AN EVALUATION OF TWO DIFFERENTIAL REINFORCEMENT PROCEDURES WITH ESCAPE EXTINCTION TO TREAT FOOD REFUSAL

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Consumption of solids and liquids occurs as a chain of behaviors that may include accepting, swallowing, and retaining the food or drink. In the current investigation, we evaluated the relative effectiveness of differential reinforcement of the first behavior in the chain (acceptance) versus differential reinforcement for the terminal behavior in the chain (mouth clean). Three children who had been diagnosed with a feeding disorder participated. Acceptance remained at zero when differential reinforcement contingencies were implemented for acceptance or mouth clean. Acceptance and mouth clean increased for all 3 participants once escape extinction was added to the differential reinforcement procedures, independent of whether reinforcement was provided for acceptance or for mouth clean. Maintenance was observed in 2 children when escape extinction was removed from the treatment package. The mechanism by which consumption increased is discussed in relation to positive and negative reinforcement contingencies.

DESCRIPTORS: differential reinforcement of alternative behavior, escape extinction, food refusal, negative reinforcement, pediatric feeding disorder

A pediatric feeding disorder is identified when a child fails to consume a sufficient volume or variety of food to maintain weight or grow. Despite its reported prevalence, there are surprisingly few empirical demonstrations of treatment for feeding problems in the literature employing strategies based on operant conditioning. Further, in the majority of these studies on treatment of feed-

ing disorders, components have been implemented within the context of a treatment package (e.g., Ahearn, Kerwin, Eicher, Shantz, & Swearingin, 1996; Hoch, Babbit, Coe, Krell, & Hackbert, 1994; Ives, Harris, & Wolchik, 1978; Riordan, Iwata, Finney, Wohl, & Stanley, 1984; Werle, Murphy, & Budd, 1993). Thus, the individual contribution of treatment components to increase food consumption remains uncertain.

The difficulty in analyzing the components of treatment that are important in increasing food consumption is compounded by the fact that consumption is not a single response. Rather, eating and drinking consist of a chain of behaviors that may include ac-

cepting, chewing, swallowing, and retaining the food or drink. Problems in consumption may occur at any point along the chain. Therefore, it is important to evaluate which behaviors should be targeted for treatment and which operant contingencies contribute to increases in food and liquid consumption.

Some investigators have proposed that reinforcement of the first behavior in the chain (acceptance) is important for increasing consumption of solids and liquids (Hoch et al., 1994; Riordan, Iwata, Wohl, & Finney, 1980). This hypothesis is based on the assumption that increasing acceptance is a prerequisite to increasing consumption. However, it is unclear if reinforcement of acceptance results in an increase in acceptance only or if reinforcement of acceptance produces concomitant increases in swallowing.

There is a possibility that treatments may vary depending on the topography of the feeding problem (e.g., total food refusal vs. food selectivity). For example, it may be necessary to increase the initial behavior in the chain (acceptance) for children who display total food refusal. Reinforcement of acceptance may not be necessary for children who consume some food, because the initial behavior in the chain is already in their repertoire. For these children, it may be more appropriate to target later behaviors in the chain (e.g., swallowing). However, no studies to date have compared the relative effectiveness of reinforcement of acceptance versus reinforcement of swallowing.

Riordan et al. (1980) showed that differential reinforcement (DRA) of acceptance was not effective in increasing the food consumption of 2 girls with food selectivity. Initially, the treatment consisted of providing the child with access to preferred food and social praise following acceptance of bites of nonpreferred food or sips of liquid. Even though acceptance of food increased, the authors noted anecdotally that packing (hoarding) or expulsion occurred during the rein-

forcement of acceptance phase. Therefore, the contingency was altered so that the child was required to swallow the bites or sips to receive reinforcement.

Although the Riordan et al. (1980) study showed that targeting acceptance may increase problem behaviors further along in the chain (i.e., packing and expulsion), the same results were not indicated in the Riordan et al. (1984) investigation. Acceptance and grams consumed increased as a result of reinforcing acceptance alone for 3 children who displayed food selectivity. These results showed that it was possible to provide reinforcement for the first behavior in the chain (acceptance) and concomitantly increase subsequent behaviors in the chain (swallowing) with children who display food selectivity.

