Fall 12-15-2017

A Translational Evaluation of Renewal of Inappropriate Mealtime Behavior

Vivian Ibañez
University of Nebraska Medical Center

Cathleen C. Piazza
University of Nebraska Medical Center

Kathryn M. Peterson
University of Nebraska Medical Center

A TRANSLATIONAL EVALUATION OF RENEWAL OF INAPPROPRIATE MEALTIME BEHAVIOR

By

VIVIAN FERNANDA IBAÑEZ

A DISSERTATION

Presented to the Faculty of

the University of Nebraska Medical Center

in Partial Fulfillment of the Requirements

for the Degree of Doctor of Philosophy

Medical Sciences Interdepartmental Area Graduate Program

(Applied Behavior Analysis)

Under the Supervision of Professor Cathleen C. Piazza

University of Nebraska Medical Center

Omaha, Nebraska

December 2017

Supervisory Committee:

Kathryn M. Peterson, Ph.D. Wayne W. Fisher, Ph.D.

Brian D. Greer Ph.D.

ACKNOWLEDGEMENTS

My parents, Fernando and Amarilis, who left Guatemala in April of 1989 to give my siblings and I a better life. Each of our accomplishments is a reminder of their bravery, unconditional love, work ethic, and resilience. My papi taught me to speak up and seek opportunities with confidence and humility. My mami showed me how to take care of family with a heart of gold. I am forever grateful for their love and lessons.

My siblings, Jennifer, Emely, and Fernando, who are my best friends. Their advice, support, humor, and love formed our bond. Love truly knows no distance. My niece and nephew, Annelise and Lorenzo, who brought a new kind of love to my life. They continuously remind me of the importance of my work with children. My grandmother, Margarita Palacios, who was always a letter and phone call away.

Dr. Piazza, my mentor, who will forever hold a very dear place in my life. Her passion for the children and families we serve is remarkable. Her dedication and service to the field of applied behavior analysis has forever changed the lives of people all around the world, including mine. I am fortunate that she took me under her wing and shaped my behavior to grow as a scientist-practitioner. She expanded my ability to help children with feeding disorders and encouraged me to view everything as an opportunity.

Dr. Peterson, who supported me from the very beginning. Her guidance and motivation were essential to my life, professionally and personally.

My feeding family at the University of Nebraska Medical Center's Munroe-Meyer Institute's Pediatric Feeding Disorders Program, who assisted me with this study. I especially thank my fellow doctoral students who became some of my best friends and colleagues.

Thanks to all of the families who allowed me to work with their children and celebrate their feeding milestones.

Finally, my husband, Faris, who pursued new opportunities with me. His encouragement since our early graduate school days helped me exceed my own expectations. Without his patience, perspective, and love, my graduate career, and more importantly, my life, would not be the same.

A TRANSLATIONAL EVALUATION OF RENEWAL OF INAPPROPRIATE MEALTIME BEHAVIOR

Vivian F. Ibañez, Ph.D.

University of Nebraska Medical Center, 2017

Supervisor: Cathleen C. Piazza, Ph.D.

The term *renewal* describes the recurrence of previously extinguished behavior that occurs when the intervention context changes. Renewal has important clinical relevance as a paradigm for studying treatment relapse because context changes are necessary for generalization and maintenance of most intervention outcomes (Podlesnik, Kelley, Jimenez-Gomez, & Bouton, 2017). The effect of context changes are particularly important during intervention for children with feeding disorders because children eat in a variety of contexts, and extinction is an empirically supported and often necessary intervention. Therefore, we used an ABA arrangement to test for renewal during intervention with 3 children diagnosed with a feeding disorder. The A phase was functional reinforcement of inappropriate mealtime behavior in a simulated home setting with the child's caregiver as feeder; B was function-based extinction in a standard clinic setting with a therapist as feeder; and the return to the A phase was function-based extinction in a simulated home setting with caregiver as feeder. Returning to Context A resulted in renewal of inappropriate mealtime behavior across children, despite the caregivers' continued implementation of function-based extinction with high levels of integrity.

