Practical Research

Parent-Implemented Liquid Fading to Establish Milk Consumption in a Child With Autism Spectrum Disorder

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The current study used a liquid fading procedure to establish milk consumption in a child with autism spectrum disorder. Before the study started the participant was still drinking powdered infant formula and had refused to switch to whole milk. All procedures, including data collection, were implemented by his mother through consultation in a home setting. The liquid fading protocol consisted of 8 steps, in accordance to the procedures used by Luiselli, Ricciardi, and Gilligan (2005) with modification. Baseline and intervention phases were evaluated by using a changing criterion design. At the end of the intervention the participant had reached 100% whole milk consumption within 3 months; this result was maintained 1 and 3 months later. The social acceptability of the intervention, as indicated by the mother, was high. This study suggests the effectiveness of antecedent-based intervention, without escape extinction, by the parent in a home setting; the procedure was able to be implemented through consultation.

Key Words: autism spectrum disorder, food selectivity, home setting, liquid fading, parent-implemented

Introduction

Autism spectrum disorder (ASD) is a lifelong developmental disability defined by the Diagnostic and Statistical Manual of Mental Disorders (Fifth edition). It includes deficits in social communication and social interaction and restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). According to the Centers for Disease Control and Prevention (2014), about 1 in 68 children with ASD are identified in the United States. It is almost 5 times as common among boys (1 in 42) than among girls (1 in 189).

Children with ASD have significantly more feeding problems and eat a significantly narrower range of foods than do children without the disorder (Schmitt, Heiss, & Campbell, 2008; Schreck, Williams, & Smith, 2004). A large percentage of children with

ASD presents comorbid feeding problems, including food or liquid refusal and food selectivity (Ahearn, Castine, Nault, & Green, 2001; Field, Garland, & Williams, 2003; Schreck et al., 2004). Parents of children with ASD are often challenged to ensure that their children consume a sufficient quantity and variety of foods (e.g., vegetables and dairy products) to meet their nutritional needs (Tiger & Hanley, 2006).

Liquid refusal is one concern for parents of children with ASD. Failure to consume adequate amounts of fluids can pose health risks, leading to diarrhea, vomiting, and restricted caloric intake (Luiselli, Ricciardi, & Gilligan, 2005).

Several studies have shown that behavioral interventions for feeding problems in children with ASD are effective (Ahearn et al., 2001; Luiselli et al., 2005; Najdowski, Wallace, Doney, & Ghezzi, 2003; Williams & Foxx, 2007).

The majority of studies have shown that escape extinction in the form of physical guidance and non-removal of the spoon is the most effective component of intervention for feeding problems (Piazza, Patel, Gulotta, Sevin, & Layer, 2003). Despite the effectiveness of escape extinction, Luiselli (2006) cautioned that serial actions to implement physical guidance

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or non-removal of the spoon could be painful, cause choking or aspiration, or make conditioned food aversion. Furthermore, it may be difficult for parents or caregivers to implement escape extinction procedures.

Ahearn (2003) suggested that there is a need to develop more antecedent-based procedures for treating feeding problems, particularly for children with food selectivity. Also, Bachmeyer (2009) acknowledged that some behavioral procedures can be effective without escape extinction. In antecedent-based procedures, antecedent stimuli in some aspect of the physical or social environment are manipulated to evoke a desired response or to make a competing, undesirable behavior less likely (Miltenberger, 2008).

Antecedent-based intervention has several advantages over consequence-based intervention for food selectivity and refusal. One benefit is that antecedent-based intervention typically starts when a child comfortably accepts and consumes food (Luiselli, 2006). Antecedent-based procedures are suitable for overcoming the problems associated with food selectivity, principally by modifying variables that can decrease the aversive properties of food or drink presentations. For example, food is presented at a level of complexity appropriate for the child. As described previously, antecedent-based procedures begin where children comfortably accept foods. In summary, these procedures have a non-aversive and preventive focus and are used to decrease the value of escape. Preventing challenging behaviors in this way increases the likelihood that the children's consumption behavior will be successfully reinforced. Also, eliminating challenging behaviors means that children are at less risk of choking on, or aspirating food: a critical consideration relative to conditioned food aversion.