Differential positive reinforcement alone may not be effective for children who display total food refusal (low levels of baseline acceptance). Hoch et al. (1994) found that reinforcement for acceptance alone was not effective at increasing oral intake to an acceptable level. A substantial increase in acceptance and oral intake was observed only when inappropriate behaviors no longer produced escape (i.e., the spoon remained at the child's lip until the bite was taken). However, expulsion increased for 1 participant as a result of DRA for acceptance and escape extinction. Therefore, Hoch et al. altered the contingencies from DRA for acceptance to DRA for swallowing. It is not clear, however, whether this contingency manipulation affected behavior, because acceptance and grams consumed were similar under the two different contingency arrangements.

Similarly, Coe et al. (1997) used differential reinforcement of acceptance and escape extinction to treat the food refusal of 2 children. Initially, acceptance increased for both participants; however, expulsion also increased. Therefore, the differential reinforcement contingency was changed from

DRA for acceptance to DRA for swallowing. Expulsion decreased for 1 participant but not the other. Once an extinction procedure (i.e., re-presenting the food each time it was expelled) was in place for expulsion for the 2nd participant, expulsion decreased and swallowing increased.

The purpose of the current study was to extend the literature on differential reinforcement and escape extinction in the treatment of pediatric feeding disorders. First, we examined the extent to which differential reinforcement alone resulted in increases in food or liquid consumption for 3 children with total food refusal. Second, we compared the effectiveness of reinforcement of the first behavior in the chain (acceptance) relative to reinforcement of the final behavior in the chain (mouth clean). Finally, we implemented the two differential reinforcement contingency arrangements (DRA for acceptance and DRA for mouth clean) with escape extinction to evaluate whether one differential reinforcement contingency was more effective than another when combined with escape extinction.

METHOD

Participants and Setting

Three children who had been diagnosed with a pediatric feeding disorder participated. Alex was a 3-year-old boy who had been diagnosed with congenital heart disease, gastroesophageal reflux (GER), and developmental delays. Sunshine was a 2-year-old girl who had been diagnosed with GER and developmental delays. Jarred was a 3-year-old boy who had been diagnosed with GER and developmental delays. All 3 children had been admitted to an intensive pediatric feeding disorders day treatment program for poor oral intake and gastrostomy (G) tube dependence. Upon admission to the day treatment program, these children received most of their nutritional needs via G tube.

G-tube feedings were administered once or twice during the day at regularly scheduled intervals. An overnight pump was used for evening feedings for all 3 participants.

All sessions were conducted in a room with an adjacent observation room equipped with one-way mirrors and sound. Each child used age-appropriate seating arrangements (e.g., booster seat, high chair) and eating or drinking utensils during all sessions. Toys were also visible during reinforcement phases. All foods were presented at a bolus equal to a level spoonful. Three meals and two snacks were presented each day, with approximately five 5-min sessions during meals and three 5-min sessions during snacks.

Dependent Variables and Data Collection

The major dependent variables were acceptance and mouth clean for all 3 participants. During eating sessions, acceptance was scored if the entire bolus of food was in the child's mouth within 5 s of the presentation. During drink sessions, acceptance was scored if any portion of the liquid entered the child's mouth within 5 s of the presentation. During eating and drinking sessions, mouth clean was scored if there was no visible food or liquid in the child's mouth (without expulsion) 30 s after acceptance. We measured mouth clean rather than swallowing because our experience has been that the behavior of swallowing is difficult to measure reliably. Data on acceptance and mouth clean were collected on laptop computers using an event-recording procedure. These data were converted to a percentage by dividing the total number of occurrences of acceptance by the number of bite or drink presentations multiplied by 100%. Mouth-clean data also were converted to a percentage by dividing the occurrences of mouth clean by the number of bites or drinks that entered the child's mouth (i.e., accepted before or after 5 s of presentation) multiplied by 100%.

A second observer independently scored 17%, 15%, 16%, and 26% of sessions for Alex (eating), Alex (drinking), Sunshine, and Jarred, respectively. Interobserver agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100%. The total interobserver agreement for acceptance was 95% (range, 58% to 100%) for Alex (eating); 95% (range, 83% to 100%) for Alex (drinking); 97% (range, 87% to 100%) for Sunshine; and 97% (range, 74% to 100%) for Jarred. The total interobserver agreement for mouth clean was 90% (range, 58% to 100%) for Alex (eating); 94% (range, 73% to 100%) for Alex (drinking); 98% (range, 87% to 100%) for Sunshine; and 92% (range, 91% to 100%) for Jarred.

