Teaching Chewing: A Structured Approach

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KEY WORDS
- chewing
- feeding
- food texture
- oral–motor
- pediatrics

OBJECTIVE. A structured intervention was used to teach chewing to two children with special needs. Neither child had a history of chewing or eating high-textured food.

METHOD. The intervention combined oral–motor and behavior components to teach chewing. A multiple baseline design was used to evaluate treatment effectiveness.

RESULTS. Both children improved their chewing skills while increasing the texture of foods eaten and the variety of foods eaten.

CONCLUSION. This structured intervention could be used to teach chewing to a range of children who did not acquire this skill during normal development.

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The absence of chewing is one of many feeding problems documented in children, especially those with congenital delays. Swallowing food without chewing and chewing delays are behaviors frequently found in children with Down syndrome, autism spectrum disorder, cri du chat (Collins, Kyle, Smith, Laverty, Roberts, & Eaton-Evans, 2003), and cerebral palsy (Gisel, 1994). In addition to neuromotor deficits, lack of appropriate early experience has been suggested as a cause of chewing problems. In a study of the effects of institutional deprivation, chewing problems were prevalent among 6-year-old Romanian adoptees whose diets did not allow practice with high-texture foods (Beckett et al., 2002). In examining a sample of 350 children referred to our feeding program, we found that 26% ate inappropriate food textures; and most of the children ate only low-texture food and failed to exhibit any chewing (Field, Garland, & Williams, 2003). In a few cases, children from our clinic sample were typically developing but did not develop chewing skills because of lack of exposure to textured food.

Although chewing problems are common among children with feeding problems, descriptions of and research on interventions for chewing problems are not. In a review of the literature, we found only one article that described an intervention specifically targeting chewing. The authors of this study used modeling and shaping to teach an 8-year old boy with Down syndrome to bite on a graham cracker and rewarded him with a favorite food for doing so (Butterfield & Parson, 1973). Across the course of a 24-day, home-based treatment, the reinforcement requirement was changed such that the boy had to bite an ever-increasing number of times before receiving reinforcement. At 42-week follow-up, the authors reported the boy was eating six foods that required chewing and that the chewing had generalized from home to school (Butterfield & Parson, 1973). Although this study was successful in teaching chewing, the variety of foods requiring chewing was limited.

Although not directly targeting chewing, a series of studies by Gisel and her colleagues described an oral–motor intervention that improved biting and chewing in young children with cerebral palsy (Gisel, 1994; Gisel, Applegate-Ferrante, Benson, & Bosma, 1996; Gisel, Benson, Applegate-Ferrante, & Bosma, 1995). The oral–motor intervention used in these studies involved three separate components: tongue lateralization, lip control, and vigor of chewing. The tongue lateralization component involved placing peanut butter initially on the lateral borders of the tongue and eventually, across the course of treatment, placing the peanut butter on the four corners of the lips so the child would have to remove the peanut butter from outside of the oral cavity. The lip control component consisted of teaching the child to close his or her lips first around a licorice stick and eventually suck from a straw. Finally, in the vigor of chewing component, small pieces of cookie were placed over the molars, and the child was encouraged to chew these. The cookie progressed in hardness across the course of treatment. This oral–motor intervention was conducted for 5 to 7 min per day before the school lunch meal for 10 to 20 weeks. The results of all studies showed an improvement in chewing (Gisel, 1994; Gisel et al., 1995, 1996). Although the studies did improve chewing, it was not clear how many, if any, of the children did not chew at the beginning of the study. Thus, it is unknown whether the intervention used by Gisel and her colleagues would be successful for initially teaching chewing.