Several studies have evaluated the use of antecedent-based intervention in food refusal or selectivity through, for example, simultaneous presentation (Ahearn, 2003), stimulus fading (Luiselli et al., 2005), and use of a high-probability instructional sequence (Patel, Reed, Piazza, Mueller, Bachmeyer, & Layer, 2007).

Stimulus fading is one of the methods a feeder can use to increase food acceptance, decrease expelling behaviors, and increase swallowing when other procedures are ineffective (Patel, Piazza, Kelly, Ochsner, & Santana, 2001). Stimulus fading involves a systematic change in stimulus control from preferred

to non-preferred stimuli. When the target foods are liquids, liquid fading can be used to substitute liquids associated with low rates of consumption for liquids associated with high rates of consumption.

Luiselli et al. (2005) evaluated feeding intervention for liquid refusal in a 4-year-old girl with ASD. At referral stage, the girl would accept a blend of 50% nutritional supplement drink with 50% whole milk. She was taught to drink whole milk through positive reinforcement and a stimulus fading procedure implemented at school by a teacher. The teacher praised her each time she swallowed: the teacher repeated the verbal instruction 'Drink' each time 60s had elapsed without the girl drinking. Fading steps were changed each time the girl consumed 90% or more of the nutritional supplement drink and whole-milk mixture in two or three consecutive sessions. Probe assessments were scheduled after the completion of every two consecutive fading steps. At the conclusion of the liquid fading protocol, the child consumed 100% milk, without interruption. As demonstrated by Luiselli et al. (2005), liquid fading that entails slowly changing the characteristics of a preferred drink is one strategy of promoting the consumption of previously rejected liquids. However, compared with the treatment of solid food refusal, treatment of liquid refusal has been less well studied (Luiselli et al., 2005).

Most studies of feeding problems in children with ASD have been conducted by clinicians or researchers in the clinical setting (Piazza, Patel, Santana, Goh, Delia, & Lancaster, 2002). However, large efforts and costs are required. For example, during day treatment program, children need to be hospitalized. In addition, after the children's discharge, it may not be possible to ascertain that generalization and maintenance will be obtained in multiple settings including in the home setting.

Gentry and Luiselli (2008) taught a mother to implement interventions that combined several antecedent components with positive reinforcement to treat selective eating through home-based training. The participant's interfering behaviors included motor stereotypy and sometimes noncompliance. Najdowski et al. (2003) found that parents implemented an effective treatment package as therapists and as primary data collectors through home-based supervision. In their study, the participant engaged in a number of refusal behaviors, including protesting,

whining, or crying. The treatment package was composed of different reinforcement of alternative behavior, escape extinction, and demand fading, which initially required only small portions of food. This intervention was acceptable and at a comfortable level for the participant. Tarbox, Schiff, and Najdowski (2010) found that the mother of their participant was able to implement all procedures at home. In this case, because the mother was responsible for data collection, every effort was made to simplify the procedures as far as possible. The participant's inappropriate behaviors were not particularly severe.

As indicated above, several studies have found that, after training, parents can implement feeding intervention in a home setting. Mueller, Piazza, Moore, Kelley, Bethke, Pruett, Oberdorff, and Layer (2003) found that training parents to implement a feeding protocol at home represents natural context intervention that may be superior to procedures taught within specialized clinic settings.

Generally, children's mealtimes are scheduled three times a day. These times are an appropriate opportunity for parents or caregivers to teach the children in a home setting how and what to eat or drink. If antecedent-based intervention can be implemented successfully in the home setting by parents or caregivers, it should then be possible to use it in multiple settings with multiple stimuli to improve their children's food selectivity.

