device was used that produced an immediate reduction in finger sucking.

DESCRIPTORS: finger sucking, sensory attenuation, awareness enhancement device, functional analysis, automatic reinforcement

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Thumb sucking is a common childhood behavior that is estimated to occur in 23% to 46% of children aged 1 to 4 years (Infante, 1976; Larsson & Dahlin, 1985; Traisman & Traisman, 1958). This behavior is generally not of concern, and most children cease sucking their thumb or fingers without intervention before they enter school (Friman & Schmitt, 1989; Traisman & Traisman, 1958). However, some children do not stop without intervention, which can result in health problems if finger sucking continues past 4 years of age. The child may be at greater risk for dental malocclusion (Friman, 1987; Schmitt, 1987), digital deformities (Reid & Price, 1984), and speech difficulties (Luke & Howard, 1983). Emotional problems resulting from negative peer

social evaluation may also be a repercussion of thumb sucking (Friman, McPherson, Warzak, & Evans, 1993).

To date, only two studies have attempted to gain information regarding the functions of digit (finger or thumb) sucking behaviors in typically developing children. Miltenberger, Long, Rapp, Lumley, and Elliott (1998) conducted a functional analysis of the thumb sucking of a 7-year-old girl and found that the behavior was most evident in the alone condition (absence of socially mediated consequences). Similarly, Rapp, Miltenberger, Galensky, Roberts, and Ellingson (1999) assessed thumb sucking that was exhibited by a 5-year-old boy and determined that the behavior was maintained in the absence of social consequences.

Although few studies have evaluated automatically reinforced repetitive behaviors in typically developing children, the analysis methods described by Iwata, Dorsey, Slifer,

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Bauman, and Richman (1982/1994) are commonly used to assess behaviors maintained by nonsocial sources of reinforcement for individuals with developmental disabilities. Kennedy and Souza (1995), for example, analyzed the eye poking of a 19-year-old with mental retardation through indirect experimental methods and hypothesized that the eye poking was maintained by visual stimulation. Piazza, Hanley, and Fisher (1996) used a conceptually similar analysis to determine the function of cigarette pica exhibited by a 17-year-old male with mental retardation. After conducting various antecedent manipulations, they concluded that pica was maintained by the consumption of the tobacco rather than other cigarette components (i.e., filter, paper, herbs). Rapp, Miltenberger, Galensky, Ellingson, and Long (1999) analyzed the specific sensory reinforcers for hair pulling and hair manipulation exhibited by a 19-year-old woman with mental retardation. Rapp *et al.* concluded that both behaviors were maintained within a response chain by automatic positive reinforcement in the form of digital stimulation. Finally, Goh *et al.* (1995) attempted to isolate specific sources of oral and digital stimulation of automatically reinforced hand mouthing by comparing each individual's level of hand mouthing in the presence and absence of manipulable objects. These authors concluded that hand manipulation was the reinforcing component of hand mouthing (for 10 of 12 participants) because these individuals engaged in less hand mouthing when the objects were present. However, this method did not permit Goh *et al.* to demonstrate whether object manipulation produced stimulation equivalent to, or that simply competed with, hand mouthing.

Research has not yet been conducted to investigate the utility of treatments that do not require social mediation to treat digit sucking in typically developing children. If digit sucking is automatically reinforced and typically does not occur when adults are

present, treatments need to be developed that do not require the presence of an adult. Nonsocial interventions that involve protective equipment, including apparatus such as gloves and mitts, have been used to attenuate the sensory consequences produced by self-injury exhibited by individuals with disabilities (Mazaleski, Iwata, Rodgers, Vollmer, & Zarcone, 1994; Roscoe, Iwata, & Goh, 1998). By contrast, such procedures have been used sparingly (e.g., see Watson & Allen, 1993) with typically developing children. Similarly, the awareness enhancement device (AED; Rapp, Miltenberger, & Long, 1998), which emits a tone (mild punishment) contingent on hand-to-head behavior, has been used to treat automatically reinforced hair pulling in an adult with mental retardation. However, this device has not been employed as an independent intervention and has not been used for children without disabilities. Both approaches seem potentially useful in circumstances when automatically reinforced digit sucking persists when adults are not present in the room.