Several studies have also addressed deficits in oral–motor functioning through the use of behavioral approaches. Four children with special needs or chronic health conditions who ate only puree texture or, in one case, nothing, were taught to eat higher textures by systematically increasing the texture and providing reinforcement for eating, thus using the behavioral components of stimulus fading and positive reinforcement (Shore, Babbitt, Williams, Coe, & Snyder, 1998). Stimulus fading has also been reported in a pair of studies involving children with adipsia. Babbit, Shore, Smith, Williams, and Coe (2001) worked with two children who would eat solid foods but refused to drink from any form of cup. These clinicians established liquid intake on a spoon and then used a five-step fading procedure that was successful in establishing cup drinking in both children. In another study, a boy who drank only water was taught to drink milk mixed with a high-calorie supplement powder by systematically fading the powder into the water, then systematically replacing the water with milk (Patel, Piazza, Kelly, Ochsner, & Santana, 2001). Another pair of studies addressed oral-phase dysphagia with interventions containing behavioral components. In one study, least-to-most prompting, an eliciting stimulus, and social reinforcement were used to establish swallowing in three young children with chronic health conditions (Lamm & Greer, 1988). In another study, one child who had never swallowed food or liquid was taught to eat using peer modeling and token reinforcement (Greer, Dorow, Williams, McCorkle, & Asnes, 1991).

In a recent article in this journal, we described an intervention that combined oral–motor and behavioral components to successfully treat food refusal in a young girl with Down syndrome and a tongue thrust (Gibbons, Williams, & Reigel, 2007). The goal of the current study was to expand the literature on the treatment of chewing deficits by again describing the outcomes of an intervention that uses both oral–motor and behavioral components in teaching chewing to two children with special needs.

Method

Participants and Setting

The first participant, Sam, was a 9-year-old boy with Down syndrome who was referred because he would eat only a limited number of pureed foods. His parents reported that he would leave the meal before finishing and refused to self-feed. Although he did not exhibit a tongue thrust, problems with tongue movement had been noted by his previous oral–motor therapists. Sam had received outpatient intervention for his eating problems first through early intervention, then from clinic-based therapists. A variety of techniques, including several oral–motor programs, were reported in his medical records, but how the techniques were implemented was not described. The goals of treatment were to establish chewing, increase variety and texture of solid foods eaten, establish open-cup drinking, and eliminate inappropriate mealtime behaviors. Treatment was conducted in 124 meal sessions over the course of 19 days in a day-treatment feeding program.

The second participant, Frank, was a 5-year-old boy with a complicated medical history that included kidney transplant, stroke, microcephaly, and neuromotor dysfunction. He was referred for gastrostomy tube dependence and food selectivity by texture. His caregiver reported that he would eat only smooth foods; the presentation of any texture was met with resistance and vomiting. For several years, Frank received outpatient feeding therapy from a community provider. Mostly non-nutritive exercises were used secondary to his vomiting with the introduction of solid food. Frank still had some residual weakness on his left side from his stroke and exhibited difficulty coordinating his tongue movement. He was able to eat low textures and drink thin liquids without difficulty. The goals of treatment were to establish chewing, increase the texture of solid foods eaten,

eliminate inappropriate mealtime behaviors, and eliminate gastrostomy feedings. Before treatment, Frank was receiving 500 mL of formula by means of gastrostomy tube. At the beginning of treatment, 250 mL of formula was replaced with water. After 1 week, the other 250 mL of formula was eliminated because of increased oral intake. All water given through the gastrostomy tube was eliminated at the end of the second week. Treatment was conducted in 149 meal sessions over the course of 20 days in a day-treatment feeding program.

For both children, meal sessions were initially conducted in a therapy room with a PhD- or master's-level feeding therapist. Some sessions were conducted by graduate interns under the supervision of a feeding therapist. Both children were seated in a wooden chair with armrests and an adjustable footrest. Neither child required adaptive seating. In the final 2 weeks of treatment, meal sessions were conducted in multiple environments with a variety of persons, including caregivers, to promote generalization.

Dependent Measures

Data were collected by the therapist conducting the meal session for every session. Interobserver reliability was conducted by either a therapist who was not conducting the meal session or a graduate intern.

Data were collected on the following primary behaviors:

- *Chew:* Child was observed moving his jaw up and down in a chewing motion such that the upper and lower teeth make contact and the up-and-down movement occurs at least 3 times within 5 s.
- *Mouth clean:* No food or drink larger than a pea was visible in child's mouth within 30 s of acceptance.