The purpose of the current study was to evaluate the use of a liquid fading procedure, without any consequence-based interventions, including escape extinction, by a mother in a home setting with a child who had ASD and could not switch from powdered infant formula to whole milk because of refusal to drink whole milk. We also assessed the social acceptability of the liquid fading procedure from the mother's perspective.

Methods

Participant

The participant was a 7-year-old boy who had been diagnosed with ASD and was reported to consume only a limited number of foods. He attended a special public school for students with intellectual disabilities. After school, for 1 hour once a week, he was receiving behavioral intervention at a university-based clinic for children with ASD. He did not have

intelligible speech, and he initiated interactions with adults mainly by making eye-contact with them or reaching out his hand to them. However, he could imitate one-step motor responses and match picture to picture. At the time of the intervention he was being taught to match spoken words to objects, to imitate two-step motor responses, to coordinate eye and hand by using scissors, and to use activity schedules in learning sessions. He scored 40 on the Childhood Autism Rating Scale (CARS). His Vineland Adaptive Behavior Scales, Second Edition (Vineland-II) composite standard score was 37, which revealed low levels of adaptive functioning (between -5 Standard Deviations and -4 Standard Deviations) in the areas of communication, daily living skills, and socialization. His Brief Assessment of Mealtime Behavior in Children (BAMBI; Lukens & Linscheid, 2008) scores were high for factors indicating the consumption foods of limited variety (23 points), followed by factors indicative of food refusal (6 points) and factors that were features of autism (5 points). Specifically, the boy occasionally cried or screamed at mealtimes and often expressed dislike of certain foods, refusing to eat them. He often preferred the same foods at each meal, namely crunchy foods [e.g., *furikake* (dried seasoning powder) or fried foods]. Also, he often preferred to have his food prepared and served in a particular way. When seated he could drink from a cup by himself without any physical guidance. Also, direct observation at school lunchtime revealed that, when seated, the boy could use a spoon or fork without any physical guidance. He had already acquired chewing and swallowing skills.

Prior to intervention, the participant's mother had to prepare separate meals for him every day. His diet consisted mainly of rice with *furikake* (dried seasoning powder) or curry, roasted tuna, or fried chicken. Among vegetables, he would eat only potatoes, carrots, corns, and onions that were cooked into a curry. He did not want to eat dairy products, vegetables, or fruits. He preferred to drink water, sport drinks mixed with water, or barley tea. At school he was provided with school lunches that were varied from day to day. On the school lunch menu, bread and rice were the only foods that he would eat. He was not required to eat if he refused.

At the time of the intervention, the participant's growth was within normal limits (Rohrer index 126)

and he presented with no medical conditions (e.g., no gastroesophageal reflux, oral motor deficits, delayed gastric emptying, or vomiting) that would have interfered with his ability to eat or drink. However, according to parental report, his mother had failed to make him drink whole milk. He would not switch from powdered infant formula to whole milk, and he drank the powdered infant formula almost every day before he went to sleep. For the sake of the participant's nutritional balance and also for convenience of preparation, his mother needed him to switch from powdered infant formula to whole milk.

Materials and Measurement

Materials. The participant used the same powdered infant formula and cup that he always used and introduced the same brand of milk as that provided at school lunches. To prepare the liquid mixture, the mother used a measuring spoon and measuring cup.

Measurement. The independent variable was the concentration of whole milk, and the dependent variable was the percentage of liquid mixture consumed out of 160 ml. Prior to each session, the mother prepared a liquid mixture according to the predetermined protocol of Luiselli et al. (2005), which was modified based on the results of assessment by first author with consideration for implementation by the mother. The liquid mixture was prepared in a kitchen away from the participant's sight. The liquid fading protocol is presented in Table 1.

After the session, the mother poured the remaining liquid mixture from his cup into the measuring cup. The amount of liquid mixture remaining was divided by the volume of his cup (160 ml) to compute the percentage of consumed liquid in the session.

Experimental Design and Procedures

Baseline and intervention phases were evaluated by using a changing criterion design. The study was conducted over a three-month period.