The present study had two main purposes. The first was to extend functional analysis methods to chronic finger sucking displayed by 2 typically developing children. The second purpose was to evaluate two interventions that were designed to treat finger sucking in the absence of socially mediated consequences. In addition, data were collected on treatment generality and acceptability for both children.

## METHOD

### *Participants and Setting*

Sally was a typically developing 7-year-old girl who attended second grade. According to Sally's parents, she had been sucking her fingers since birth. Her parents had employed a number of unsuccessful strategies to eliminate this behavior, including applying an aversive substance to her fingers, tap-

ing her fingers, and having her wear a glove on the finger-sucking hand. These procedures were reported to be unsuccessful because of problems with compliance or inconsistent monitoring. Sally was reported to suck her fingers in the presence of others and while alone. However, it was most likely to occur while she watched television alone, listened to bedtime stories, and when she was in bed. Finger sucking involved placing the third and fourth fingers of her right hand, up to the knuckles, into her mouth (sucking fingers being rested on her bottom lip). She was occasionally observed to suck other fingers from either hand.

Ash was a typically developing 10-year-old boy who attended third grade. According to Ash's mother, he had sucked his fingers since he was an infant. It was reported that Ash had received several warnings from his dentist regarding the damage he was causing his teeth and that he had developed small calluses on his fingers. His finger sucking occurred most often while he was watching television alone and in bed. Interventions attempted by Ash's mother included offering a tangible reward for the absence of finger sucking and having Ash wear bandages on his fingers. These procedures were unsuccessful because of problems with compliance and long-term follow-through.

Ash's finger sucking took the form of placing the third and fourth fingers of his right hand, up to the knuckle, into his mouth. Although there were some occasional sucking motions observed and heard, his fingers rested in the oral cavity upon his lower lip most of the time. While Ash sucked his fingers, he was also observed to stroke his face with the nonsucking fingers of either hand.

All sessions in all phases were conducted in the living rooms of the participants' homes.

#### PHASE 1: FUNCTIONAL ANALYSIS

##### *Target Behaviors and Interobserver Agreement*

The target behavior for both participants was finger sucking, which was defined as the

closure of the lips over any of the fingers. Data were collected during 10- and 20-min segments by videotaping each participant in his or her living room. These segments were scored using a real-time recording method (Miltenberger, Rapp, & Long, 1999). Each segment was divided into 600 s on a scoring sheet on which the occurrence and nonoccurrence of finger sucking were recorded on a second-by-second basis, providing a percentage duration measure. Interobserver agreement scores were obtained by having a second observer score 77% of the segments independently, then comparing the results from both observers for the occurrence and nonoccurrence of finger sucking. The number of seconds of agreement on the occurrence and nonoccurrence of finger sucking was divided by the total number of seconds within the segment and multiplied by 100% to obtain the percentage of agreement between observers. The mean agreement score for Sally's finger sucking was 97.1% (range, 91.7% to 100%), and the mean score for Ash's finger sucking was 99.4% (range, 94.3% to 100%).

##### *Experimental Design*

Levels of finger sucking were evaluated in various condition with a multielement design (Iwata et al., 1982/1994). For each condition, consequences were provided by the participants' mothers. After implementing the initial functional analyses, a pairwise analysis, consisting of a sensory attenuation (adhesive bandages) condition and an alone condition (fingers free), was conducted in order to determine whether attenuation of the stimulation produced by finger sucking would decrease the behavior. A multielement design was also used for this analysis.

Prior to conducting the analysis, each mother was given detailed instruction about the experimental condition and the consequences that she would provide for her child's behavior. Researchers conducted role

plays with the mother to ensure that she responded appropriately during each condition. Instructions were reviewed prior to each session.