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The Renewal Effect

Researchers have identified context as one factor that may influence generalization and long-term maintenance of intervention outcomes (e.g., Kelley, Liddon, Ribeiro, Grief, & Podlesnik, 2015; Stokes & Baer, 1977). Researchers describe context as the exteroceptive stimuli associated with learning such as an experimental chamber, a color, or an odor (e.g., Kincaid, Lattal, & Spence 2015), and contextual control as the condition under which learning occurs (Podlesnik, Kelley, Jimenez-Gomez, & Bouton, 2017). For example, Bouton and Bolles (1979) trained rats in Context A and extinguished responding in Context B and associated each context with different exteroceptive stimuli. When Bouton and Bolles returned the rats to Context A and continued extinction trials, the trained response returned, which Bouton and Bolles referred to as the *renewal effect*.

Results of Bouton and Bolles (1979) suggested that learning was specific to the context in which it occurred, and numerous researchers have demonstrated renewal of extinguished behavior in respondent- (e.g., Bouton & King, 1983; Bouton & Peck, 1989; Bouton & Swartzentruber, 1989; Gunther, Denniston, & Miller, 1998; Nakajima, Tanaka, Urshihara, & Imada, 2000; Rauhut, Thomas, & Ayres, 2001) and operant- (Trask, Schepers, & Bouton, 2015) conditioning arrangements. In fact, Bouton, Todd, Vubric, and Winterbauer (2011) suggested that operant extinction is relatively specific to the context in which the organism learns that the response no longer produces reinforcement.

Clinical Implications of the Renewal Effect

Renewal has important clinical relevance as a paradigm for studying treatment relapse. Relapse, when previously extinguished undesirable behavior returns (Mace & Critchfield, 2010), is a common problem among individuals with behavioral health disorders that negatively impacts the long-term effectiveness of intervention. Results of renewal studies suggest that extinguished behavior will return or relapse in the absence of a change in implemented contingencies simply

by changing the context in which extinction occurs. Researchers have used a three-phase arrangement (ABA, ABC, or AAC) to study renewal, in which a reinforcement phase in Context A is followed by two phases of extinction in either Contexts B and A in ABA renewal, in Contexts B and C in ABC renewal, or in Contexts A and C in AAC renewal. The focus of these arrangements is the pattern of responding associated with the context changes. For example, Kelley, Liddon, Ribeiro, Greif, and Podlesnik (2015) conducted a translational study in which researchers provided reinforcement to participants for task completion in Context A, extinguished task completion in Context B, and continued extinction in Context A. Although task completion decreased to zero during extinction in Context B, responding increased during extinction in the return to Context A. Researchers also have demonstrated renewal with ABC and AAC arrangements, but the ABA arrangement produces the most robust demonstrations of renewal (Podlesnik, Kelley, Jimenez-Gomez, & Bouton, 2017).

The Renewal Effect and Pediatric Feeding Disorders

Despite the clinical relevance of renewal to behavioral health disorders, there are no studies, to our knowledge, that have evaluated operant renewal with a socially significant problem. Although there are many behavioral health disorders that likely would benefit from an evaluation of operant renewal, pediatric feeding disorders is an excellent subject for a variety of reasons. Basic studies show that context changes during extinction reliably produce renewal. Clinical studies on pediatric feeding disorders show that extinction is an empirically supported and often necessary intervention component (Ahearn, 2002; Ahearn, Kerwin, Eicher, Shantz, & Swearingin, 1996; Borrero, Schlereth, Rubio, & Taylor, 2013; Cooper et al., 1995; Hoch, Babbitt, Coe, Krell, & Hackbert, 1994; Kerwin, 1999; LaRue et al., 2011; Patel, Piazza, Martinez, Volkert, & Santana, 2002; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004; Volkert & Piazza, 2012). In addition, researchers have conducted most feeding intervention studies in clinic settings with highly trained therapists (e.g., Ahearn, Kerwin, Eicher, &