We used the above dependent measures to determine the outcomes of our intervention. To ensure that the child was chewing, we observed the child in the process of chewing. To ensure the child was not only chewing but also chewing the food efficiently enough to swallow it, we used a surrogate measure for swallowing (mouth clean) to ensure the child's mouth was empty after taking each bite.

Data were also collected on the following secondary behaviors:

- *Accept:* Child allowed food or drink in the mouth within 5 s of presentation.
- *Expel:* Food or drink that was previously inside child's mouth was visible outside of lips before next bite.
- *Negative vocalization:* Child cried, said "no," or made negative statements about food.
- *Gag:* Child made a gagging sound or indications (neck extension, tongue protrusion, changes in skin color) of gagging.
- *Tongue lateralization:* Child moved tongue to either the left or right corner of the mouth such that the tip of the tongue could be observed in the respective corner.
- *Bite:* Child bit down and through a piece of food with the feeder observing or hearing the child taking the bite.

Dietary intake was also measured for all meal sessions by recording the type of food and the intake in grams (premeal weight minus postmeal weight). The diet was monitored by a pediatric nutritionist. Interobserver agreement was measured using the exact count method (Cooper, Heward, & Heron, 1987). For Sam, reliability was calculated for chew and mouth clean in 30% of chewing sessions. Agreement was 82% for both behaviors with a range from 7% to 100%. Reliability was conducted for 39% of texture-fading sessions for mouth clean. Agreement was 87% with a range of 23% to 100%. For Frank, reliability was calculated for chew and mouth clean for 24% of chewing sessions. Agreement was 88% for both behaviors with a range of 13% to 100%. Reliability was conducted for 30% of texture-fading sessions for mouth clean with an agreement of 92% and a range of 75% to 100%.

Procedures

Baseline. Baseline sessions were conducted to assess the children's ability to eat high-textured foods and to chew. During baseline chewing sessions, a timer was set for 10 min, and the children were presented with dry, crisp foods and asked to take bites. At the end of the 10 min, the session was terminated. During baseline sessions, all inappropriate mealtime behavior was ignored. If the child attempted to leave the room, he was redirected back to his chair until the termination of the session. During baseline texture-fading sessions, each child was presented with regular-textured table foods and milk from an open cup. These sessions were conducted under the same conditions as the chewing sessions. For both types of sessions, data were recorded on chewing, mouth cleans, gags, accepts, expels, negative vocalizations, biting, and chewing. In baseline, data were not collected on tongue lateralization because it was not possible to accurately observe this behavior when not in isolation.

Using elements from interventions in two studies previously described (Butterfield & Parson, 1973; Gisel, 1994) as well as a texture-fading procedure (Shore et al., 1998), a treatment package was developed that was designed to accomplish the following goals: instruct the child to bite and chew, improve tongue lateralization, improve lip closure, and increase texture of foods eaten. This treatment package was implemented in two types of meal sessions, which we termed chewing sessions and texture-fading sessions.

For both children, several behavioral components were included: positive reinforcement in the form of both praise

(e.g., "Good chewing!") and tangible rewards (e.g., access to a preferred video, book, or toy for 10 s). Parents were asked to identify possible reinforcers for their children before intervention. Across the course of treatment, each child was allowed to select reinforcers (e.g., pick a new video or book) to avoid satiation. Planned ignoring was used to address gagging, crying, or other inappropriate behaviors. If one of these behaviors occurred, no verbal attention was provided by therapists or parents. Escape prevention was used to address refusal. If a child refused to take a bite or drink, the bite or drink would be presented without comment until it was accepted. Stimulus fading was used to gradually and systematically increase the texture of food eaten. Shaping was used to establish and improve chewing by initially reinforcing the child for biting just one time and then changing the criterion for reinforcement so the child would need to bite an increasing number of times to gain access to reinforcement.