*Attention.* The attention condition was designed to assess whether finger sucking was maintained by social positive reinforcement. In this condition, the subject sat in the living room with the television on while the mother sat nearby. The mother began the session by telling the child not to bother her while she did some work and then proceeded to look busy. When finger sucking occurred, the mother immediately made a statement of disapproval lasting approximately 5 s and returned to her work.

*Demand.* The demand condition was designed to assess whether finger sucking was negatively reinforced by escape from tasks. A spelling task (see Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999) was chosen because both mothers reported that her child found homework assignments involving spelling to be difficult, and, therefore, potentially aversive. Each child was asked to spell words out loud that were one to three grade levels above his or her current grade level. One word was presented approximately every 30 s. Praise was given for correct spellings, and corrective feedback was given for incorrect responses. The mother was instructed to turn away from the child for 30 s upon the occurrence of finger sucking, allowing escape from the task.

*Alone/fingers free.* The alone condition was designed to evaluate levels of finger sucking in the absence of socially mediated consequences. In the alone condition, the child sat in the living room watching television without the mother present.

*Control.* The control condition served as a comparison for all other conditions and consisted of having the mother and child play together in the living room. The mother was instructed to provide the child with positive verbal or physical attention at least

once every 30 s and to ignore occurrences of finger sucking.

*Adhesive bandages.* During this condition, regular adhesive bandages (3/4 in. wide) were placed above the knuckle and over the tips of the third and fourth fingers of the right hand. This condition was intended to evaluate levels of finger sucking when stimulation of the target digits, the mouth, or both was attenuated.

### *Results and Discussion*

Figure 1 shows data from the functional analyses. For Ash, finger sucking was highest in the alone condition ( $M = 74.2\%$ ), with a substantially lower level in the attention condition ( $M = 1.6\%$ ). During the attention condition, finger sucking was reduced to zero by the third session, suggesting that attention (in the form of social disapproval) from his mother may have served to punish finger sucking. Finger sucking was not observed in either the demand or control conditions. During the pairwise analysis, the alone/fingers free condition produced consistently high levels ( $M = 90.3\%$ ) of finger sucking. By contrast, no finger sucking occurred during the adhesive bandages condition.

Sally sucked her fingers most in the alone/fingers free condition ( $M = 51.8\%$  duration). A considerably lower level of finger sucking was initially observed in the attention condition ( $M = 0.62\%$ ); repeated exposure to the attention condition resulted in zero levels of behavior by the third session. This result suggests that social disapproval may have punished finger sucking and that no social consequence was required to maintain high levels of behavior. Finger sucking was not observed during the demand or control conditions. In the pairwise analysis, the alone/fingers free condition resulted in higher levels ( $M = 56.7\%$  duration) of finger sucking. Conversely, the adhesive bandages