Swearingin, 1996; Babbitt, Hoch, & Coe, 1994, Gulotta, Piazza, Patel, & Layer, 2005; Kadey, Piazza, Rivas, & Zeleny, 2013; Patel, Piazza, Layer, Coleman, & Swartzwelder, 2005; Volkert, Vaz, Piazza, Frese, & Barnett, 2011; Piazza, Fisher, et al., 2003; Wilkins, Piazza, Groff, & Vaz, 2011). Therapists then train caregivers who subsequently implement intervention. Even if the caregiver serves as the initial change agent (Seiverling, Williams, Sturmey, & Hart, 2012; Tarbox, Schiff, & Najdowski, 2010), children feed in many contexts, and teachers, relatives, or day-care providers also may implement intervention. Although these factors suggest that we should expect renewal to occur, there have been no studies that have evaluated renewal systematically during intervention for pediatric feeding disorders.

Our interest was to test for renewal in the context of our typical clinical model. In that model, a trained therapist implements intervention in the clinic; we train the caregiver to implement intervention in the clinic and in the home. Postdischarge, the caregiver continues intervention in the home. To that end, we tested for ABA renewal in the current study in which A was functional reinforcement of inappropriate mealtime behavior in a simulated home setting with the child's caregiver as the feeder; B was function-based extinction of inappropriate mealtime behavior in a standard clinic setting with a clinic therapist as feeder, and a return to A was function-based extinction in the simulated home setting with the child's caregiver as the feeder.

Method

Participants

Carlos was a 3-year-old boy whose diagnoses included autism spectrum disorder, apraxia, global developmental delays, and food selectivity. At the time of admission, Carlos reportedly received 100%, 209%, and 46% of his daily calories, protein, and fluids, respectively, via 8-oz sippy-cup feedings of Pediasure with Fiber at 7:30 a.m., 12:00 p.m., and 5:30 p.m. and McDonalds chicken nuggets, graham crackers, Kellogg's Eggo Bites Chocolatey Chip Pancakes,

and Idahoan Four Cheese mashed potatoes. Our program's registered dietician estimated that Carlos' intake of nutrients was adequate only due to his consumption of Pediasure with Fiber. Carlos' caregiver was the referral source. Fernando was a 3-year-old boy whose diagnoses included bottle dependence; food refusal; allergies to soy, dairy, and gluten; colitis; chronic diarrhea; speech delays; and a history of pneumonia. At the time of admission, Fernando reportedly received 78%, 146%, and 66% of his daily calories, protein, and fluids, respectively, via 8-oz sippy-cup feedings of Elecare Jr. mixed with almond milk at 8:00 a.m., 12:00 p.m., 6:00 p.m., and 7:00 p.m. and small amounts of crackers, fruit snacks, and applesauce. Our program's registered dietician estimated that Fernando's mean intake was low in vitamins D and K, pantothenic acid, phosphorous, and potassium. Fernando's pediatrician referred him for bottle dependence and food refusal. Pierre was a 4-year-old boy whose diagnoses included gastrostomy-tube dependence; gastroesophageal reflux disease and a history of vomiting, which resulted in a Nissen Fundoplication; tetralogy of fallot; and pulmonary atresia. At the time of admission, Pierre reportedly received 71%, 137%, and 102% of his daily calories, protein, and fluids, respectively, via 3.5-oz gastrostomy-tube feedings of a caregiver-prepared blended-food diet every 30 min from 7:30 a.m. to 9:00 p.m. delivered via gravity at 100 mL per hour. Our program's registered dietician estimated that Pierre's mean intake met 100% of his nutritional needs only due to gastrostomy-tube feedings of a blended-food diet and that his growth was inadequate. Pierre's pediatrician referred him for gastrostomy-tube dependence. Lorenzo was a 2-year-old boy whose diagnoses included gastrostomy-tube dependence, vomiting, failure to thrive, gastroesophageal reflux disease, hypercalcemia, developmental delays, and a history of prematurity. At the time of admission, Lorenzo reportedly received 100%, 148%, and 54% of his daily calories, protein, and fluids, respectively, via 5-oz gastrostomy-tube feedings of Pediasure 1.5 (8:00 a.m., 12:00 p.m., 4:00 p.m., and 8:00 p.m.) delivered via pump at 200 mL per hour. Our program's registered dietician estimated that Lorenzo's intake of nutrients was adequate only due to his consumption of Pediasure 1.5. Lorenzo's pediatrician referred him for gastrostomy-tube dependence.