Chewing Sessions. In chewing sessions, the primary focus was biting and chewing. The treatment used in these sessions was a modification of the treatment described by Butterfield and Parson (1973) and involved shaping chewing by initially reinforcing each bite, eventually reinforcing the child biting progressively more bites. The following treatment plan was used for both children in chewing sessions:

1. A timer was set for 10 min.
2. A small piece of a crisp, dissolvable food was placed on the child's molars, and the child was told to bite.
3. As soon as the child bit through the food and the biting sound was heard, the child was praised, and tangible reinforcement (e.g., videos, books, toys) was provided for 10 s.
4. A small amount of preferred drink was also offered after each bite.
5. If the child met the definition of chew, additional praise was provided for chewing.
6. If the child expelled the food without chewing, it was placed back on the child's molars without comment.
7. If the child swallowed the food without biting, another piece of food was placed on the child's molars, and the child was instructed to bite.
8. If the child refused to allow the food on his molars, it was held to his mouth without comment until the food was accepted.
9. Gagging was ignored.
10. The therapist alternated placing the food on the left and right side of the mouth.
11. The session was ended when the timer rang.

Decision rules were used to change the schedule of reinforcement such that the child would be required to progressively bite more times on each piece of food before gaining access to reinforcement. The size of the food pieces presented was also increased across the course of treatment.

Chewing sessions were conducted as described previously for both children. For Sam, termination criterion for the sessions was changed from 10 min to a specific number of bites (nine) during the third week of treatment because Sam was beginning to refuse to take bites and waiting for the timer to signal session termination. The number of bites required before the session was terminated was increased by one bite as Sam began to accept and chew the bites faster. For chewing sessions, data were collected on chewing, biting, mouth cleans, acceptance, negative vocalizations, and expels.

Texture-Fading Sessions. In the second type of session, called texture-fading sessions, the focus of treatment was to increase the child's tolerance of higher texture foods, improve lip closure, and improve tongue lateralization. Texture fading, or progressively increasing texture as it is tolerated, has been shown to be an effective method of increasing the texture of foods eaten (Shore et al., 1998). Although Gisel (1994) used drinking from a straw, we used a small open cup to address lip closure. Tongue lateralization was taught by placing a small amount of yogurt or pudding in the left or right corner of the mouth and reinforcing the child for licking the food. The following treatment plan was used for texture-fading sessions for both children:

1. A timer was set for 20 min.
2. A bite of textured food was presented with the instruction, "Take a bite."
3. When the child accepted the bite, the child was praised. A verbal prompt for the child to chew was then given.
4. If the child was observed chewing or attempting to chew, the child was praised and tangible reinforcement was provided for 10 s.
5. If the child expelled the food, the behavior was ignored and another bite was given.
6. If the child refused the food presentation, the food was held to the child's mouth without comment until it was accepted.
7. Gagging was ignored.
8. A small amount of food was placed alternately in the left or right corner of the child's mouth, and the child was instructed to lick the food.
9. If the child met the criterion for tongue lateralization, praise and tangible reinforcement was provided for 10 s.
10. A small open cup containing 0.25 oz of a preferred liquid was handed to the child. The child was provided with praise and 10 s of tangible reinforcement after the drink was consumed.
11. The session ended when the timer rang.

The following decision rules were used to determine when texture would be increased to the next step in the fading sequence:

1. Mouth clean occurs for ≥ 80% of bites presented for three of four consecutive meals.
2. Expels occur for ≤ 20% of bites presented for three of four consecutive meals.
3. Gags occur for ≤ 20% of bites presented for three of four consecutive meals.

For this intervention, we defined food textures as follows:

- *Puree:* Smooth food without any lumps (e.g., pudding, stage-2 baby food)
- *Ground:* Food that had been processed by a food processor with no lumps larger than 0.25 in.
- *Mashed:* Food that was mashed with a fork and had larger pieces (0.25 to 0.5 in.).
- *Table:* Regular-texture table food; if the fading procedure required less than a spoonful, the table food was cut into smaller pieces. All table food was cut into pieces; for example, a chicken nugget or hot dog would be cut into approximately 0.5-in. pieces. At the end of treatment, both boys were biting pieces off some foods (e.g., hamburger on a roll).