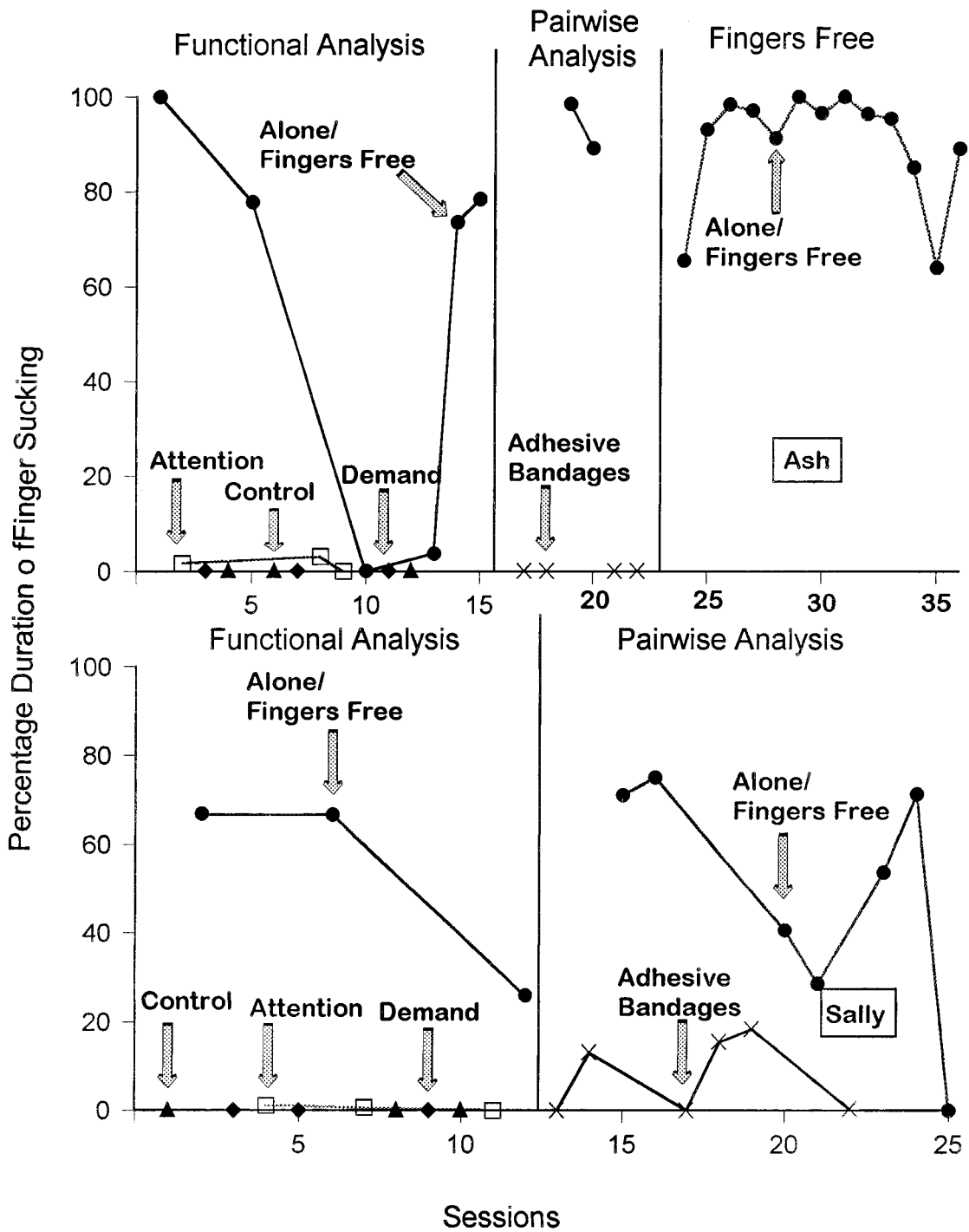


Figure 1. The left side shows the percentage duration of finger sucking for Ash (top panel) and Sally (bottom panel) across control, alone, demand, and attention conditions. The right side shows the percentage duration of finger sucking during the adhesive bandages and alone/fingers free conditions.

condition resulted in a substantially lower level of finger sucking ( $M = 7.8\%$ ).

Although results of the functional and pairwise analyses did not allow us to isolate the specific sensory consequence that maintained finger sucking for either of the children, the analyses did allow us to draw two conclusions. First, finger sucking occurred most frequently in the alone condition for both participants and appeared to be maintained by automatic consequences. Second, the application of adhesive bandages to the fingers (which putatively attenuated the sensory product of finger sucking) resulted in a decrease in finger sucking for Sally and the cessation of finger sucking for Ash. This suggested that oral stimulation, digital stimulation, or both, were maintaining finger sucking. Based on this information, interventions involving gloves were evaluated for both children. Gloves were chosen in place of adhesive bandages because they are reusable and, unlike adhesive bandages, they did not leave residue on the fingers. Similar to the effect observed in the adhesive bandages condition, it was presumed that the glove would attenuate the sensory products of finger sucking and, likewise, minimize the need for socially mediated consequences. This was an important consideration given that the behavior typically occurred when no other person was present. Due to the fact that only moderate decreases in finger sucking were observed for Sally during the glove conditions, the use of the AED (Rapp *et al.*, 1998) was evaluated for her behavior.