Before the current study, each child participated in an interdisciplinary evaluation conducted by a dietitian, a pediatric gastroenterologist, master's and bachelor's level feeders with specialized training in behavior analysis, a psychologist, and a speech and language pathologist to confirm the safety of oral feeding, followed by an admission to an intensive day-treatment feeding program that they attended Monday through Friday from about 9:00 am to about 5:00 pm. A speech and language pathologist was available for consultation during each child's admission.

Feeders

Clinic therapists conducted sessions during the functional analysis and during the B phase of the renewal analysis in the solids and liquids standard clinic settings. Caregivers who conducted sessions in the A phases of the analysis were the participants' biological mothers. Caregivers observed the trained therapist conduct most sessions of the functional analysis and function-based extinction intervention. A therapist used verbal instruction and role play to train the caregiver to implement the function-based baseline and function-based extinction intervention before each phase of baseline and extinction, respectively. In addition, the caregiver wore a Bluetooth headset through which the therapist provided coaching throughout the function-based baseline and function-based extinction intervention. We provided ongoing coaching to ensure that the caregiver implemented the procedure with high integrity to minimize the possibility that changes in rates of responding during the renewal test were affected by lapses in treatment integrity (St. Peter Pipkin, Vollmer, & Sloman, 2010).

Settings and Materials

We conducted sessions in three settings in a pediatric feeding disorders clinic and in a university-based autism center. Settings contained utensils, food trays, a scale, and timers. The *solids and liquids standard clinic settings* were 4-m x 4-m therapy rooms in the pediatric feeding disorders clinic. These rooms contained one-way observation, a rectangular table, a sanitizer dispenser on the wall, and a chair. The *solids simulated home* setting was in a semiprivate area of

a university-based early intervention clinic. This room contained a square table with a red table cloth, a table lamp, a compact refrigerator, a coffee maker, a small pantry shelf containing a variety of foods (e.g., chips, applesauce), a variety of home decorations (e.g., a framed photo of a family, a bowl of plastic fruit, a painting hung on the wall, artificial flowers in a vase), striped curtains that covered two freestanding room partitions, and a chair. The *liquids simulated home setting* was in a kitchen of a university-based recreational therapy program. This room contained a large table with chairs, materials in a typical kitchen (e.g., full-size refrigerator, toaster, stove, blender, stand mixer, a counter with snacks, pots, pans), and a chair. Carlos sat in a Special Tomato Soft-Touch sitter that we secured to a regular chair. Fernando and Lorenzo sat in a high chair. Pierre sat in a booster seat.

We asked the caregiver to select eight target foods from a list provided by the first author that the child did not eat currently, but that the caregiver wanted the child to eat. Generally, we targeted two foods from each of the food groups of fruits, proteins, starches, and vegetables or foods from the food group(s) for which the child's diet was deficient based on recommendations from our program's dietitian. We also incorporated dietary recommendations from other professionals such as the child's physician when appropriate. The feeder presented the foods at a pureed texture, which is table food blended in a chopper until smooth with liquid added as needed. The bolus size was a level small maroon spoon for all children. The caregiver also selected a liquid such as Pediasure or milk that the child did not currently consume orally, and our program's dietitian ensured that the liquid was calorically and nutritionally appropriate for the child. The feeder presented liquids in a pink cut-out cup. The bolus size was 2 cc.

Dependent Variables, Reliability, and Procedural Integrity

Trained observers sat in a room with one-way observation adjacent to the therapy room during standard clinic-setting sessions and in an unoccupied therapy room or a private office in the clinic during simulated home-setting sessions. Observers used Vidyo, a HIPPA-compliant

telehealth video conferencing platform, to watch simulated home-setting sessions on Ipads, one of which was in the simulated home setting and one of which was in the room with the observer. Observers used laptop computers to collect data using the DataPal 1.0 program.

