A CLINICAL CASE STUDY OF RUMINATION AND EMESIS IN AN ADULT MALE WITH INTELLECTUAL DISABILITY

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An evaluation of a series of interventions was conducted for an individual who engaged in life – threatening rumination and emesis. There is substantial research indicating that delivery of peanut butter (Barton & Barton, 1985; Greene, Johnston, Rossi, Rawal, Winston, & Barron, 1991) and/or chopped bread following meals (Thibadeau, Blew, Reedy, & Luiselli, 1999), chewing gum (Rhine, & Tarbox, 2009), and satiation procedures (Dudley, Johnson, & Barnes, 2002; Lyons, Rue, Luiselli, & DiGennaro, 2007; Rast, Johnston, Drum, & Conrin, 1981) can be effective treatments for rumination. In the current case, each of these interventions was found to be either ineffective or contraindicated based on the participant’s fragile health status. Previous literature has shown that liquid delivery can affect rates of rumination in some clients (Barton & Barton, 1985; Heering, Wilder, & Ladd, 2003). We examined how liquid affected the rate of rumination during and after meals. Based on the individual’s medical condition, oral nutrition and fluids were discontinued indefinitely and a gastrostomy-jejunostomy tube was used for nutrition. All rumination ceased when fluids and nutrition were delivered via the jejunostomy tube. Finally, a fluid analysis procedure was implemented in which the participant received small amounts of fluid while NPO. Color and flavor were manipulated systematically, and results suggested that flavor impacted the rate of rumination.
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A CLINICAL CASE STUDY OF RUMINATION AND EMESIS IN AN ADULT MALE WITH INTELLECTUAL DEVELOPMENTAL DISABILITY

Rumination and emesis are among the most severe forms of self-injurious behavior (SIB) exhibited by people with intellectual developmental disabilities (Lang & Melamed, 1969; Weiss, 2002). Rumination is the repetitive regurgitation, chewing and reswallowing of previously ingested food, resulting in malnutrition, decreased resistance to disease, dehydration, esophagitis, and tooth decay (Rast, Johnston, Drum, & Conrin, 1981). Rumination is common in certain animals, such as cattle, sheep, and goats as this helps their digestive processes. However, in humans – rumination or rumination syndrome can have catastrophic consequences. Serious medical problems such as electrolyte imbalance, malnutrition, significant weight loss, respiratory complications tooth decay, and resistance to disease (Boris & Dalton, 2007). In some cases, medical or organic factors cause rumination; however, there is some evidence that rumination may be under control of operant processes (Lyons, Rue, Luiselli, & DiGennaro, 2007; Wilder, Register, Register, Bajagic, & Neidert, 2009).

Emesis is expelling digested or undigested food from the mouth or nose. While not as common as rumination, emesis can occur in individuals with intellectual disabilities and sometimes co-occurring with rumination. Among the serious effects of vomiting are tooth decay, malnutrition, dehydration, and potentially death (Starin & Fuqua, 1987). Luiselli, Haley, and Smith (1993) noted that between 8-10% of institutionalized clients engage in ruminative vomiting behavior that can become life threatening. Rumination and emesis are dangerous topographies of problem behavior for the medical implications they each can have, and when they co-occur, those medical issues are exacerbated.
Some of the early behavioral interventions for rumination and vomiting were punishment in the forms of electric shock and other aversive stimuli (Kohlenberg, 1970; Sajwaj, Libet, & Agras, 1974) as well as overcorrection procedures (Azrin & Wesolowski, 1975; Foxx, Snyder, & Schroeder, 1979). Although punishment procedures were successful in some cases, an increased interest in function-based analyses and treatments led to the development of less intrusive approaches to understanding and treating these disorders. Iwata, Dorsey, Slifer, Bauman, & Richman (1982/1994) described a methodology for identifying environmental influences on behavior disorders (i.e., functional analysis), which could then be manipulated as treatment. Functional analytic logic has been successfully extended to a range of settings, populations, and behavior disorders, including rumination and emesis.

Results of studies using functional analysis procedures to assess rumination indicate that the behavior appears to most often be maintained by automatic reinforcement (Kliebert & Tiger 2011; Lyons et al., 2007; Wilder et al. 2009; Woods, Luiselli, & Tomassone, 2013). Perhaps due to complications associated with manipulating consequences for automatically reinforced behavior, interventions for rumination often focus on antecedent factors. Luiselli (2015) reported that the majority of interventions for rumination included either fixed time or continuous access to food or fluids. It is thought that the effectiveness such interventions involves the presentation of gustatory stimuli, which functions as an abolishing operation (AO) that temporarily decreases the effectiveness of further gustatory stimulation as reinforcement and decreases behavior maintained by that stimulation (rumination and emesis).

Rast, Johnson, and their colleagues conducted a series of studies designed to analyze the effects of antecedent variables on rumination. For example, the investigators investigated how the quantity of food affected rates of rumination in individuals with intellectual disabilities by
manipulating portion sizes for three individuals (Rast et al., 1981). Results showed that after consuming larger portions of food lower rates of rumination were observed, demonstrating an inverse relationship between quantity of food and rate of rumination, these results were supported by a parametric analysis of food quantity and rumination (Rast, Johnston, & Drum, 1984). The results of these studies did not clarify if reductions in rumination were a function of caloric value of the increased portions or of the volume of food consumed; therefore, a subsequent study was conducted to investigate the impact of food on rumination by direct manipulation of calories and the mechanical properties (e.g. a physical effect; volume of stomach contents by addition of fiber) on rumination (Rast, Johnston, Allen, & Drum, 1985). Results indicated that fiber showed small effects on the rate of rumination however, it was unclear how the addition of fiber affected stomach volume. An inverse relationship between the amount of calories and rate of rumination was observed, although caloric content did not appear to the sole determinant of subsequent levels of rumination. Rast et al. (1985) concluded that stomach volume can potentially affect rumination and that satiation with high volumes of food can be an effective treatment for some individuals.

Interest in the variables associated with rumination increased following the series of investigations by Rast and colleagues. Several researchers demonstrated the effectiveness of satiation with starch to decrease rumination (Dudley, Johnson, & Barnes, 2002; Dunn, Lockwood, Williams, & Peacock, 1997; Lyons et al., 2007). Other researchers investigated other food-related variables. For example, Thibadeau, Blew, Reedy, and Luiselli (1999) showed that, for their participant, providing chopped bread reduced rumination and the effects maintained at 15 months. Other researchers showed that providing peanut butter after meals could decrease rumination (Barton & Barton, 1985; Greene, Johnston, Rossi, Rawal, Winston, & Barron, 1991).
Although satiation procedures have been shown to be effective to reduce rumination, there are some limitations to this approach. First, some satiation procedures may be contraindicated due to health concerns. For example, unlimited portions of food can lead to higher risk of aspiration in individuals with swallowing issues. Second, weight gain can accompany satiation procedures, which may reduce the longevity of treatment. Finally, Dudley et al.’s (2002) participant refused to eat the extra food at one point in their study, which made the satiation procedure ineffective. Some researchers have investigated the use of antecedent fluids on rumination. Barton and Barton (1985) combined the use of peanut butter and a fluid rescheduling procedure at meals to reduce rumination in four children with rumination. A fluid rescheduling procedure is an intervention designed to restrict fluids to the individual, specifically around mealtime to increase the response cost of ruminating. Heering, Wilder, and Ladd (2003) also employed a fluid rescheduling procedure and demonstrated significant reduction of rumination following meals.