The texture-fading schedule was based on the foods the children were currently eating. Because both children were eating some foods that met the definition of ground texture, such foods were used as a starting point for both children. To reduce the effort required for the children, the texture fading manipulated two variables: texture and spoon volume. The texture-fading schedules, although similar, were slightly different (Table 1). Because Frank had a long history of gagging and vomiting with textured foods, texture fading was initially conducted using smaller steps. Although we typically use probe sessions of higher texture to determine whether we can advance in texture more rapidly, in this study we used the parent reports of the textures of foods the children were eating instead of probe sessions. During texture-fading sessions, data were taken on accepts, expels, mouth cleans, gags, vomit, negative vocalizations, and tongue lateralization.

The children's entire intake for the day was presented in the chewing and texture-fading sessions. Caregivers fed the children in the evening if they asked for food. To limit the length of their day-treatment admissions as much as possible, we conducted multiple sessions per day to increase the amount of training the children received. We generally alternated between the two types of sessions because the chewing sessions involved smaller amounts of food so both children did receive more chewing sessions than texture-fading sessions because more of these sessions could be conducted without risk of satiation. The child's intake varied from session to session, depending on the child's performance in the meal. Most foods provided during treatment were selected from foods that the family reported were in their typical diet. Across the day, both fluid intake and intake of solid foods were monitored. Across the course of treatment, weight was monitored.

Table 1. Texture-Fading Schedules

Sam		Frank	
Spoon Size	Texture	Spoon Size	Texture
0.25 spoon	100% ground	0.50 spoon	100% ground
0.50 spoon	100% ground	Full spoon	100% ground
Full spoon	100% ground	0.25 spoon	25% ground 75% mashed
Full spoon	75% ground 25% mashed	0.50 spoon	25% ground 75% mashed
Full spoon	50% ground 50% mashed	Full spoon	25% ground 75% mashed
Full spoon	25% ground 75% mashed	Full spoon	100% mashed
Full spoon	100% mashed	Full spoon	25% mashed 75% table
Full spoon	75% mashed 25% table	0.50 spoon	100% table
Full spoon	50% mashed 50% table	Full spoon	100% table
Full spoon	100% table		

Meals. At the end of treatment for both children, both the chewing sessions and texture-fading sessions were replaced with meals. At this point, the children had demonstrated the ability to chew during chewing sessions, and the texture of the food had been increased to the point it could be chewed in the texture-fading sessions. During the meals, the child was presented with a range of table foods and rewarded with praise and tangible rewards for accepting and chewing bites of food. For both children, tangible rewards were not provided at all meals, and only praise was used as a consequence for acceptance and chewing. Meals were conducted in a variety of settings with the children's caregivers to promote generalization.

Parent Training

The caregivers of both children were trained to implement the intervention before discharge from intensive treatment. The therapists initially modeled the intervention, then the caregiver would implement the intervention with the therapist seated next to him or her to provide feedback. The caregivers were asked to use the intervention in the evening away from the clinic and were trained to use a simplified version of our data collection system. Training videos of the therapist implementing treatment and narrating the treatment plan were provided to caregivers at discharge along with a written home treatment plan.

Experimental Design

A multiple baseline design across two children was used to evaluate the effectiveness of treatment. In this study, three baseline chewing sessions and three baseline texture-fading sessions were conducted for Sam before the introduction of treatment. For Frank, five baseline chewing sessions and five baseline texture-fading sessions were conducted before the introduction of treatment. Although the number of baseline sessions differed, because neither child demonstrated any chewing and Frank consumed only two bites during one of the texture-fading baseline meals, baseline was not extended further.