Experimental Design and Procedure

A multielement design was used to evaluate acceptance and mouth clean in the differential reinforcement for acceptance (DRA ACC) versus differential reinforcement for mouth clean (DRA MC) conditions. A reversal design was used to evaluate acceptance and mouth clean with the two different treatment components (DRA ACC or MC alone vs. DRA ACC or MC with escape extinction). In the first phase, acceptance and mouth clean were evaluated under escape baseline conditions. Following baseline, reinforcement was delivered following acceptance (DRA ACC) or mouth clean (DRA MC). Subsequently, an escape extinction (EE) procedure was implemented while the reinforcement contingencies for acceptance and mouth clean remained identical to the previous phase.

Four foods from each food group were presented during all meal sessions. Food items (16 total foods, four from each food group) were identified prior to the study. The order of food presentation was selected randomly at the beginning of the session.

Foods were presented at a pureed texture for Alex and Sunshine and a wet ground texture for Jarred. All sessions were 5 min in duration. However, during EE the meal length may have exceeded 5 min because the child was required to consume the last bite presented before the session was terminated.

Baseline. The therapist presented a bite or drink approximately every 30 s from the initial acceptance. Brief verbal praise was delivered if the child accepted the bite or drink within 5 s of the presentation or had a mouth clean. No differential consequences were provided for expulsion or vomiting (i.e., bite presentation continued). If the child held the bite or drink in his or her mouth 30 s after acceptance, the therapist verbally prompted the child to swallow the bite or drink (e.g., "You need to swallow your bite [drink]") on a fixed-time (FT) 30-s schedule, and the next bite or drink was presented after the previous one was swallowed. If the child engaged in any inappropriate behaviors (e.g., head turns, bats, blocks) during the presentation, the spoon or cup was removed for 30 s. If the child did not engage in any inappropriate behavior, the spoon or cup remained at the child's lips for 30 s, at which time a new bite or drink was presented. The next bite or drink was presented immediately after the escape period or after 30 s elapsed.

DRA ACC versus DRA MC. The procedures were identical to baseline, but reinforcement (e.g., preferred toys and attention) was delivered following acceptance in the DRA ACC condition or mouth clean in the DRA MC condition. A paired-choice preference assessment identified the highly preferred items (Fisher et al., 1992) used as reinforcement. The therapist delivered reinforcement (e.g., placed toys on a tray or table in front of the child) for 20 s following acceptance in the DRA ACC condition. The therapist delivered reinforcement for 20 s following a mouth clean in the DRA MC

condition. Reinforcement was delivered independent of other behaviors that may have occurred during each bite or drink presentation (i.e., crying, batting at the spoon, head turning, etc.). Bites or drinks were presented approximately 30 s after initial acceptance. Bite or drink presentation continued on the FT 30-s schedule independent of the delivery of reinforcement for acceptance or mouth clean. We followed this procedure so that reinforcement delivery would not alter the rate of bite or drink presentation. If we had waited to present the next bite or drink after reinforcement delivery, the rate of bite presentation would have been higher in the DRA ACC than in the DRA MC condition. No differential consequences were provided for expulsion or vomiting (i.e., bite presentation continued). If the child held the bite or drink in his or her mouth 30 s after acceptance, the therapist verbally prompted the child to swallow the bite or drink (e.g., "You need to swallow your bite") on an FT 30-s schedule, and the next bite or drink was presented after the previous bite was swallowed. If the child engaged in any inappropriate behaviors (e.g., head turns, bats, blocks) during the presentation, the spoon or cup was removed for 30 s. If the child did not engage in any inappropriate behavior, the spoon remained at the child's lips for 30 s, at which time a new bite or drink was presented. The next bite or drink was presented immediately after the escape period or after 30 s elapsed.

DRA ACC plus EE versus DRA MC plus EE. The therapist presented a bite or drink approximately every 30 s from the initial acceptance. The reinforcement contingencies were identical to the previous phase (DRA ACC vs. DRA MC). Bites or drinks were presented approximately 30 s after initial acceptance. That is, bite or drink presentation continued on the FT 30-s schedule independent of the delivery of reinforcement for acceptance or mouth clean. However, inappro-

priate behavior no longer produced escape. The therapist held the spoon or cup to the child's mouth until he or she took the bite or drink (i.e., nonremoval of the spoon or cup). If the child did not accept the bite or drink, the therapist verbally prompted the child to take the bite or drink (e.g., "Sunshine, take a bite") on an FT 30-s schedule. If the child expelled his or her bite or drink, it was scooped up and re-presented until the bite or drink was swallowed. If the child held the bite or drink in his or her mouth 30 s after acceptance, the therapist verbally prompted the child to swallow (e.g., "You need to swallow your bite") on an FT 30-s schedule. No differential consequences were provided for vomiting (i.e., bite presentation continued). Sessions were 5 min in duration or when the participant finished the last bite or drink presented when time elapsed.