Assessment. Before pre-intervention training started, the first author attended the family's home twice at meal times and observed that the participant did not engage in severe interfering behavior. The mother then recorded the quantity of powdered infant formula and water for 7 days. The first author identified that the liquid mixture was made up of 160 ml of water mixed with 4 tablespoons of powdered infant formula (approximately 112 g). The mother used a tablespoon that had a half-tablespoon measure, because when the intervention began the dose of infant formula was to be decreased by this measure.

Baseline. Baseline was implemented by the mother at home. The mother said to the participant, "Here's your milk" and presented him with the cup containing 160 ml of powdered infant formula (160 ml of water mixed with 4 tablespoons of powder) at 30 to 40°C. The mother then initiated the session by instructing him to "drink". The instruction was repeated each time a 2-min interval had elapsed without the participant drinking. The mother terminated the session when he had either consumed the full contents or 10 min had elapsed, whichever came first.

Pre-intervention training. When the participant came to university-based clinic, before the mother implemented the intervention the first author conducted training with her for 15 to 20 min once a week in the observation room. During a training session, the first author (a) introduced the study of Luiselli et al. (2005) and explained the liquid fading protocol;

Table 1 Liquid Fading Protocol

Step	Concentration of whole milk	Powdered infant formula (PIF) +whole milk mixture
Baseline	0.0%	160 ml water mixed with PIF (4 tablespoon)
1	12.5%	140 ml water mixed with PIF (3.5 tablespoon)+20 ml whole milk
2	25.0%	120 ml water mixed with PIF (3 tablespoon)+40 ml whole milk
3	37.5%	100 ml water mixed with PIF (2.5 tablespoon)+60 ml whole milk
4	50.0%	80 ml water mixed with PIF (2 tablespoon)+80 ml whole milk
5	62.5%	60 ml water mixed with PIF (1.5 tablespoon)+100 ml whole milk
6	75.0%	40 ml water mixed with PIF (1 tablespoon)+120 ml whole milk
7	87.5%	20 ml water mixed with PIF (0.5 tablespoon)+140 ml whole milk
8	100.0%	160 ml whole milk

(b) distributed and reviewed a written intervention about the study; and (c) demonstrated the respective procedures. The mother was taught the liquid fading protocol, how to prepare the liquid mixture, and how to present and measure the mixture. After the demonstration, the first author asked the mother some questions about the procedures, and vice versa.

Intervention. Intervention was implemented by the mother at home. The mother followed the liquid fading protocol, which consisted of 8 steps. For example, to obtain a 12.5% powdered infant formula concentration, she mixed 140 ml of water with 3.5 table spoons of infant formula with 20 ml of whole milk. The protocol started at a 12.5% powdered infant formula concentration (140 ml water mixed with 3.5 tablespoons (approximately 98 g) and 20 ml whole milk). The mother was instructed to move on to the next step when the participant had consumed 90% or more of the powdered infant formula: whole milk mixture in six consecutive sessions. In the remaining intervention steps the whole milk content was increased according to Table 1, but otherwise the procedures were the same as in the baseline phase. After the pre-intervention training, the first author monitored the mother's implementation of the protocol once a week, and also asked the mother about any difficulties she was having with implementing the intervention and gave her feedback based on the data recorded. Finally, the author reviewed the procedure, and the proportion of liquid mixture used, with the mother.

Probe assessment. During probe sessions, the participant was presented with the cup containing 100% whole milk. During baseline phase, three

consecutive probes were conducted, interspersed between sessions. If the participant showed refusal behavior, the mother ignored it. During the intervention phase, a probe assessment was scheduled each time the participant completed a fading step.

Follow-up. The mother presented the participant with 100% whole milk continually. Data were collected 1 and 3 months after the end of intervention. The procedures were the same as in the baseline phase.