Although various treatments have been cited in the literature, the generality of these procedures has not been well established. Treatments shown to be effective with some individuals may not work with others (Lang, et al. 2011). A possible contributing factor in idiosyncratic responses to treatment is the large number of variables that may have a contributing factor in rumination and emesis. Thus, although the literature has isolated some variables that affect rumination and emesis (e.g., calories, stomach volume, fluids, etc.), these variables appear to act on an idiosyncratic basis, and there is no current technology for identifying individual characteristics that may predict treatment effects.

A purpose of the present case study was to evaluate the effects of some common variables on rumination and emesis and attempt to develop and evaluate non-aversive treatments
for rumination and emesis. An additional purpose of this study was to evaluate the effects of variables associated with fluids (e.g., form of fluid delivery, pace of delivery) on rumination and emesis.
GENERAL METHOD

Participant

Medical and behavioral history. Jack was referred to a specialty clinic for assessment and treatment of rumination and emesis. Jack was a 25-year-old African American male, diagnosed with Autism Spectrum Disorder, Impulse Control Disorder, Anxiety Disorder Not Otherwise Specified, and Severe Intellectual Disability. In addition, Jack had a history of medical disorders including Essential Hypertension, GERD, Anemia, Pneumonia, UTI, and Mild Esophageal Dysmotility. Jack resided at a large residential and training center for individuals with intellectual and developmental disabilities. He was ambulatory and had generally good fine and gross motor skills. Jack communicated with 2-4 word utterances and was able to point and gesture. A Vineland Adaptive Behavior Scale, Second Edition was administered to Jack in May, 2015. Results indicated that he functioned at the 1:1 year age equivalent level for receptive language and 1:9 year age equivalent level for expressive language. Other subdomain scores ranged from 0:3 (interpersonal relations) to 5:1 (written) year age equivalence. The scale was administered shortly following his arrival at his current placement, and informal observations and anecdotal reports from caregivers indicate that some skill areas may not adequately reflect his actual abilities.

Historical information. Available documentation of Jack’s history was generally sparse and unspecific. Records indicate that Jack was removed from the care and custody of his family following abuse allegations when he was around the age of 16 years old (no date or specific circumstances were available). He resided at group homes from 2009-2012. The first recorded instances of rumination and emesis occurred in 2010 following two unsuccessful attempts to place Jack in community-based settings. Documents indicated these placements failed due to “significant weight loss, rumination, and vomiting” (no other details or data were provided). Jack
was placed in a foster care home from 2012-2014. There were no recorded instances of rumination, emesis, or behavioral problems during that placement.

In November 2014 Jack was removed from his foster home placement, placed under care of the local Child Protective Services agency, and admitted a large residential facility. Removal from the home was based on allegations that Jack was locked in a closet, gagged, and deprived of food. It was unclear how long the alleged abuse and neglect had occurred

Upon placement in the residential facility at which the current case study was conducted, Jack weighed 105 lbs. He engaged in rumination 1-2 times per minute and engaged in emesis 6-12 times per day. Observations and documents from the first few weeks of his placement indicated that his rumination and emesis showed evidence of temporal patterning in relation to meals. He typically engaged in high rates of rumination (1-2x per minute) for approximately 1.5-2 hours following meals and then engaged in an episode of emesis. Reports indicate that Jack also would drink from the toilet, sink, or shower and steal fluids to consume.

Observations of the topographical features of Jack’s rumination revealed some interesting characteristics. When Jack engaged in rumination, there was little or no obvious movement of his throat or body; often, the sole evidence of the occurrence of rumination was bulging of his cheeks indicating the presence of a bolus of vomitus in his mouth. When Jack engaged in emesis, he simply opened his mouth and emitted vomitus.

Health Status. At the start of services, Jack received fluids 2-3 times per week to treat severe dehydration. He was severely underweight throughout the course of assessment and treatment. He weighed 105 lbs. upon admission to the facility, and his measured weight ranged from 98 lbs. to 126 lbs. (mean = 108 lbs.) during the course of this case study. His Body Mass Index (BMI) was 14.5, which 32% under the criterion for a designation of “underweight”
(BMI<18.5 is considered underweight). At the beginning of treatment, his medical team reported that he was in early stages of kidney failure, and they were deeply concerned that if he continued to engage in rumination and emesis he would be at risk for heart failure. Severe malnutrition due to frequent rumination and emesis had also resulted in metabolic refeeding syndrome. This condition occurs in individuals with severe malnutrition and characterized by fluid and electrolyte disorders, especially hypophosphatemia, along with neurologic, pulmonary, cardiac, neuromuscular, and hematologic complications. Essentially, metabolic refeeding syndrome causes the body to go into "shock" (e.g., heart failure, a shift in electrolytes, decreased respiration) if too many calories are consumed or weight gain occurs too quickly. Because of the risk of metabolic refeeding syndrome, Jack’s daily caloric intake was limited to 1200 calories.

The texture of fluids provided to Jack’s fluids was thin, and food was presented in a ground texture initially and, subsequently, a chopped texture. He had only five teeth remaining on his bottom jaw at the time of admission, and those teeth were decayed and needed to be removed. Jack was assigned a 1:1 caregiver/client ratio at all times due to stealing food/fluids and eating too fast. Jack was weighed twice a week with his clothes and shoes on, using the same scale each time. His primary care physicians and gastroenterologist specialists unanimously concluded that there was no biological or medical reason for Jack’s rumination and emesis and that these behaviors were “behavioral” in nature.

Medications. At the start of the study, Jack was prescribed a variety of psychotropic medications. Because documentation of Jack’s medication history was so sparse, the basis for some of his prescriptions was somewhat unclear; nevertheless, Jack’s psychiatrist decided to maintain his ongoing prescription regimens until sufficient information on which to base changes was available. At the start of treatment, Jack was prescribed Clonazepam (.5 mg/day) for anxiety.
and to treat emesis, Depakote (500 mg/day) for anxiety, Mirtazapine (30 mg/day) for regurgitation/emesis, Olanzapine (20mg/day) (reason unclear), Trazodone (150mg/day) for regurgitation/emesis. Olanzapine and Trazodone were discontinued during the third phase of this case study.