RESULTS

The data for acceptance of food for Alex are depicted in the top panel of Figure 1. During escape baseline, Alex did not accept any of his bites. Acceptance remained at 0% during both DRA ACC and DRA MC. However, when EE was superimposed on the two differential reinforcement procedures, acceptance increased above 80% for both DRA ACC plus EE and DRA MC plus EE. No differences were noted between the two reinforcement conditions. Initially, responding remained high when EE was removed from the treatment package. However, after about 57 sessions, acceptance began to decrease in both conditions. There was an increase in acceptance in both conditions when EE was reimplemented. The data for mouth clean are displayed in the bottom panel of Figure 1. Because no bites entered the mouth, no instances of mouth clean occurred during baseline or the DRA conditions. Mouth clean remained high during the DRA ACC plus EE and DRA MC
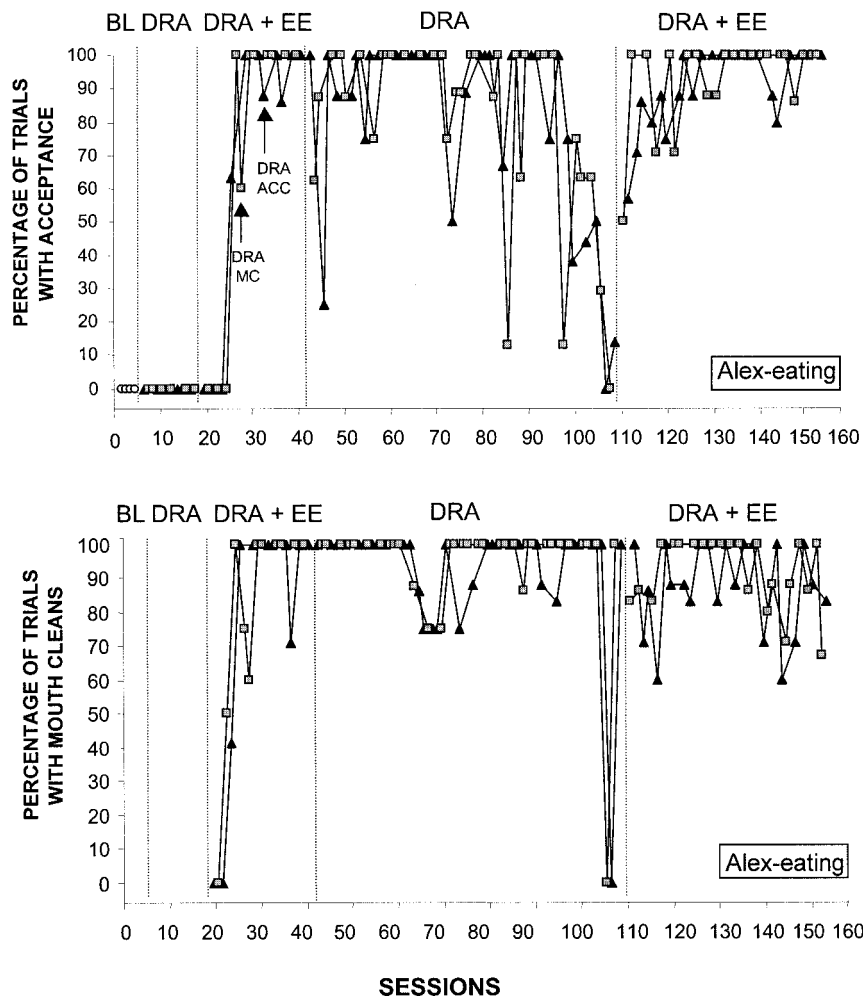
Figure 1.   Percentage of trials with acceptance (top panel) and percentage of trials with mouth clean (second panel) for Alex (eating). DRA = differential reinforcement for alternative behavior; EE = escape extinction; DRA ACC = differential reinforcement for acceptance; DRA MC = differential reinforcement for mouth clean.

plus EE phases and the second DRA phase. No differences were noted in packing, expulsion, or inappropriate behaviors across the two DRA conditions.