## PHASE 2: TREATMENT EVALUATION

### *Response Measurement*

Response definitions, data collection, scoring, and reliability procedures were identical to those of Phase 1. Data were collected during 10-min sessions, and interobserver agreement was calculated in the same manner as in Phase 1. The mean agreement

scores for occurrences and nonoccurrences of finger sucking, calculated for 33% of the sessions, were 98.1% (range, 96.2% to 100%) for Sally and 98.9% (range, 94.0% to 100%) for Ash.

### *Generalization Assessment*

To obtain information on the occurrence and nonoccurrence of finger sucking during periods when researchers were not present, the participants' mothers were asked to conduct random checks of their child's behavior while the child was alone watching TV. During or after each check, the mother documented the time and date of the check, whether finger sucking was occurring, and whether the child was wearing the treatment device (*i.e.*, glove or AED).

### *Experimental Design*

A multiple baseline across participants design was used to evaluate the effectiveness of gloves for reducing finger sucking. An ABAB reversal design was used to assess the effectiveness of the AED for Sally's finger sucking.

### *Procedure*

*Baseline.* Sessions were conducted in the home approximately two or three times per week (two or three sessions were conducted per visit). The researcher set up the video equipment in the living room, pushed the record button, then exited the room, leaving the participant time alone to watch a television program.

*Glove.* This treatment condition involved having Sally and Ash wear a glove on the hand favored for sucking. Because Sally's mother reported that Sally had chewed on cotton gloves in the past, she was fitted with a rubber work glove that had sandpaper sewn over each of the fingers (crafted by her mother). Ash wore an athletic glove that he selected from a local sporting good store. Sally and Ash were each instructed to wear

the glove any time they sat down to watch television and when they went to bed.

Once Ash had ceased finger sucking for a period of 5 months, a fading process was implemented in which 0.5 cm was removed from the fingertips of the glove following the absence of finger sucking for two to four sessions.

*Dual gloves (Sally only).* This condition was identical to the previous glove condition except that Sally wore two gloves to attenuate the stimulation produced by the sucking of other fingers. Sally was instructed to wear the gloves while watching TV and while in bed.

*Awareness enhancement device (Sally only).* The AED (Rapp et al., 1998) emitted a 65 to 70 dB tone contingent upon Sally's placement of either of her hands within 6 in. of her head. Once activated, the tone did not terminate until the hand that violated the proximity boundary was lowered from the head. Speakers were sewn into wristbands worn on both wrists, and the amplification unit was placed into a small pouch and pinned to the collar of her shirt (near the area of her mouth). Prior to the videotaped assessment sessions, an experimenter placed the device on Sally and asked her to simulate finger sucking in order to demonstrate how the device worked. Simulations were performed several times for each hand.

#### *Treatment Acceptability*

To obtain information on the acceptability of the treatment, the Treatment Evaluation Inventory Short Form (TEI-SF; Kelly, Heffer, Gresham, & Elliott, 1989) was completed by the participants' parents. The TEI-SF has nine questions, each answered on a 5-point scale for a maximum acceptability score of 45. A modified version of the TEI-SF (containing fewer questions and simplified language) was also completed by each child (available from the second author upon request). This modified version has seven

questions, each answered on a 5-point scale for a maximum acceptability score of 35.

#### *Results and Discussion*

Figure 2 shows that Sally's finger sucking occurred at a high, stable level during baseline ( $M = 60.9\%$ ). Implementation of the glove phase initially resulted in a decrease in digit sucking to near-zero levels; however, it increased to moderate levels within four sessions ( $M = 17.7\%$ ). Addition of the second glove resulted in an immediate reduction of finger sucking to zero. Again, these results were not maintained, and finger sucking returned to moderate levels ( $M = 19\%$ ). Implementation of the AED resulted in the suppression of finger sucking for nine sessions ( $M = 0\%$ ). Following the withdrawal of the AED, finger sucking increased slightly after 10 sessions ( $M = 1.3\%$ ). Reimplementation of the AED phase resulted in near-zero levels of finger sucking ( $M = 0.2\%$ ) for 12 sessions.