Definitions and Data Collection

Data were collected on laptop computers using B-DataPal Pro software. Rumination was scored using duration recording. Rumination started when Jack brought food or fluid back up from his stomach and held it in his cheeks and ended when he swallowed the bolus. Duration recording permitted estimation of the total time of rumination in seconds in order to determine if food texture, fluid intake, or other variables altered the length of rumination episodes. Additionally, we converted the rumination to rate per minute for some analyses. This was done by dividing the number of bouts of rumination by the total time. Emesis was recorded using event recording, and was defined as bringing food or fluid back up from his stomach and expelling it onto the ground, into the toilet, or another area. These definitions were used throughout all three phases of treatment. Data were also collected on the delivery of fluids to Jack (staff behavior, frequency measure) and meal consumption (duration measure).
PHASE I: PRELIMINARY OBSERVATIONS, ASSESSMENTS, AND INTERVENTIONS

Anecdotal Assessments

The Motivation Assessment Scale (MAS) (Durand & Crimmins, 1988), Questions about Behavioral Function (QABF) (Matson & Vollmer, 1995), and Functional Analysis Screening Tool (FAST) (Iwata, & DeLeon, 1995) were conducted with three members of Jack's staff. Assessments were conducted in quiet places at Jack’s residence, away from distractions. Administrators provided caregivers with a copy of the assessments, read the questions aloud in sequential order, and recorded the caregivers’ responses. Caregivers’ responses were summarized and reviewed to identify patterns of agreement across respondents indicating possible operant functions for rumination and emesis.

Anecdotal Assessment Outcomes. Results from the anecdotal assessments of Jack’s rumination are presented in Table 1. Outcomes for the MAS showed that all three respondents scored “Automatic” as the highest category (mean = 13, range = 6-23). Respondents did not show unanimous agreement on the second or third-ranked categories. For the QABF, two of the three respondents scored non-social reinforcement as the likely maintaining category for Jack’s rumination and emesis. One caregiver indicated that rumination was maintained by positive reinforcement in the form of access to tangible items. For the FAST, all three respondents indicated that rumination was maintained by automatic positive reinforcement. Anecdotal assessments were not completed for emesis.

Preliminary Observations

Prior to initiating formal analytic procedures, thirty-nine mealtime observations were conducted over a course of 3 weeks. Following the 15th observation, caregivers were provided with a daily schedule and instructions about how to work with and respond to Jack’s behavior.
This was done in order to promote consistency among caregivers in their interactions with Jack. The purpose of the observations was to develop operational definition of Jack’s target behaviors, establish baselines of the target behaviors and identify potential relations between caregiver behavior, environmental events and conditions, and Jack’s behavior. Investigators collected data on percent of meal consumed, frequency and duration of rumination bouts, frequency of emesis, fluid intake, and Jack’s requests for fluids. During the first nine observations, data were collected on attention from staff, but was this was discontinued, as the data did not indicate that rumination and emesis reliably preceded or followed staff attention. Staff were monitored to ensure that they provided Jack with the correct amount of fluid and provided the correct food texture.

Preliminary Observations: Outcomes. Multiple significant findings were discovered during the observation phase. Figure 1 displays data from breakfast, lunch, and dinner observations. Average duration of rumination is on the primary axis and response per minute is on the secondary axis. The data suggest that during breakfast, Jack engaged in short, rapid bouts of rumination, indicated by the lower average duration (mean = 24 minutes per session, range = 3 minutes – 37 minutes per session), and a relatively high rate of rumination (mean = .91 rpm, range = .58 rpm-1.17 rpm). During lunch, Jack’s duration of rumination was the shortest (mean = 22 minutes per session, range = 6 minutes – 45 minutes) and rumination rate was low (mean = .59 rpm, range = .20 rpm-1.16 rpm). Jack engaged in longer bouts (mean = 34 minutes per session, range = 24 minutes – 50 minutes per session) and consistently high rates (mean = 1.02 rpm, range = .63 rpm-1.23 rpm) of rumination during dinner. The lower average duration and high rate of rumination after breakfast indicates that bouts were relatively briefer in duration. After lunch, Jack engaged in the shortest duration and lower rates of rumination than after breakfast or dinner. Finally, Jack engaged in the longest durations and highest rates of
rumination following dinner meals. The orderly variability in rate and duration across mealtimes suggests that meal-specific variables affected Jack’s rumination (e.g., food type, time of day).

Modified Functional Analysis: Procedures

Following the initial observations, a modified functional analysis was conducted (Iwata et al., 1982/1994). Prior research on rumination and emesis indicated that these behaviors are most frequently maintained by automatic reinforcement (Kliebert & Tiger 2011; Lyons et al., 2007; Wilder et al., 2009; Woods et al., 2013); therefore, Jack’s functional analysis included only alone and no interaction conditions. This was done in order to quickly and efficiently determine if Jack’s behaviors persisted in the absence of social contingencies (Vollmer, Marcus, Ringdahl, & Roane, 1995). The FA was conducted using a sequential design; four sessions in the alone condition were followed by four sessions in the no-interaction condition. All sessions were carried out in a 3.1 x 3.1 m room with a one-way observation window and sessions lasted from 40-60 minutes. Sessions were scheduled for 60 minutes; however, sessions were terminated prior to 60 minutes if rumination ceased to occur. All sessions were conducted immediately following meals.

During alone sessions, Jack was alone in the session room with a table, a chair, and an empty garbage can (for emesis). If Jack vomited on the floor, a therapist went into the room and quickly cleaned it up, providing no attention to Jack. This was necessary because Jack had been observed to engage in emesis, pick it up from the floor, and re-consume the emesis. During the no interaction condition, the staff sat in the session room, providing no attention to Jack regardless of rumination or emesis. If Jack engaged in emesis during the no interaction condition, a second therapist entered the room and cleaned it up, providing as little attention as possible.
Modified Functional Analysis: Outcomes. Results of the functional analysis indicated that Jack engaged in substantial amounts of rumination in both conditions but engaged in emesis only in the alone condition. These outcomes suggest that rumination and emesis were maintained by contingencies of automatic reinforcement. Figure 2 shows responses per minute of rumination across alone, no interaction, and regular programming observations. These data show that rumination occurred at a mean rate of 1.12 rpm with a range of 1.01 rpm-1.30 rpm during the alone condition, with a slight downward trend across the four alone sessions. Responding was significantly more variable during the no interaction condition, although the level of responding was largely unchanged (mean = 1.30 rpm, range = .63 rpm -1.86 rpm). High variability persisted during regular programming, although the overall level of responding was slightly lower than alone and no interaction conditions (mean = .84 rpm, range = .20 rpm- 1.23 rpm).

Figure 3 displays average rate and duration of rumination per condition. During the alone condition, the average rate of rumination was 1.12 rpm. The average rpm of rumination increased during the no interaction condition to 1.30 rpm. During regular programming, the average rate of rumination was .84 rpm. Frequency of emesis varied during the modified FA. In the alone conditions, Jack’s frequency of emesis ranged from 0-5 instances per session and there were no instances of emesis during the no interaction condition (See Figure 4). There did not seem to be an effect of Jack’s typical staff on rumination nor emesis.

Extended Observation: Procedure

A single, extended observation was conducted to identify possible patterns in Jack’s rumination and emesis throughout multiple meals, staff change, and snacks. The 5 hour, 55-
minute observation began at lunchtime (12:20 pm) and ended at 6:15 pm. Meals were delivered at 12:30 pm and at 5:00 pm with a snack at 3:00 pm. Staff change occurred at 2:00 pm.