The data for acceptance of drinks by Alex are displayed in the top panel of Figure 2. Levels of acceptance were low during escape baseline and the DRA conditions. There was an increase in acceptance in both conditions when EE was implemented. Acceptance decreased in both conditions when EE was removed from the treatment package. When EE was reimplemented, acceptance increased

to 100% in both conditions. The data for mouth clean are depicted in the bottom panel of Figure 2. Instances of mouth clean were low during baseline and DRA ACC and DRA MC conditions, but increased and remained high in the DRA ACC plus EE and DRA MC plus EE conditions. Again, mouth clean decreased once EE was removed from the treatment package (DRA ACC vs. DRA MC). Levels of packing, expulsion, and inappropriate behaviors were similar across both DRA conditions.
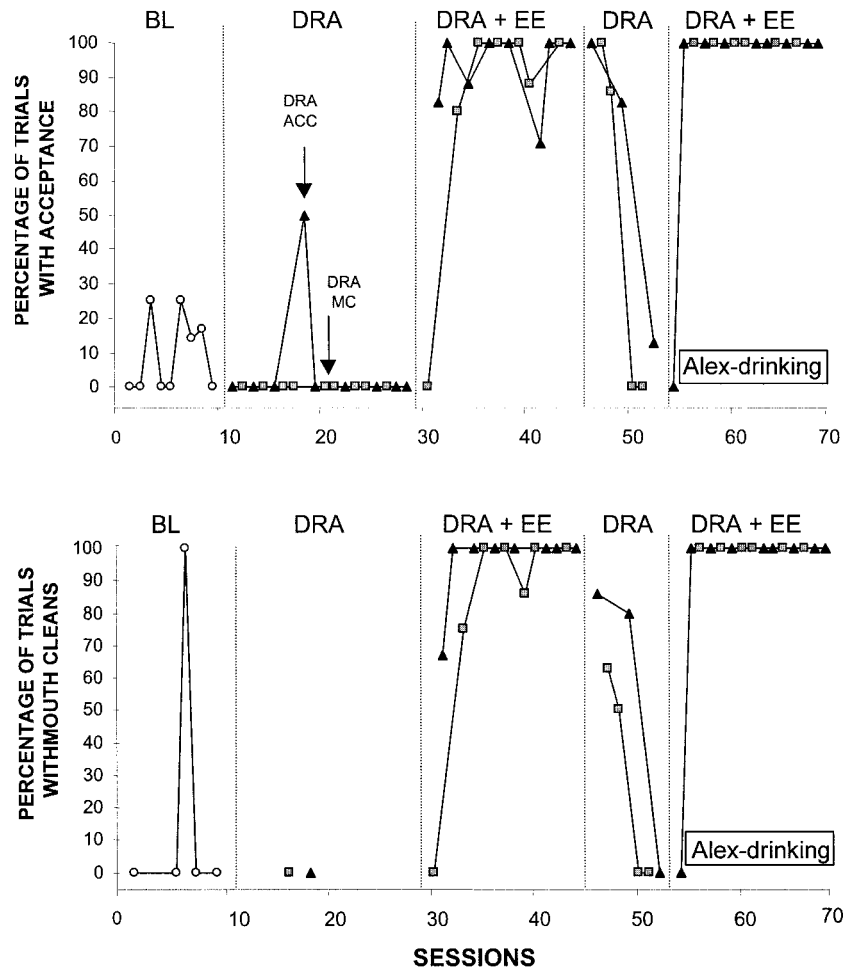
The data for acceptance for Sunshine are

Figure 2.   Percentage of trials with acceptance (top panel) and percentage of trials with mouth clean (bottom panel) for Alex (drinking).

shown in the top panel of Figure 3. During escape baseline, acceptance was at 0% and remained low during the DRA ACC versus DRA MC comparison. However, acceptance increased above 80% in both conditions when EE was added to the treatment package. Again, acceptance decreased in both conditions when EE was removed. Finally, acceptance increased in both conditions when EE was reimplemented. The data for mouth clean are displayed in the bottom panel of Figure 3. Mouth clean did not occur in baseline because no bites entered the mouth. In one of the DRA ACC sessions, Sunshine did have a mouth clean for one

bite. No instances of mouth clean occurred in any other DRA ACC session because no other bites entered the mouth. Similarly, no instances of mouth clean occurred in the DRA MC condition. Mouth clean increased in the DRA ACC plus EE versus DRA MC plus EE phases. Mouth clean decreased once EE was removed from DRA ACC and DRA MC. No differences were observed in packing, expulsion, or inappropriate behaviors across both conditions.