Social acceptability. After the intervention, the social acceptability of the intervention using liquid fading procedure was measured by using a modified version of the Treatment Acceptability Rating Form-Revised (TARF-R). Items were referenced to the work of Langthorne and McGill (2011), and the modified form contained 9 items (Table 2). The mother rated each item by using a Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Ethical Considerations

The study was approved by the Ethics Committee of the Graduate School of Comprehensive Human Sciences, University of Tsukuba. Before the study, the first author gave the mother a consent form and explained to her the purpose and method of the study and her right to refuse to cooperate. Informed consent was obtained from the mother, who in this case was an agent of the participant. None of the authors had any conflicts of interest.

Results

Figure 1 shows the percentages of whole milk con-

Table 2 The Result of Social Acceptability of Liquid Fading Intervention

Item	Question	Score
1	I find this intervention to be an acceptable way of improving the child's liquid refusal.	4
2	I would be willing for this procedure to be used again to improve the child's liquid refusal.	4
3	I believe it would be acceptable to use this intervention without the child's consent.	4
4	I like the procedure used in this intervention.	4
5	I believe this intervention is likely to be effective in improving the child's liquid refusal.	4
6	I believe the child experienced discomfort during the intervention.	2
7	I believe the assessment is likely to result in permanent improvement in the child's liquid refusal.	4
8	I believe it would be acceptable to use this intervention with people who cannot choose intervention for themselves.	3
9	Overall I had a positive reaction to this intervention.	4

Note. Score was rated each item using a Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Fig. 1 Amount of Liquid Mixture (Top) and Percentage of Mixture Liquid Consumption (Bottom)

sumed by the participant in the baseline, intervention, and probe assessment sessions. In the baseline phases, the participant consumed only 100% powdered infant formula. He did not consume whole milk during the baseline probe assessment. During intervention, 100% consumption was approached as the concentration of whole milk was increased gradually, except once, in session 18. Finally, the participant's consumption of whole milk reached 100%. This was maintained at 1 and 3 months after the end of the intervention. The results of the social acceptability assessment are shown at Table 2. The mother responded that she neither agreed nor disagreed with recommending the intervention to other people. But she responded "disagree" to a question about whether she felt uncomfortable about the intervention, and she gave high scores to the remaining items in the social acceptability test. Overall, the mother had a positive reaction to the intervention.

Discussion

The current study used a liquid fading procedure to establish whole milk consumption in a child with ASD. As demonstrated by Luiselli et al. (2005), this study showed that it was possible to establish whole milk consumption in such a child in a relatively short time.

Before the study, it was confirmed that the par-

ticipant often disliked certain foods and would not eat them, often preferring the same foods at each meal. Also, he often preferred to have food prepared and served in a particular way. Direct observation at lunchtime at school revealed that he could use a spoon or fork without any physical guidance. When seated, he could drink from a cup by himself without physical guidance. However, he was still drinking powdered infant formula and would not drink whole milk at all.

Given the nutritional requirements at his current age, it was judged that whole milk would be a better supply of calcium for him than powdered infant formula. The mother's convenience in preparing the milk was also considered. By gradually increasing the concentration of whole milk in the liquid mixture, the participant was successfully led to consume the whole milk and to maintain this consumption. This study therefore demonstrated the effectiveness of liquid fading intervention.

Another meaningful result was that, according to the mother, the participant did not show challenging behaviors when presented with the gradually increasing quantities of whole milk. This suggests that he did not experience discomfort during the intervention.

It is important to note that the liquid fading procedure was implemented by the mother at home. Before the study, the participant would not drink whole milk. Through a gradual increase in the con-

centration of whole milk in the liquid mixture, the participant was successfully led to consume whole milk, and consumption was maintained stably after the end of intervention after 1 and 3 months. These results suggest the effectiveness of antecedent-based intervention, without escape extinction, by the parent in a home setting. Moreover, the procedure could be implemented through consultation. Most interventions for children with feeding problems, including food refusal or selectivity, are conducted in clinical or hospital settings with trained experimenters (Freeman & Piazza, 1998; Luiselli et al., 2005; Tarbox et al., 2010). Freeman and Piazza (1998) recommend that more study needs to be done to assess the factors that result in successful treatment in natural settings.