Extended Observation: Outcomes. Figure 5 shows the results of the extended observation. The data are presented in a cumulative record format, with cumulated duration of responding in seconds on the vertical axis and time of day (minutes of observation) on the horizontal axis. The bold purple sections in the data path represent times when Jack was eating, red sections indicate emesis, and blue sections indicate fluid delivery. The figure reveals that Jack ruminated throughout much of the observation period. Rumination occurred at consistent, moderate levels during and after lunch. Almost immediately following a delivery of fluid, Jack engaged in emesis and there was a brief pause in rumination. Rumination reemerged at high levels but decelerated through the middle of the afternoon. There was no effect of staff change at 2:00 pm (indicated by the phase line), about 90 minutes after lunch.

Almost immediately before a scheduled snack, Jack went to the bathroom, drank from the toilet, and immediately engaged in emesis. He repeated this 3 times. After the snack, rumination occurred at high and consistent levels until the next fluid delivery. Following the fluid, Jack engaged in emesis almost immediately. No rumination or emesis was observed for 22 minutes, after which Jack went to the bathroom, drank from the toilet, and engaged in emesis nine times. Following this episode, neither rumination nor emesis was observed for 66 minutes. Jack’s dinner was delivered at 5:00 pm and rumination resumed at steady and consistent levels following consumption of his meal.

Based on previous findings suggesting that fluid intake can affect rumination, data were analyzed to determine if changes in the frequency or patterning of rumination or emesis occurred following fluid delivery. Graphic displays were constructed showing the cumulative duration of
rumination and occurrences of emesis before and after fluid delivery. Data collection began at the first occurrence of rumination during or following a meal. Four representative examples of these analyses are shown in figures 6, 7, 8, and 9. Figure 6 shows data from the no interaction condition of the functional analysis. The rate of rumination before fluid delivery was .62 rpm and increased to 1.62 rpm following fluid delivery. Figure 7 shows data following a breakfast meal. Rumination occurred at .45 rpm before fluid was delivered and at 1.00 rpm. Figure 8 shows data after a different breakfast meal, indicating that rumination occurred at .39 rpm before fluids and at .88 rpm after fluids. Figure 9 shows data collected following a dinner meal, in which fluids were delivered twice but no change in rumination occurred. Overall, data on the effects of fluids indicated that there was an immediate, albeit inconsistent, effect in which fluid delivery resulted in immediate increases in rumination. These increases appeared to be largely due to the occurrence of fewer “breaks” in responding after, relative to before, fluid delivery. We recorded the food type, texture, and flavor for each observation (see information on graphs) but did not detect relationships between these variables and changes in rumination or emesis.

Food/Fluid-Based Manipulations and Outcomes. Collaborating with Jack’s professional team, several manipulations of food/fluid-related variables were evaluated as potential treatment components. At the beginning of this project, Jack received no more than four ounces of fluid per hour. In an attempt to decrease rumination that may have been “facilitated” by fluid intake, his fluids were not delivered an hour prior to or following meals. This intervention did not reduce rumination and was terminated.

The dietician and clinical team then conducted two trials in which Jack received peanut butter following meals (Barton & Barton, 1985; Greene et al., 1991). During this intervention, Jack was provided with two tablespoons of peanut butter immediately after a meal. Only two
tablespoons were provided due to concerns of aspiration. There was no significant clinical effect and Jack continued to ruminate (Figure 10).

Following trials with peanut butter, Jack was given chopped bread after meals (Thibadeau, Blew, Reedy, & Luiselli, 1999). Jack was provided with two pieces of chopped sandwich bread after he had completed meals on six trials. This intervention did not appear to decrease rumination.

Although these interventions did not produce clinically significant outcomes independently, they were combined as components of an intervention that the facility implemented throughout the remainder of Phase I and all of Phase II of the current project.

Interobserver Agreement. Interobserver agreement (IOA) data were not collected for the initial observations. IOA was conducted for 25% of functional analysis sessions. Partial interval agreement was calculated by dividing the sessions into 10-second intervals and averaging IOA across all intervals. The lower number of responses (or time) was divided by the higher number within each interval. Results were summed across intervals, divided by the number of intervals, and the result was multiplied by 100. The mean IOA for rumination was 86.75% (range = 83%-90%) and IOA for emesis was 100%.

Phase I: Discussion. Data derived from Phase I indicate that Jack’s rumination and emesis appeared to be maintained by automatic reinforcement. The results from the anecdotal assessments and the modified functional analysis support previous findings that rumination and emesis are likely maintained by automatic reinforcement (Kliebert & Tiger 2011; Lyons et al., 2007; Wilder et al., 2009; Woods et al., 2013).

The data collection system (B-DataPro) that we used during all phases allowed for molecular analysis of rumination through the construction of cumulative records of Jack’s
behavior. Cumulative records especially helpful to aid in recognizing patterns of behavior at a molecular level (Fahmie & Hanley, 2008) and, in the current study, showed immediate and potentially important changes in rumination following fluid deliveries. Past research has found that fluids can make rumination “easier” to do (Barton & Barton, 1985; Heering et al., 2003). This seems consistent with patterns in Jack’s records showing that the effects of fluids were most apparent when there were periods with no rumination prior to fluid delivery. Perhaps decreases in rumination prior to fluid delivery were due to increased effort or aversiveness, which was altered by the presentation of fluids.

The extended observation permitted a general view of the course of Jack’s rumination over the course of a typical day. He was observed to engage in rumination almost continuously for about 90-120 minutes following meals, after which he ingested fluids (either from the toilet, during the extended observation; however, he was also observed to attempt to drink from the sink or to “steal” fluids from others; or scheduled fluid delivery) and engaged in emesis. Given this pattern, which was also supported by caregiver reports, it is likely that Jack did not properly digest most of his meals.

During the observations, clinic therapists noted variations in Jack’s topography of emesis. Sometimes, Jack simply leaned over, opened his mouth, and expelled vomitus. There were no visible stomach contractions or straining to emit the vomitus. At other times, Jack crouched on his hands and knees, his stomach visibly contracted, and he strained to expel the vomitus. Although these topographies were different, it did not seem useful to differentiate them for the purposes of data collection because both resulted in the expulsion of vomitus. However, it is possible that there were functional differences between the two topographies, and future research
might attempt to determine if different topographies are differentially affected by environmental influences.

Limitations to Phase I include the lack of IOA for some portions of the study. Jack was a new resident of the facility and, therefore, early portions of this project were conducted while specific target behaviors were being identified and operationally defined. After relevant responses were defined, IOA data were collected as resources permitted. In the early part of Phase I, there was little structure in Jack’s schedule and in strategies to manage his behavior. In order to obtain useful and informative data about the environmental influences on Jack’s behavior, it was necessary to create a schedule for caregivers to follow, as well as a set of instructions about how to manage his rumination and emesis. The validity or representativeness of data collected prior to these developments may be questionable. Finally – the termination criterion for sessions during the modified functional analysis was not sufficiently specific. The procedure was to end session after 60 minutes or if Jack had emesis and stopped rumination but did not account for if rumination ceased without emesis.