The data for acceptance for Jarred are depicted in the top panel of Figure 4. Jarred did not accept any of his bites during the escape baseline. Subsequently, no bites were
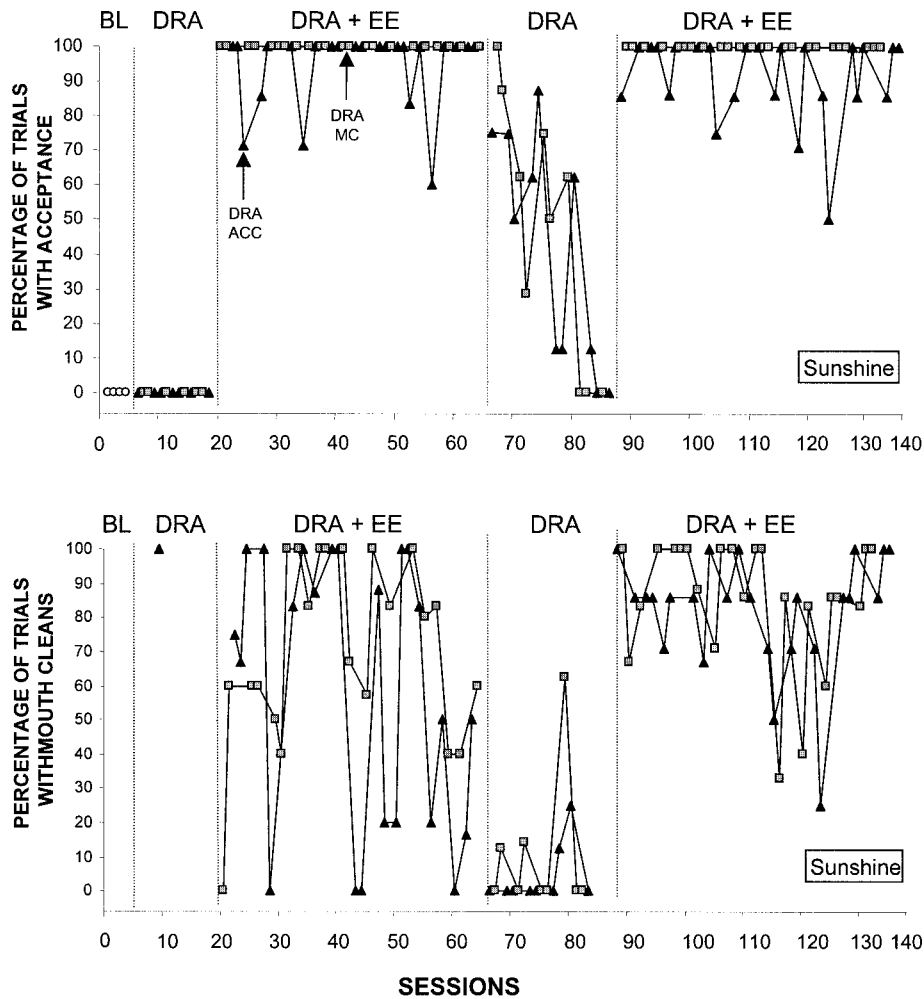
Figure 3.   Percentage of trials with acceptance (top panel) and percentage of trials with mouth clean (bottom panel) for Sunshine.

accepted in the DRA ACC versus DRA MC phase. However, acceptance increased in both conditions when EE was implemented. Initially, Jarred continued to accept bites without the EE contingencies; however, acceptance decreased to zero over time. Once EE was reimplemented, acceptance increased to previous levels. The data for mouth clean are shown in the bottom panel of Figure 4. Mouth clean did not occur during initial baseline and DRA ACC and DRA MC conditions because no bites entered the mouth. However, mouth clean increased and remained high in the DRA ACC plus EE and

DRA MC plus EE conditions. As with acceptance, mouth clean remained high initially when EE was removed from the DRA treatments; however, mouth clean decreased over time. No differences were observed in packing, expulsion, or inappropriate behaviors across both DRA conditions.