One of the reasons for the successful outcome of this study was that the procedure was simple for the mother to implement in a home setting by using a tablespoon marked with a half-measure.

It is notable that the child's challenging behavior was not particularly severe, although this was reported only during the probe assessment. In the case of participants who engage in severely challenging behavior, despite the potential increase in cost, the researcher or instructor can visit the home and implement the procedure with the participant directly to address his or her challenging behaviors.

Moreover, intervention began when the participant was comfortably accepting liquids: that is, the participant had a low level of aversion, or non-aversion, to them at the start of intervention.

Lastly, during the intervention, the fading step was changed when the participant had consumed 90% or more of the powdered infant formula—whole milk mixture in six consecutive sessions. Six consecutive sessions may seem quite long, but it was an appropriate period to confirm that the participant's consumption behavior was stable.

Although we did not conduct a formal assessment of procedural adherence, the mother was willing to accept our consultations and managed the procedures. In addition, the mother reported that, because the liquid fading protocol was uncomplicated, it was not difficult. This intervention would therefore be acceptable for implementation in natural settings.

As with other studies (Luiselli et al., 2005; Patel et al., 2001), this study had a scheduled periodic probe assessment. However, in the intervention phase only 3 consecutive probes were conducted, after the first

fading step (i.e., at the 12.5% powdered infant formula concentration). Although the participant drank 50% of the whole milk at the third probe session, his mother stated that she did not want to implement probe sessions, as the participant showed challenging behaviors such as disruptive vocalizing, pushing the cup of whole milk out of his reach, or spitting whole milk from his mouth into the cup during the probe session. He then refused to drink at all when a mixture of 25% powdered infant formula concentration was presented (session 18). The first author interpreted this as a carry-over effect. Therefore no more probe sessions were conducted after the first fading step. The need for probe assessments should be considered when parents implement the intervention (i.e., it should be noted whether or not probe assessment is necessary when the parents implement the intervention).

A limitation of this study was that the data on the participant's challenging behavior relied on anecdotal reports. Fortunately, he did not spill the cup of liquid or spit the liquid out during the intervention. A future study will need to record data on challenging behavior and use it to judge whether or not to conduct probe assessments.

The amount of milk provided depends on the child's age. Preschoolers typically should be given 147.9 ml (5 ounces) to drink, and school-age children 177.4 to 207.0 ml (6 to 7 ounces) (Williams & Foxx, 2007). However, in this study, the participant used a 160 ml cup and did not increase the amount of whole milk, notwithstanding the fact that the participant reached 100% whole milk consumption. A future study needs to use quantities that are age-appropriate to the participant. Another limitation of the study was that the target liquid was only whole milk. Other studies in which liquid fading protocols are used should be generalized to other target liquids with consideration of nutritional benefits.

The current study used the liquid fading procedure alone to establish whole milk consumption in a child with ASD. Although it appears that antecedent-based interventions alone are more successful for children with food selectivity, the use of antecedent-based interventions alone has been evaluated in only 8 of 20 children with food refusal (Seubert, Fryling, Wallace, Jiminez, & Meier, 2014).

As noted, this conclusion must be interpreted with caution, because the study included a single partici-

pant. When seated, the boy could drink from a cup by himself and use a spoon and fork at lunchtime, without any physical guidance. Also, he had already acquired chewing and swallowing skills. If these skills have not been acquired, children must learn them before any antecedent-based intervention for food selectivity can be implemented. Also, if children present strong challenging behaviors during meals, parents or caregivers cannot be expected to implement antecedent-based interventions in the home setting. Antecedent-based procedure focuses on non-aversion and prevention of food selectivity in patients with ASD. In some cases, the procedure is composed of very small steps and the process needs to be lengthened. Therefore, it might not be appropriate for parents or caregivers to expect an immediate change.

Lastly, future studies need to evaluate the effects of the fading procedure on other feeding problems, using a variety of target foods or liquids.

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