Results

The treatment package was effective in increasing both the variety and texture of food eaten by both boys. The treatment package was also successful in eliminating the need for Frank's gastrostomy tube feedings. At the end of treatment, both boys were eating table foods and drinking from an open cup. Before treatment, Sam ate only 13 foods. By the end of treatment, Sam had eaten more than 80 foods. Before treatment, Frank ate only 3 low-texture foods. By the end of treatment, Frank had eaten more than 50 foods (Figure 1).

During baseline chewing sessions, neither Sam nor Frank exhibited chewing. Both boys improved their chewing across the course of treatment (Figure 2). Sam was observed chewing correctly for more than 80% of bites during his last five sessions and for 100% of bites for his last session. Although Frank was observed chewing correctly for 100% of bites for most of his sessions, his performance at the end of treatment was more variable because the foods were more difficult to chew and the pieces of food presented were larger.

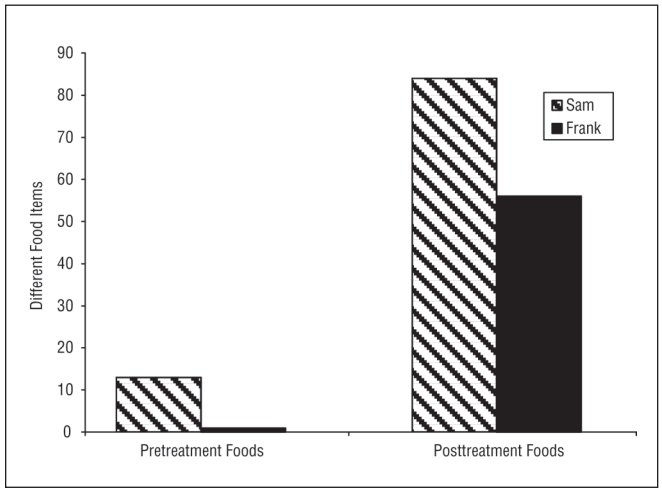

Figure 1. Table foods eaten.

Both boys were able to move from ground texture to table foods. By the end of treatment, both boys were consistently accepting and swallowing bites of table food with minimal to no gagging (Figure 3).

Follow-up information was gathered for both children. Sam's parents sent video of Sam eating table food and reported that he continued to expand his diet. Frank was seen at 4-month follow-up and was observed eating table foods and chewing.

Discussion

The results of this study indicate that the intervention used was successful in teaching chewing, increasing the texture of foods eaten, and increasing the variety of foods eaten for both boys. These improvements in the children's eating also allowed them to eat family meals and allowed the family to eat in a variety of settings outside the home. In one child, the need for gastrostomy tube feedings was eliminated.

Although the outcomes of this intervention demonstrated that both children successfully increased their ability to chew and eat higher texture foods, it is not clear which, if any, of the components of the intervention were responsible for the improvements. Although the empirically based, multi-component treatment package was designed to address many of the skills related to eating table foods, such as biting and chewing, tongue lateralization, lip closure, and increasing texture, we would predict that some components of this intervention would not be needed for some children. For instance, Sam demonstrated very little tongue lateralization at the beginning of treatment. Frank, however, could lateralize his tongue with little difficulty early in treatment. To determine which of the components are necessary to meet the goal of eating table food, a component analysis could be conducted in future studies to assess the contribution of the individual treatment components.

We believe that this approach to chewing instruction differs from what is currently being used by many clinicians. Although we can point to no data reporting how clinicians are teaching children to chew, anecdotally we have seen many children whose treatment for chewing has included the use of chewy tubes or other nonnutritive objects. We are in agreement with Gisel (1994), who argued that the use of food stimuli in treatment would elicit a natural eating reaction. Moreover, we suggest that using food rather than nonfood objects during treatment prevents possible problems with generalization. Most children who present with feeding problems have some form of developmental delay (Field et al., 2003). Undergeneralization and overgeneralization are common challenges for this population. For some children, chewing on a chewy tube or other object may not generalize