Overall, Phase I resulted in the development of useful measurement systems to assess Jack’s rumination and emesis. Results of preliminary observations, indirect assessments, and unstructured and structured observations indicated that Jack’s behavior was automatically reinforced. The behavior appeared to occur at slightly lower levels in the presence of caregivers, and was temporarily exacerbated by food and fluids. Preliminary probes of potential treatments (fluid scheduling, peanut butter and chopped bread at the end of meals) did not show clinically significant results. Because initial implementation of some standard, evidence-based interventions were not successful, more intensive interventions were analyzed during Phase II.
PHASE II: IN-HOME INTERVENTION ANALYSES

Method. Although Phase I produced information about the environmental influences on Jack’s rumination and emesis, preliminary evaluations of standard, evidence-based interventions did not produce clinically acceptable results and Jack’s health continued to decline. At the end of Phase I Jack’s weight was at the lowest level observed during this study. Based on the severity of Jack’s behavior and his tenuous health status, an empty apartment at the residential facility was opened so that Jack’s treatment team could utilize the space to evaluate the effectiveness of additional interventions. The apartment had bedrooms, a kitchen, a bathroom, a living area, and a dining area.

For five days, from 7:00 am to 7:00 pm, Jack received continuous treatment and evaluation from a team that was specially organized for this project. All members of the team were graduate students completing supervised experience in behavior analysis. The team assumed all responsibility for Jack’s care during this period, including toileting, meals, and active programming. All medications and meals were delivered to the home. Jack continued to spend evenings and nights at his assigned residence (he lived in the infirmary at the facility). Team members transported Jack from the infirmary at 7:00 am and returned him to the infirmary at 7:00 pm. A wheelchair was provided for his transport due to his fragile medical state and to prevent unnecessary expenditure of calories.

Data were collected on laptop computers using B-DataPal Pro software. Rumination was scored using duration recording. Rumination started when Jack brought food or fluid back up from his stomach and held it in his cheeks and ended when he swallowed the bolus. Duration recording permitted estimation of the total time of rumination in seconds in order to determine if food texture, fluid intake, or other variables altered the length of rumination episodes.
Additionally, we converted the rumination to rate per minute for some analyses. This was done by dividing the number of bouts of rumination by the total time. Emesis was recorded using event recording, and was defined as bringing food or fluid back up from his stomach and expelling it onto the ground, into the toilet, or another area. Fluid delivery was a frequency measure and was defined as each ounce of fluid was one instance of fluid delivery. Popsicle consumption was measured as a duration beginning when Jack started to eat the popsicle and ended when the popsicle wrapper was empty. Announcements were defined as anytime the therapist said to Jack, “It’s time for ______” to state a meal, snack, popsicle, or scheduled fluid delivery time.

Data were recorded continuously on rumination, emesis, fluid/food consumption, popsicle consumption, and announcements. Therapists worked in four, 3-hour shifts (e.g., 7am-10am, 10am-1pm, 1pm-4pm, and 4pm-7pm) each day. One therapist worked directly with Jack during each shift and one to two data collectors were present, recording data on laptop computers.

For the first two days, the goal was to insure consistency in Jack’s schedule and in how caregivers responded to Jack. Therapists kept Jack involved in activities (e.g., board games, walks, playing basketball), general chores (e.g., sweeping, picking items up, cleaning), assessments (Assessment of Functional Living Skills [AFLS], The Assessment of Basic Language and Learning Skills [ABLLS]), and other active programs. The food was delivered to the apartment by the central kitchen’s staff. Breakfast was delivered at 7:00 am, snack was at 10:00 am, lunch was at noon, afternoon snack was at 3:00 pm, and dinner was at 5:00 pm. Therapists noted that when food arrived or was delivered – Jack reliably and immediately engaged in emesis in the restroom. In order to address this, therapists occasionally did not
announce when food arrived and attempted to bring in the food to avoid Jack from seeing the food prior to eating. These attempts appeared to be unsuccessful – upon seeing the food, Jack immediately went to the restroom to engage in emesis. If he was unable to reach the bathroom, Jack engaged in emesis on the floor or in a trashcan.

On the third day of Phase II, a protocol was implemented to address Jack’s emesis prior to food or fluid delivery. When food/fluid arrived, team members announced that the food/fluid was ready and instructed Jack that he could that he could A) throw up now and then wait 10 minutes to eat, or B) if he did not throw up, he could eat right away. If Jack engaged in emesis, a visual timer was set for 10 minutes and he was not permitted access to food/drink until the timer expired.

During Phase II, free access to popsicles was introduced as a preventative intervention. Pedialyte popsicles were used for a variety of reasons; research results suggested that popsicles might reduce rumination, and Pedialyte popsicles provided much-needed hydration and electrolytes to aid in resolving his electrolyte imbalance. Jack was able to verbally request a popsicle, and caregivers delivered a popsicle to him whenever he requested. If he engaged in rumination while eating the popsicle, the caregiver stated, “You need to have an empty mouth before eating” and ensured that no vomitus was present in his mouth before allowing further access to the popsicle. If attempted to eat the popsicle while engaging in rumination, the caregiver physically blocked access to the popsicle.

Interobserver Agreement. IOA for Phase II was conducted for 5% of total observation time or one shift. Partial interval agreement was used which was calculated by dividing the lower number of responses (or time) by the higher number and multiplying by 100. Intervals were 10s
each and IOA was averaged across all 10s intervals. IOA for Rumination was 88.5%, emesis 100%, and popsicle duration 41%.

Results. Data from our intensive intervention are in Figures 11-14. Figure 11 is a display of the average rumination per shift (e.g., 7:00am-10:00am, 10:00am-1:00pm, 1:00pm-4pm, and 4:00pm-7:00pm) across days (x-axis). Data indicate that the overall rate of rumination declined across the first four days, but increased on the last day. The data show an overall lower average rate of rumination (mean = .26 rpm, range = .11 rpm-.37 rpm) between 1:00 pm and 4:00pm, whereas the highest level of rumination was observed between 10:00 am and 1:00 pm (mean = .40 rpm, range = .30 rpm-.54 rpm).

Figure 12 shows the frequency of emesis per shift across days. For the first two days, higher instances of emesis were observed between 10:00 am and 1:00 pm and between 4:00 pm and 7:00 pm than between 7:00am-10:00am and 1:00pm-4:00 pm. Following implementation of free access to popsicles frequency of emesis per shift varied greatly and there was no pattern.

Delaying access to food contingent upon emesis appeared to show promise to decrease occurrences of emesis (Figure 13). Of 27 total trials in which the contingency was stated Jack engaged in emesis 15 times (55.5%). On the first day of this intervention, Jack engaged in emesis in 5 of 8 trials (62.5%). On the following day, Jack engaged in emesis in 6 of 10 trials (60%). Finally, on the third day of intervention Jack engaged in emesis in 3 of 8 trials (37.5%).