DISCUSSION

In the current investigation, we conceptualized consumption as a chain of behaviors and compared the relative effectiveness of reinforcing two different responses in the
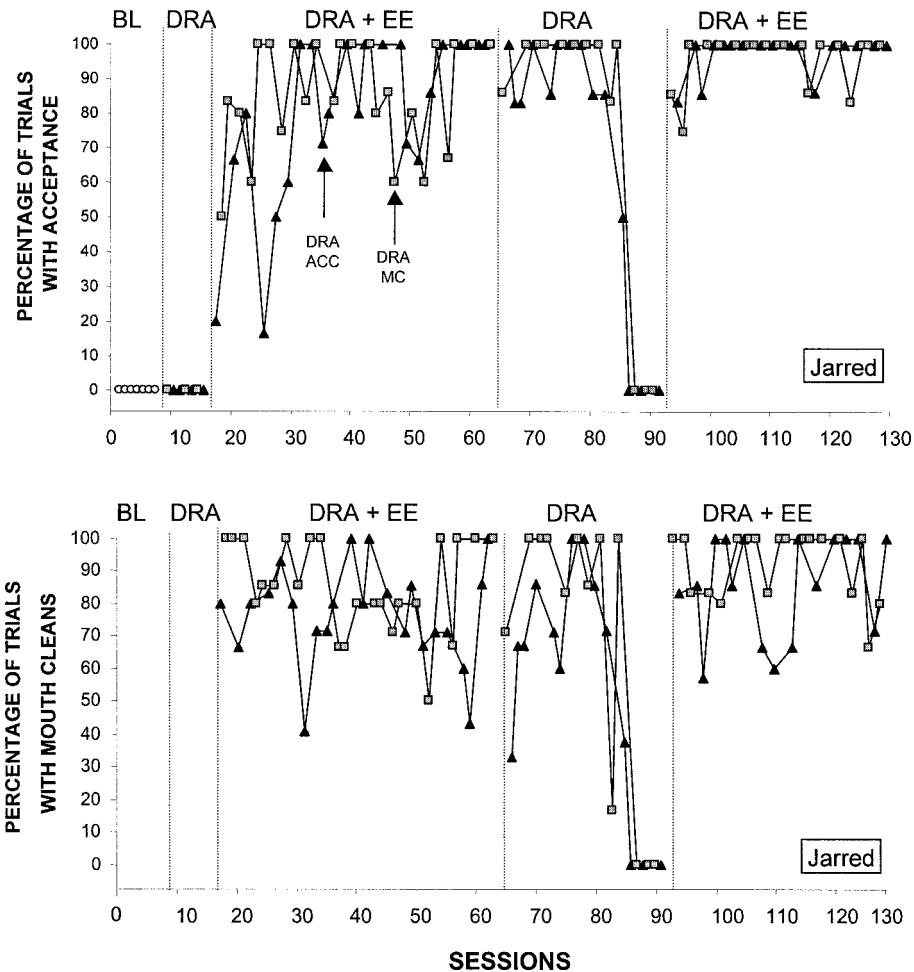
Figure 4.   Percentage of trials with acceptance (top panel) and percentage of trials with mouth clean (bottom panel) for Jarred.

chain. In one condition, differential reinforcement was provided for the first behavior in the chain (acceptance); in the other condition, differential reinforcement was provided for the terminal behavior in the chain (mouth clean). The data from the current investigation showed that differential reinforcement alone was not effective for increasing consumption for any participant. In addition, the data also suggested that consumption increased during escape extinction, independent of whether acceptance or mouth clean was reinforced. Furthermore, differences in other problem behaviors (i.e., packing, expulsion, and inappropriate be-

haviors) were not observed during either reinforcement condition.

There are several possible explanations for these results. Reinforcement alone may not have been effective at increasing consumption because all of the participants in this study exhibited total food refusal. Thus, the children had few opportunities to contact the reinforcement contingencies (Hoch et al., 1994). By contrast, the participants with food selectivity in the Riordan et al. (1980, 1984) studies exhibited some level of acceptance and swallowing in baseline, and consumption increased during the differential reinforcement treatment. Similarly, 1 of the

participants in the Hoch et al. study had low levels of acceptance in baseline, which increased following implementation of differential reinforcement, although not to clinically acceptable levels. In the current investigation, 1 participant exhibited acceptance in one of the four analyses (Alex, drinking). Nevertheless, neither acceptance nor mouth clean increased during the differential reinforcement treatment for either participant. Future studies should investigate the extent to which differential reinforcement contingencies are effective with food refusal versus food selectivity.

A second possibility is that the effectiveness of differential reinforcement may be related to the function of refusal behavior. Many forms of feeding problems are hypothesized to develop as a result of medical complications (e.g., GER), which may cause pain or discomfort while eating (Hyman, 1994). Thus, the child learns to associate eating with aversive stimulation and develops a variety of behaviors (e.g., batting at the spoon, crying) to avoid eating. If these behaviors are successful in producing escape, they become strengthened. In addition, they may persist even when medical complications have been resolved. If refusal behaviors are strengthened, it is likely that more appropriate feeding behaviors (eating) are not established in the child's repertoire.