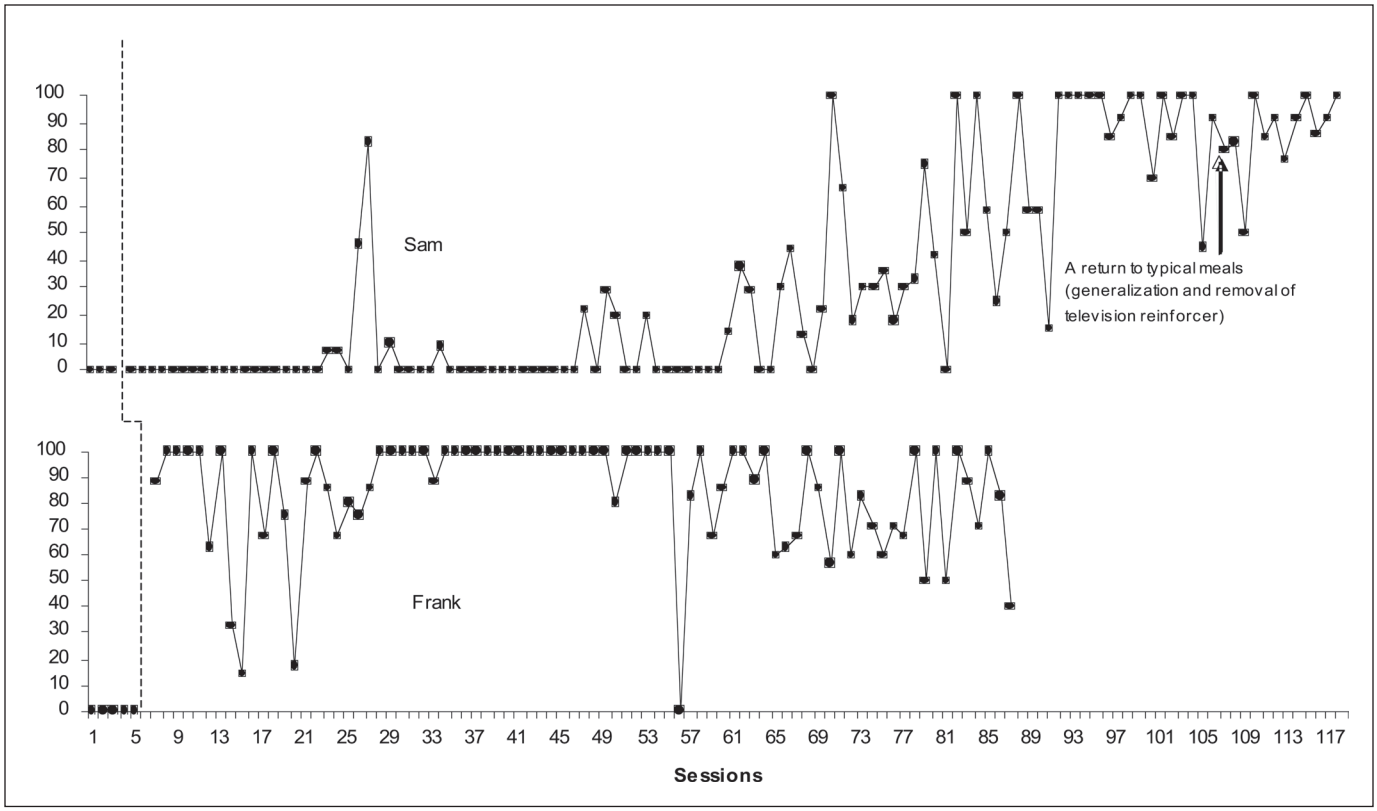

Figure 2. Correct chewing.