Figure 14 shows a comparison of total minutes of rumination duration versus the total minutes of popsicle consumption. Duration in minutes is displayed on the y-axis and day is listed on the x-axis. During restricted access to popsicles (7/10/2015, 7/11/2015), Jack’s total popsicle consumption was lower than 90 minutes per day and the duration of rumination was about 90 minutes on the first day and significantly higher on the second day (7/11/2015). Following
implementation of free access to popsicles, an inverse relationship between popsicle consumption duration and rumination was observed. The duration of rumination decreased while duration of popsicle consumption increased substantially.

Discussion. Before this Phase, the treatment team observed that facility staff had difficulties implementing programs as scheduled and responding to Jack in consistent ways. Therefore, during the first two days of Phase II, the treatment team focused on establishing a consistent schedule and implementing interventions with fidelity. Data collected during those days showed that Jack’s rumination and emesis occurred at relatively high levels. Following this brief “baseline” period, two interventions were implemented: a) unlimited access to popsicles and b) delaying delivery of food if Jack engaged in emesis.

Measures of rumination decreased substantially after implementation of free access to popsicles. Jack requested popsicles frequently and often asked for another one immediately after consuming one. It is possible that decreases in rumination were, in part, a result of decreased opportunity to ruminate, as he was actively consuming popsicles for a majority of the day. However, measures of neither rumination nor popsicle consumption (nor the sum of both) approached the total daily observation time of 720 minutes. It is also possible that popsicle consumption functioned as an AO for the automatically reinforcing consequences of rumination (Simmons, Smith, & Kliethermes, 2003). By providing stimulation that was similar to that suspected to maintain rumination, popsicle consumption may have temporarily decreased the reinforcing effects of rumination and temporarily decreased ruminative behavior. Finally, it is possible that consuming popsicles made rumination more difficult, so that rumination was reduced through some “mechanical” means (Rast et al., 1985). Future research should attempt to identify the specific functional relationships between access to certain foods and rumination.
Although the overall frequency of Jack’s emesis did not decrease significantly, following implementation of the delay contingency although the patterning of his emesis across shifts did appear to change. However, after implementation of the protocol emesis became highly variable. The increased variability in his emesis may have been to the disruption in Jack’s daily schedule of food/fluid consumption. Prior to Phase II, Jack’s food and fluid deliveries were predictably timed. Following free access to popsicles Jack could gain access to fluid throughout the day, which could have affected his emesis.

The free access to popsicles drastically impacted Jack’s ruminative behavior. There was an inverse relationship between popsicle consumption and rumination behavior. Use of popsicles are a novel edible item to use to decrease rumination in the literature however there are various edibles cited that have a similar effect (Kliebert & Tiger, 20011; Lyons et al., 2007; Wilder, Draper, Williams, & Higbee, 1997). An issue with treating rumination disorder seems that what works per individual is idiosyncratic. For example: peanut butter, chopped bread, fluid rescheduling, pacing, etc. did not work for Jack however popsicles did seem to have an effect.

There are several limitations to Phase II. A very significant limitation is that no acceptable experimental design was used to evaluate the treatments. Because of concerns about Jack’s very fragile medical status, as well as time, resource, and administrative constraints, it was neither possible nor desirable to delay interventions or to reverse from interventions that appeared successful. Therefore, conclusions about the effects of the interventions evaluated during Phase II must be made with great caution. Second, IOA data were collected during only 5% the time during Phase II. This occurred due to staffing and resource limitations. Although 5% represents an inadequate sample of IOA, it is notable that IOA data were collected for a total of 180 minutes, or nearly 1.5 hours of Phase II observations – a substantial absolute duration of
IOA. Additionally, IOA for duration of popsicle consumption was inadequate and low. Third, no procedural fidelity checks were conducted. A purpose of Phase II was to improve the fidelity with which treatments were applied by replacing facility staff with a specially constructed team. Although it is likely that this team implemented procedures with reasonable fidelity, this cannot be confirmed in the absence of fidelity data.
PHASE III: MEDIPORT AND GASTROJEJUNOSTOMY TUBE PLACEMENT

Throughout Phases I and II of this study Jack’s interdisciplinary team, including a team of physicians, met frequently to monitor his health status. Soon after his arrival at the facility, it was determined that his fragile health status would ultimately require intrusive medical intervention. During Phase II, arrangements were made for in-patient services and immediately following Phase II, Jack was admitted to the hospital due to malnourishment and severe dehydration. Prior to administering anesthesia for the placement of a MediPort (permanent IV access through the chest), food and fluids were withheld (via a Nils per os, or NPO order) for 22 hours, during which he engaged in no rumination or emesis. Following placement of the MediPort, Jack received Total Parenteral Nutrition (TPN) through the MediPort. Jack was placed in a long-term medical facility for the recovery period, and ate regular meals for 25 days. Jack continued to engage in rumination and in emesis while eating and receiving TPN.

Subsequently, Jack received a gastrojejunostomy (G/J) tube on 8/10/2015 and was released from the hospital and returned to the residential facility on 8/12/2015. Jack returned to his previous placement at the infirmary, where he was attended by facility staff. Data systems were developed so that caregivers could collect data on emesis frequency and amount (mL) and a 15-minutes time sampling system was developed for rumination signs of emotional distress, and heaving. Caregivers also recorded the amount and type of food/fluid Jack received as well as his activities.
PHASE IV: FLUID ANALYSIS

Based on observations that Jack did not engage in rumination and emesis when oral food and fluids were withheld (i.e., during the NPO order), Jack's medical team decided to maintain an NPO order indefinitely following his return to the residential facility. This is a relatively extreme approach, which is typically used as a short-term solution (Baker, Rapp, & Carroll, 2010). Six structured observations were conducted to ensure that Jack did not ruminate or engage in emesis while NPO. Results indicated that he did not engage in either behavior. In order to develop a strategy to decrease the intrusiveness of Jack’s treatment and to allow access of reinforcing foods and fluids to him, the behavioral treatment team proposed to reintroduce food or fluid slowly to Jack, in a systematic and controlled manner. Research outcomes had suggested that it may be possible to “fade in” oral feeding and drinking without reestablishing rumination or emesis (Luiselli, 2015). Jack's primary care physician recommended that this process start by introducing fluids first, based on “mechanical” concerns (i.e., that small amounts of fluids would be harder to regurgitate). In order to determine the appropriate dimensions along which fluid fading should proceed, several analyses were conducted to identify the characteristics of fluids that were associated with rumination and emesis. In other words, the next step was to determine if variables such as the color and/or taste of fluids affected the likelihood, that either rumination or emesis would occur.

Fluid Analysis: General Procedures. During the fluid analysis, sessions were conducted once daily after Jack’s G/J tube feeding was complete. Sessions were conducted at various sites at Jack’s residence (e.g., his home, workshop) and were integrated into his typical schedule. Jack sat in a chair throughout sessions and caregivers interacted with him in a typical manner,
depending on the currently scheduled activity. All instances of rumination and emesis were ignored during the fluid analysis.