Other researchers have shown that behaviors maintained by negative reinforcement can be treated by positive reinforcement contingencies alone (e.g., Lalli et al., 1999; Piazza et al., 1997). However, in the present study, positive reinforcement for eating did not compete with the putative negative reinforcement of escape. It is possible that positive reinforcement may be effective only with children who exhibit some level of appropriate feeding behaviors. Another possibility is that the preference assessment did not properly identify stimuli that would function as reinforcers, because it has been

shown that the reinforcing value of preferred leisure items for more complex behaviors such as eating is unclear (Piazza, Fisher, Hagopian, Bowman, & Toole, 1996). Food was the identified reinforcer in the Riordan et al. (1980, 1984) studies in which positive reinforcement alone was effective at increasing consumption. It is possible that preferred foods may compete with escape better than leisure items do. However, identification of preferred foods is not possible when children exhibit total food refusal, as was the case in the current investigation.

The data from the current study also suggest that escape extinction may play a role in the treatment of feeding disorders. These findings are consistent with those of Hoch et al. (1994) and Cooper et al. (1995) in demonstrating the importance of escape extinction in the treatment of feeding disorders. Hoch et al. hypothesized that one possible mechanism responsible for the effectiveness of the escape extinction procedure was that it brought the behavior of acceptance into contact with the reinforcement contingency. The results of the current investigation cast doubt on that hypothesis, because both acceptance and mouth clean increased for all participants across both DRA ACC and DRA MC conditions when escape extinction was implemented and decreased when escape extinction was withdrawn. These data suggest that acceptance increased because inappropriate behavior no longer produced escape.

One limitation of the current investigation is that the failure to find differences between the DRA ACC and DRA MC conditions may have been a function of multiple treatment interference (Heward, 1987). That is, the participants may not have discriminated which behavior (i.e., acceptance or mouth clean) produced reinforcement because of the rapid alternation between conditions. Future studies should examine this

question when treatments are implemented in isolation (e.g., reversal design).

Even though it appeared that escape extinction was an important component of treatment, it was not clear if the differential reinforcement contingency added to the effectiveness of escape extinction. That is, we did not conduct a condition in which escape extinction was implemented alone to determine if escape extinction was effective in the absence of differential reinforcement. Future studies should evaluate the effectiveness of escape extinction alone and in conjunction with differential reinforcement for the treatment of feeding disorders.

Interestingly, when escape extinction was removed, the effects of the treatment appeared to be maintained for some time. Acceptance remained high for Alex (eating) and Jarred for about 55 and 17 sessions, respectively, at which point the behavior returned to baseline levels. Acceptance for Alex (drinking) and Sunshine was more variable when escape extinction was removed; however, responding was higher compared to the initial reinforcement-only phase.

Consumption behavior may have been maintained after escape extinction was removed because the participants may not have discriminated the change in the contingency arrangement. Acceptance was at or near 100% for all participants in the escape extinction sessions that directly preceded the reversal of the escape extinction contingency. In addition, inappropriate behaviors declined to near zero during escape extinction. Therefore, the removal of the escape extinction contingency during the reversal may not have been apparent immediately because the participants were not exhibiting the behavior (e.g., head turns, batting at the spoon, blocking of the mouth) that would have led to removal of the spoon.

Because no differences were noted between the two conditions (DRA ACC plus EE vs. DRA MC plus EE), the parents chose the treatment they preferred to implement at home. All of the parents chose DRA MC plus EE as the final treatment. Upon discharge, all participants were receiving a minimum of 50% of their needs by mouth and G-tube feedings were reduced.

In sum, these data suggest that differential reinforcement alone was not effective in increasing any behavior along the response chain. Acceptance and mouth clean increased only after escape extinction was combined with positive reinforcement. Future studies should evaluate the efficacy of escape extinction without positive reinforcement.

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STUDY QUESTIONS

1. What are some variables that may influence the effects of behavioral interventions for feeding disorders?

2. What were the dependent variables, and how were they measured?

3. What was the difference between the two reinforcement procedures, and how was extinction implemented?

4. How did the authors equate the rate of food or drink presentations across the two conditions? Can you suggest an alternative method for ensuring equal presentations?

5. What treatment component was responsible for observed increases in acceptance and mouth clean, and what does this finding suggest about the mechanism by which food consumption increased?

6. Summarize the results of the comparison between the two reinforcement procedures.

7. What data suggested that the children's feeding problems did not result merely from failure to contact reinforcement for appropriate eating?

8. Results suggested that the two reinforcement procedures (DRA ACC and DRA MC) were effective at different points in the treatment process. Describe a potential advantage and disadvantage of both contingencies.

Questions prepared by Claudia Dozier and Pamela Neidert, The University of Florida