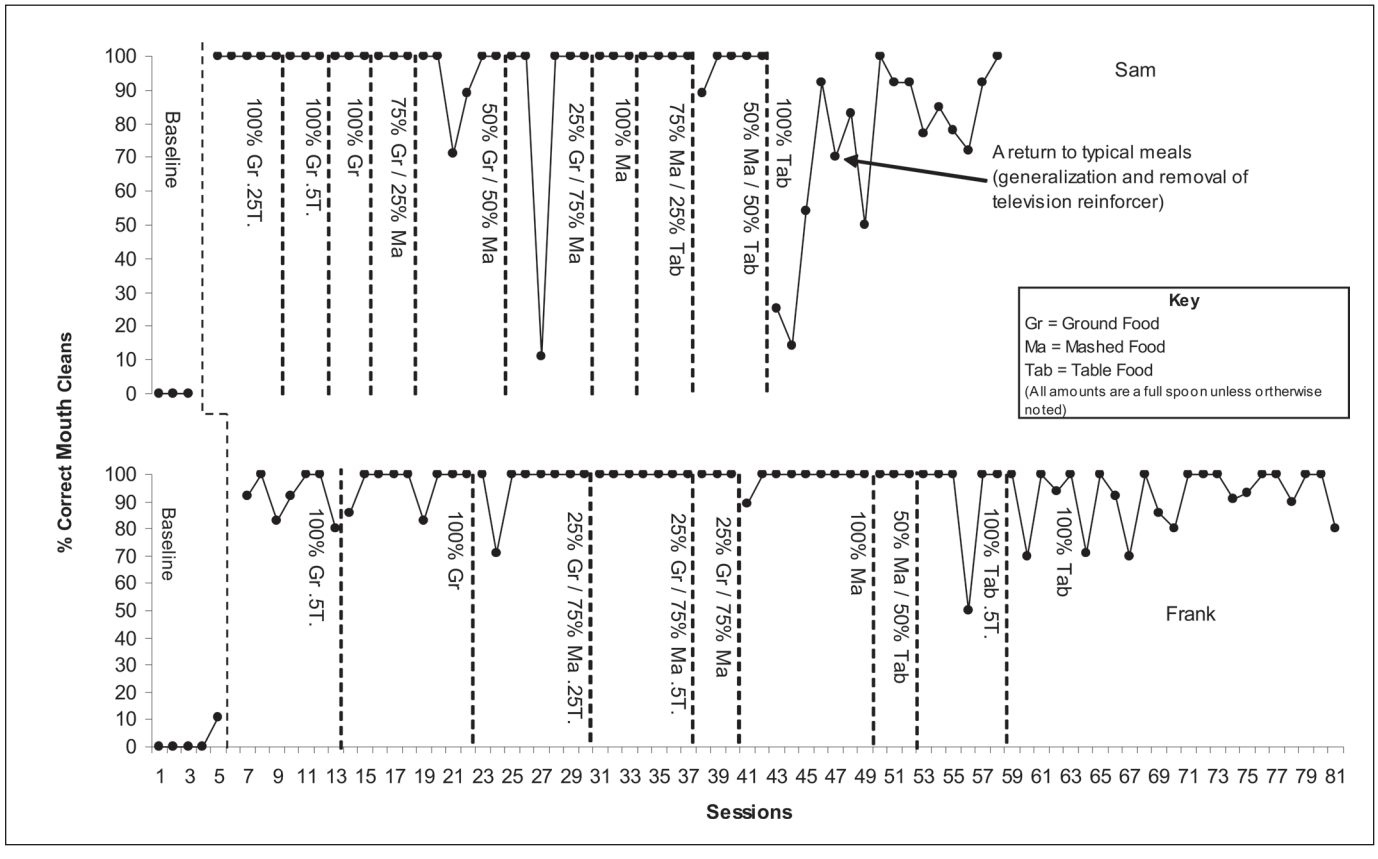

Figure 3. Mouth cleans.

to chewing on food that breaks apart and has flavor. For other children, teaching them to chew on chewy tubes may result in the generalization of this behavior to other nonfood items, such as toys or clothing. The use of the intervention described in this study would preclude either problem.

The treatment for the children in this study was conducted on an intensive basis under the tightly controlled environment of a day-treatment program. Although this situation allowed for a better assessment of the intervention's effects, future research should replicate the use of this intervention in other settings with other samples of children. ▲

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