Sixteen generalization checks were conducted by Sally's mother over a 3-month period during the final three phases (AED, baseline, AED). Checks were conducted while Sally was alone watching TV. No finger sucking was observed during these checks.

Sally's mother filled out a TEI-SF for treatment involving the use of the glove, then again for treatment involving the AED. The acceptability ratings were 38 and 40, respectively, indicating that she found both treatments highly acceptable. Sally's completion of a modified version of the form resulted in scores of 26 and 35 for the glove and AED, respectively. The results suggest that both treatments were acceptable to Sally, although the AED was more acceptable.

Figure 2 also shows that baseline levels of finger sucking for Ash were high ( $M = 82.5\%$ ). Implementation of the glove phase resulted in the immediate suppression of finger sucking with a slight increase during the

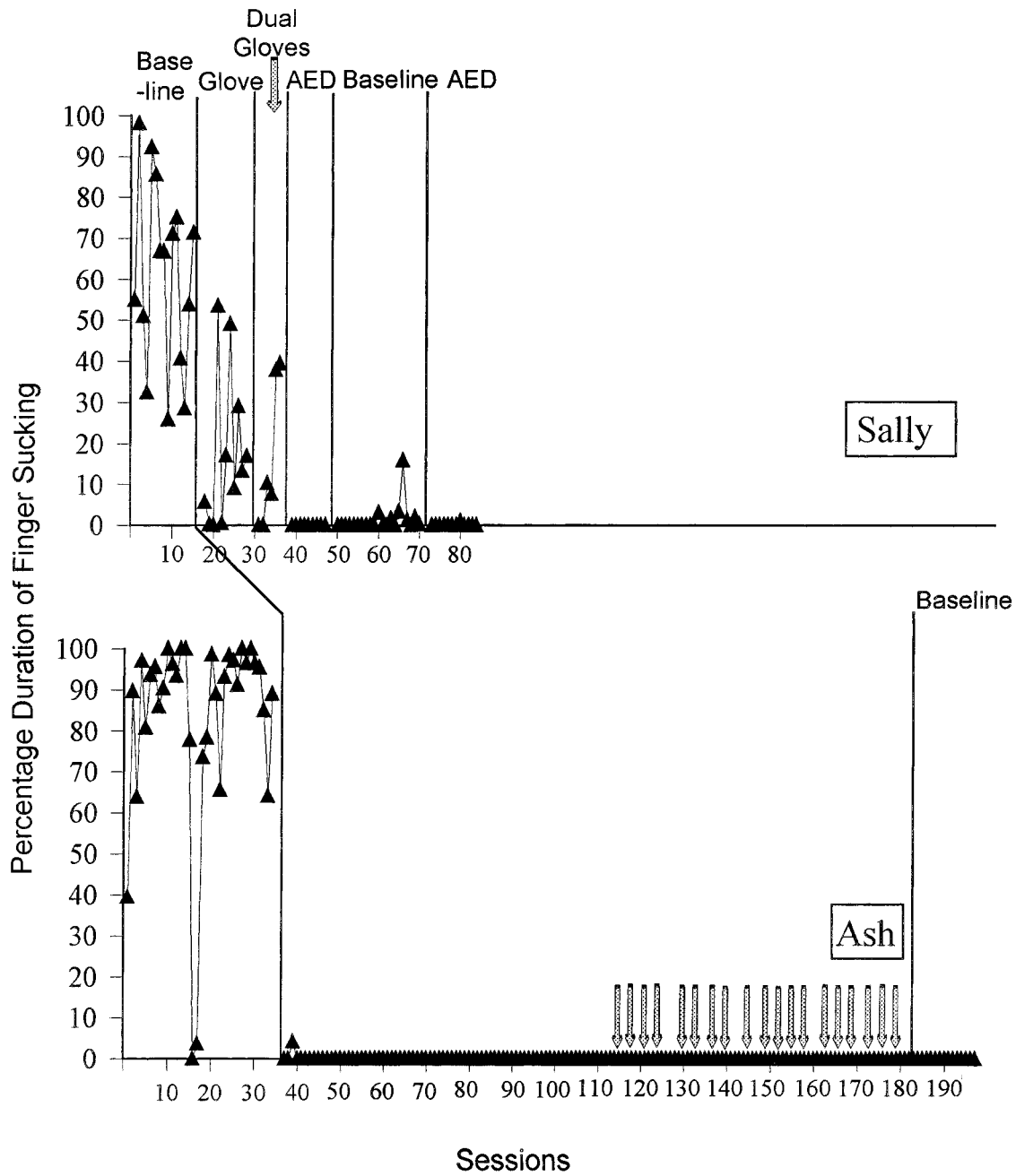


Figure 2. The top panel shows percentage duration of finger sucking for Sally across baseline and treatment phases. The bottom panel shows percentage duration of finger sucking for Ash across baseline, treatment, and treatment fading. Arrows on the graph indicate steps in fading the glove for Ash.

third session. Finger sucking subsequently returned to near-zero levels for the remainder of the sessions in the 5-month glove phase. Figure 2 also shows that as the fin-

gertips of the glove were gradually removed, Ash did not engage in finger sucking.

Ash's mother conducted 22 checks over a 3-month period during the treatment phase,



primarily during times when Ash watched TV alone. Ash had his glove off during all but one of the checks. No finger sucking was observed during 20 of the 22 checks.

Ash's mother filled out the TEI-SF for treatment involving use of the glove and provided a rating of 40, indicating that she found it highly acceptable. Ash's rating on the modified version was 29, which indicated that he also found use of the glove acceptable as a treatment.