Sessions were conducted using a 3-component multiple-schedule experimental arrangement (Simmons, Smith, & Kliethermes, 2003). During the first 15 minutes of each session (i.e., the first component of the multiple schedule), no fluid was presented to Jack. After 15 minutes, Jack received one oz of fluid every five minutes, for a total of six oz over 30 minutes (i.e., the second component of the multiple schedule). The fluid was kept in an unlabeled plastic water bottle with no label and fluid was given to Jack in 1-oz measuring cup. During the final 15 minutes of each session (i.e., the third component of the multiple schedule) no fluid was presented (this replicated the conditions of the first component).

Water versus colored water. Initially, Jack was provided grape juice for one session under the procedures described above. However, when he received juice, he seemed to be in pain (likely due to tooth decay) and began to ruminate after the second ounce. For these reasons, grape juice was discontinued and plain, room temperature bottled water was presented for 8 sessions per the procedures stated above. Subsequently, sessions were conducted in which the color of the fluid was manipulated in a multielement design in order to determine if the color of the fluid affected rumination or emesis. For color sessions, a flavorless, calorie-free purple dye was added to plain bottled water and the same procedure used.

Plain versus Propel® Grape. A multielement analysis was conducted to determine if the flavor was a contributing variable to rumination. Propel® Grape was chosen for several reasons: 1) it has no color, therefore, looks like water, 2) not carbonated, 3) sugar-free and calorie-free, and 4) is flavored. Therefore, the Propel® Grape differed from plain water only along the
dimension of flavor, permitting a relatively confound-free analysis of the contribution of that variable.

*Propel® Grape Only.* During this phase, all procedures were identical to the procedures above except that, Jack received Propel® Grape only in order to identify cumulative effects, if any, of presenting Propel® Grape across consecutive sessions.

*Water Only 6 Oz Simultaneously.* During this condition, all procedures were identical to the procedures above except that, during the second component of the schedule (i.e., after 15 minutes), Jack was offered 6, one oz cups of water consecutively (one after the other) rather than using a 5-minute delivery schedule. Investigators continued to collect for 20 minutes (this was chosen to keep the time of the second component consistent across conditions) following consumption of the six ounces prior to transitioning to the third component.

*Phase IV. Inter-Observer Agreement.* Partial interval agreement was calculated by dividing the sessions into 10-second intervals and averaging IOA across all intervals. The lower number of responses (or time) was divided by the higher number within each interval. Results were summed across intervals, divided by the number of intervals, and the result was multiplied by 100. IOA for NPO observations was conducted for 30% of sessions and IOA for rumination and emesis were both 100%. IOA for fluid analysis was taken for 23% of all sessions. IOA for fluid delivery mean was 99.3% with a range of 95-100%, rumination mean 98.3% with a range of 95-100% and emesis’ mean was 99.9% with a range of 98-100%.

Phase IV Results. Figure 15 represents the results of observations conducted immediately following Jack’s NPO order at the residence. Six observational sessions were conducted, during which no emesis nor rumination was observed.
Data from Phase IV of Fluid Analysis are displayed in Figures 16-17. During the first session in Figure 16 Jack was provided with grape juice. Rumination began after the presentation of the second oz of fluid and continued throughout the remainder of the session. After the session was completed, Jack engaged in emesis, as indicated by the red cross below the session number. After switching to room-temperature bottled water, rumination decreased to near zero levels throughout all components of the multiple schedule and emesis occurred after only two sessions (mean = .08 rpm, range = .0 rpm-.59 rpm).

When Jack was provided with colored water (Figure 16), low rates of rumination, similar to those observed with colored water, were observed. Rumination occurred at near zero rates and there was no post session emesis (mean = .02 rpm, range = .0 rpm-.06 rpm).

When the effects of water were compared against those of Propel® Grape (Figure 17), rumination occurred at lower rates during the water condition (Pre-Fluid: mean = .01 rpm, range = .0 rpm-.07 rpm; Fluid Analysis: mean = .03, range=.0 rpm-.07 rpm; Post Fluid: mean = .005, range = .0 rpm - .04 rpm) and was elevated during the Propel® Grape condition (Pre-Fluid: mean = .0 rpm, range = .0 rpm-.0 rpm; Fluid Analysis: mean = .11, range=.0 rpm-.34 rpm; Post Fluid: mean = .52, range = .0 rpm – 1.36 rpm). Post session emesis only occurred after Jack received Propel® Grape. When only Propel® Grape was presented, a significant increase in rumination was observed, both during and after fluid delivery (the second and third components of the multiple schedule) (Pre-Fluid: mean = .05 rpm, range = .0 rpm-.13 rpm; Fluid Analysis: mean = .53, range=.2 rpm-.73 rpm; Post Fluid: mean = .41, range = .0 rpm - 1.2 rpm). During the final three sessions in this condition, Jack engaged in emesis during fluid delivery and engaged in emesis following the final session. When only plain water was re-presented, Jack’s ruminative behavior reverted to near zero levels (mean = .03 rpm, range = .0 rpm-.1 rpm) and
was observed only during fluid delivery (the second component of the multiple schedule). Finally, when 6 oz of water was freely available to Jack during the second component of the multiple schedule, zero rumination was observed and only one instance of post-session emesis occurred.

Phase IV Discussion. Results of Phase IV showed that Jack was able to consume up to 6 oz of fluid without engaging in significant amounts of rumination or emesis. The results indicated that color of fluid did not affect rates of rumination, but flavored fluids seemed to set the occasion for increased rumination. It is possible that fluid flavor increased the reinforcing effects produced by rumination; however, the current data do not permit a strong interpretation of the mechanisms underlying the effects of flavor.

The results of Phase IV extend the literature on rumination and emesis in several ways. First, the combination of placement of a G/J tube and an NPO order represents a relatively extreme approach to the remediation of rumination and emesis, and one that has little precedent in the literature. Severio, Monagas, Noel & Hyman (2015) published a short case report that reported treating children with rumination with a G/J tube and NPO. Our data from the observations while Jack was NPO support Severio et al.’s (2015) data if the stomach is completely empty rumination and emesis will not occur. Although this effect was positive, the intervention is quite intrusive and results in the elimination of access to food and fluid reinforcement. Based on these considerations, this approach should be considered a temporary resolution, to be used only in extreme (i.e., life-threatening) situations.

Jack’s NPO status provided a unique opportunity to evaluate the effects of variables relating to the oral intake of fluids on his rumination and emesis. Because his NPO status eliminated rumination and emesis, and because he received no oral food or fluid from any other
source, it was possible to analyze and isolate the effects of several fluid-related variables. Very little rumination or emesis was observed when Jack was provided with plain water or with colored water. However, flavored water (and a single trial with juice) produced substantial increases in rumination and emesis, isolating flavor as an important variable in Jack’s behavior.

Similar analyses of the effects on rumination of variables such as nutritional qualities and food quantity have been conducted by Rast, Johnston, and colleagues (e.g., Rast et al. 1985; Rast et al., 1981). For example, Rast et al. (1985) found that the caloric value had an inverse relationship to rumination. The current study extends the findings of previous research on the factors contributing to rumination, showing that flavor appeared to affect Jack’s rumination, independent of caloric or nutritional content.