### GENERAL DISCUSSION

The results of Phase 1 demonstrated that finger sucking for both participants was not maintained by socially mediated reinforcement. Although use of the glove was successful in decreasing finger sucking for both children, the behavior continued to occur at problematic levels for Sally. For Ash, we hypothesize that the elimination of finger sucking that was produced over the course of the glove fading period is most likely attributable to sensory extinction (Iwata, Pace, Cowdery, & Miltenberger, 1994). That is, use of the glove prevented the production of digital stimulation and oral stimulation from finger sucking, resulting in the elimination of the behavior. For Sally, it is possible that the adhesive bandages and the gloves provided only partial attenuation of sensory products, hence the need for the alternative procedure. Although sensory extinction seems the most likely process accounting for the elimination of finger sucking for Ash, it is also possible that the gloves produced an aversive taste, thus punishing finger sucking (Mazaleski et al., 1994).

Although the glove intervention produced only transient reductions in Sally's finger sucking, her behavior was ultimately suppressed with the AED. We speculate that the elimination of Sally's finger sucking observed with the AED was the result of punishment (Rapp et al., 1998). Interestingly, although

Sally did not engage in finger sucking during AED sessions, she did engage in precursor behaviors (e.g., bringing her hand into close physical proximity to her mouth), which produced the auditory stimulus from the AED. Anecdotal reports suggest that during initial use of the AED in each phase, emission of the auditory stimulus occurred more frequently during the first two or three sessions ( $M = 6$ ) and then quickly decreased to about two incidents per session. The observed reductions in finger sucking may also have been in part the result of stimulus control of the device that was developed during these pretraining sessions (when the auditory stimulus was contingent on the simulated arm movements).

Data collected by both participants' mothers suggest that treatment effects generalized from researcher-conducted sessions to periods when only family members were present in the home. Either finger sucking was not observed to occur at all (Sally) or was observed to occur very little (Ash) during periods in which the participants watched TV alone. Verbal reports from the parents also suggested that finger sucking was greatly reduced during situations other than TV watching (e.g., bedtime, while being read a story).

The results of this investigation extend the current literature on finger sucking in a number of ways. First, this is one of only a few studies that have attempted to identify the function of finger or thumb sucking (Miltenberger et al., 1998; Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999). The present study not only ruled out the influence of socially mediated reinforcement but also attempted to extend the analyses to systematically manipulate consequences involved in digit sucking. Consistent with previous studies (Kennedy & Souza, 1995; Piazza et al., 1996; Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999), analyses were conducted to identify

sensory consequences maintaining the behavior (i.e., digital, oral, or both). Although not a part of this study, in an attempt to further isolate the variables that maintained finger sucking, we also employed conditions to attenuate stimulation to Ash's stroking fingers and to attenuate oral stimulation using Anbesol. However, results from these manipulations were inconclusive (data are available from the second author). Although no firm conclusions could be drawn about the specific sensory consequences that reinforced finger sucking for either participant, these manipulations may stimulate future research in this area.

Second, this is the first study to evaluate the use of the AED for finger sucking in a young child and the first study to collect social validity data on its use. The results obtained for Sally suggest that the AED may be a useful and acceptable intervention for decreasing a variety of hand-to-head behaviors. The high acceptability ratings obtained from Sally and her mother are interesting given that interventions involving the use of punishment (especially that of positive punishment) have been referred to as less acceptable than other interventions (Miltenberger, 1997). Research in this area should continue to obtain acceptability ratings from participants and participants' caregivers.

Last, this study is the first to evaluate the fading of a sensory attenuation device (i.e., the glove) in a typically developing child. This study is also the first to evaluate the use of the AED with a typically functioning child. Because both of these interventions reduce behavior in the absence of socially mediated consequences, additional research with these procedures is warranted.

Some limitations of this study should be acknowledged. First, conclusions regarding the specific sensory consequences that maintained each child's finger sucking could not be reached. A second limitation is that conclusions about the effectiveness of the AED

for suppressing finger sucking must be tempered due to the fact that its introduction was preceded by the two glove conditions and are subject to treatment ordering effects. However, the immediate reduction in finger sucking obtained with the introduction of the AED, the eventual return of finger sucking during the second baseline, and the zero levels of finger sucking produced with the reintroduction of the AED suggest that the device was responsible for the behavior reduction.

The results of this study provide several avenues for future investigations in the analysis and treatment of behavior maintained by sensory reinforcement. First, future research should continue to extend functional analysis methods for automatically reinforced behavior. Second, we eliminated Ash's finger sucking over the course of several months and faded use of the glove. Future research should focus on determining the minimum amount of time necessary to extinguish this type of behavior so that the attenuation procedure can be completed in a timely manner. Also, because it is difficult to discriminate between the behavior change produced by reinforcer competition and reinforcer substitutability, researchers should continue to use methods to attenuate the stimulation produced by behavior maintained in the absence of socially mediated consequences. Finally, due to the immediate reduction in behavior produced with the AED and the high acceptability ratings it received by both parent and child, further evaluation of the AED as a treatment for hand-to-head behaviors is warranted.

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*STUDY QUESTIONS*

1. Describe the data-collection procedure used in this study. What are some of its potential advantages and disadvantages?
2. What was the purpose of the “adhesive bandages on” and “alone/fingers free” comparison?
3. Describe the results of the functional analyses conducted with each participant. What do these results suggest regarding the source of reinforcement maintaining finger sucking?
4. The authors noted that the results of the functional and pairwise analyses did not identify the specific sensory consequences that maintained finger sucking. Suggest some specific sensory reinforcers that might contribute to the maintenance of finger sucking and how one might evaluate the influence of these reinforcers.
5. Describe the awareness enhancement device (AED). What are some of its potential advantages and disadvantages?
6. Summarize the results of the treatment evaluation. What features of the data add to and detract from a clear demonstration of experimental control?
7. The authors indicated that Ash’s finger sucking was most likely eliminated through sensory extinction. If so, what other processes contributed to the maintenance of low levels of finger sucking as Ash’s gloves were faded?
8. The authors commented briefly on reinforcer “competition” and “substitutability” as bases for treating problem behavior maintained by automatic reinforcement. How might these concepts have been used to develop treatments for the finger sucking of these participants?

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