Some limitations to Phase IV are noted. First, some analyses did not utilize experimental designs that could have increased the confidence with which the findings can be interpreted. For example, the comparison of the effects of water vs. colored water could have been improved through the use of a multielement, rather than an AB design. Second, the current study did not include an analysis of the variables associated with rumination and emesis of food items. The results of the current study supports past findings on the differences between bland (e.g., water) and richly flavored foods/fluids (e.g., Propel®/juice) (Rast et al., 1985). Finally, Jack’s analyses ended before an effective course of behavioral treatment for Jack’s rumination could be evaluated. Jack’s physician determined that continued efforts to reintroduce oral feeding and drinking were no longer warranted and might be detrimental to his long-term health. Based on his recommendation, Jack’s participation in this project was terminated at the end of Phase IV.
GENERAL DISCUSSION

The overarching conclusion from the current study is that rumination and emesis are very complex and serious behavioral health concerns that require individualized and intensive approaches to treatment. The earliest behavioral interventions for rumination and emesis consisted largely of punishment (Sajwaj, Libet, & Agras, 1974; Foxx, Snyder, & Schroeder, 1979); however, an increased understanding of the medical and behavioral characteristics of these disorders is slowly resulting in an increase in treatments and interventions that use reinforcement-based or other non-aversive techniques. The current study complements and extends previous attempts to assess and manipulate variables associated with rumination and emesis as treatment. (e.g., Rast et al., 1981/1984/1985;

Although several interventions have been shown to decrease rumination and emesis, the results of the current study suggest that these treatments do not seem to be universally effective, and that programs of intervention must be tailored to individual cases. For example, in the current study several treatments and interventions were attempted with varying results. Prior to and during the current study, pacing and fluid restriction interventions (Barton & Barton, 1985) were implemented by facility staff; however, Jack continued to engage in the target behaviors. A differential reinforcement of the omission of behavior (DRO) procedure was also attempted prior to the study, which did not have an effect. Other interventions, including changing Jack’s food texture and providing peanut butter and chopped breads after meals (Barton & Barton, 1985; Greene et al., 1991; Thibadeau et al., 1999) also were unsuccessful. Although the current study indicated that access to popsicles decreased Jack’s rumination, we were unable to eliminate the behavior and emesis still occurred as well.
While attempts at using reinforcement based interventions and least restrictive procedures are desired (Luiselli, 2015), a more intrusive or aversive intervention may be required (Baker, Rapp, & Carroll, 2010). Jack’s specific circumstances might allow for some unique options to discourage rumination and emesis. Because Jack’s G/J tube permitted substances to be deposited directly into the stomach or the jejunostomy, thus bypassing oral food intake and eliminating taste for food being ingested, we could have attempted to include a foul-tasting substance into the contents of his nutritional supplement. Doing so would presumably not result in aversive stimulation during food intake but would produce an aversive taste if the food was brought into contact with taste buds in the mouth. Severio, Monagas, Noel, and Hyman (2015) reported successful implementation of a similar approach with two children who engaged in rumination and had G/J tubes; however, these researchers did not attempt to reintroduce oral feeding or drinking with their participants. Future research should further investigate of the effectiveness of placing an aversive stimulus into the G-tube while attempting to reintroduce oral feeding and drinking.

Some studies in the literature suggest that rumination and emesis can be operant in nature (Lyons et al., 2007; Wilder et al., 2009); however, it is possible that these behaviors are controlled (at least in part) by respondent mechanisms. For example, it is possible that physiological factors, such as ingestion of poison or decayed food, produce stimulation that “automatically” results in emesis, if some cases of rumination and emesis are “involuntary” in that sense, then interventions corresponding to operant accounts might not be expected to be effective. If, on the other hand, rumination and emesis can be determined to have operant properties, then it will be important to identify the specific form of reinforcement maintaining the behaviors. Hagopian, Rooker, & Zarcone (2015) suggest that there are three distinct sub-
types of automatically reinforced self-injurious behavior and that some sub-types may be more resistant to interventions than other sub types. It is unfortunate that Jack’s assessments ended prior to completing the analysis of the effects of fluid characteristics and initiating a food assessment. Jack’s medical team determined that the risk of allowing Jack to consume food and fluid orally was sufficient to preclude further analysis, resulting in continued reliance on a highly intrusive but effective intervention. Although the current project was terminated prior to the development of an effective course of behavioral treatment that might have permitted the reintroduction of oral feeding and drinking for Jack, the results of the project will hopefully be useful to inform future interventions for individuals who exhibit these troubling and potentially life-threatening behavioral disorders.
**Table 1 Anecdotal results for rumination**

<table>
<thead>
<tr>
<th>Anecdotal Assessments: Rumination</th>
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<tbody>
<tr>
<td><strong>MAS</strong></td>
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<tr>
<td>Rater 1</td>
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<td>Rater 2</td>
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<td>Rater 3</td>
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<td><strong>QABF</strong></td>
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<td><strong>FAST</strong></td>
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<td>Rater 3</td>
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Table 2 Average duration, duration range, average RPM, and RPM range of rumination during differing meals

<table>
<thead>
<tr>
<th>Meal (# of data sets)</th>
<th>Average Duration (m)</th>
<th>Duration Range</th>
<th>Average RPM</th>
<th>RPM Range</th>
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<tbody>
<tr>
<td>Breakfast (7)</td>
<td>24.1</td>
<td>3.7-57.7</td>
<td>0.91</td>
<td>0.17-1.16</td>
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<tr>
<td>Lunch (4)</td>
<td>22.0</td>
<td>6.0-45</td>
<td>0.59</td>
<td>0.20-1.16</td>
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<td>Dinner (5)</td>
<td>34.0</td>
<td>16.4-45</td>
<td>1.02</td>
<td>0.63-1.23</td>
</tr>
</tbody>
</table>
Figure 1. Average duration and rate of rumination per meal time.
Figure 2. Rate of rumination across alone, no interaction, regular programming, and clinic staff programming conditions
Figure 3. Average duration and rate of rumination per condition: alone, no interaction, and regular programming.
Figure 4. Average rate of rumination and frequency of emesis: alone, no interaction, and regular programming.
Figure 5. Five hour, 55 minute observation across shift change and meals.
Figure 6. Effect of fluid delivery on rate of rumination in no interaction condition.
Figure 7. Effect of fluid delivery on rumination during regular programming.
Figure 8. Effect of fluid delivery on rumination.
Figure 9. Data in which rumination was not affected by fluid delivery.
Figure 10. Representative example of two table-spoons of peanut butter post meal.
Figure 11. Average rate of rumination across shifts and dates of intensive intervention.
Figure 12. Frequency of emesis per day by shift.
Figure 13. Frequency of successful versus unsuccessful trials with the delay of access to food/fluid following emesis.
Figure 14. Duration (minutes) of popsicle consumption compared to duration of rumination.
Figure 15. Observation proceeding G/J Tube and NPO placement and rate of rumination and frequency of emesis.
Figure 16. Fluid Analysis: Juice probe and water versus colored water comparison.
Figure 17. Fluid Analysis: Rumination rate of water versus propel.
REFERENCES


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