Observers scored *inappropriate mealtime behavior* when the utensil was in arm's reach of the child and the child turned his head 45° or greater away from the utensil during a bite or drink presentation; used his hand to contact the utensil, food or drink, or the feeder's hand or arm anywhere from the elbow down while the feeder was presenting the bite or drink; threw food, liquids, or utensils; or blocked his mouth with his hand, bib, or toys. Observers scored *acceptance* when the child opened his mouth in the absence of inappropriate mealtime behavior or leaned forward and opened his mouth while engaging in negative vocalizations such that the feeder deposited the entire bite except for food or drink pea size or smaller within 5 s of presentation. A presentation occurred when the feeder touched the child's lips at midline with the utensil.

Observers recorded whether acceptance occurred during each bite presentation and frequency of inappropriate mealtime behavior. We converted acceptance to a percentage after dividing the number of acceptances by the number of bite or drink presentations. We converted the frequency inappropriate mealtime behavior to responses per minute by dividing the number of inappropriate mealtime behaviors during the session by the duration the utensil or bite was in arm's reach.

At least one observer scored feeder procedural integrity for correct context, correct utensil presentation, incorrect praise, and incorrect attention during 87% of sessions. Observers wrote a yes or a no on an excel spreadsheet to indicate whether the feeder conducted the session in the correct context, as described above. We converted correct context to a percentage by dividing the instances of correct context by the total number of sessions. Mean correct context was 100% across participants.

Observers scored correct utensil presentation when the feeder (a) presented the utensil to the child's lips; (b) removed the utensil after the bite entered the child's mouth; and (c) presented the next bite or drink approximately 30 s after the previous bite entered the child's mouth, except as indicated below. Observers scored correct utensil presentation during function-based extinction when the feeder (a) held the utensil touching the child's lips until the child opened his or her mouth and allowed the feeder to deposit the bite or drink; (b) left the utensil touching the child's lips if the bite of food or drink did not remain on the utensil and the feeder needed to obtain another bite or drink; (c) deposited the bite or drink when the child opened his or her mouth; (d) held the utensil to the side of the child's lips if the child vomited, coughed, or gagged while the feeder was holding the utensil at the child's lips; € scooped up expelled food or liquid within 3 s of expulsion (any food or liquid larger than a pea past the plane of the lips after the feeder deposited the bite or drink) and placed the utensil with the bite back to the child's lips. Observers also scored correct utensil presentation during function-based extinction if the child was engaging in expulsion when it was time for the feeder to present the next bite or drink and the feeder presented the next bite or drink when the expelled food or liquid remained in the child's mouth for 3 s. Mean correct utensil presentation was 98% (range, 97% to 100%) and 94% (range, 93% to 100%) across therapists and across caregivers, respectively.

Observers scored the occurrence of incorrect attention during function-based extinction each time the feeder provided attention (e.g., reprimands, coaxes) immediately after inappropriate mealtime behavior. We divided the occurrences of incorrect attention by the number of inappropriate mealtime behaviors and converted the ratio to a percentage. Mean incorrect attention was 0% and 3% (range, 0% to 5%) across therapists and caregivers, respectively.

Observers scored incorrect praise if the feeder did not provide behavior-specific praise within 5 s of acceptance and mouth clean, provided praise when bites or drinks entered the mouth after 5 s, or when there was food or liquid larger than the size of a pea in the mouth at the mouth

check. We converted incorrect praise to a percentage after dividing the instances of incorrect praise by the total opportunities to provide correct and incorrect praise. Feeders provided incorrect praise during a mean of 0% and 4% of opportunities (range, 0% to 6%) across therapists and across caregivers, respectively.

A second observer simultaneously, but independently scored a mean of 87% of sessions. We trained observers before the study to collect data with greater than 85% interobserver agreement for three consecutive sessions.

The DataPal Reli 1.0 software calculated interobserver agreement by partitioning each session into 10-s intervals. DataPal calculated total agreement coefficients for acceptance, correct utensil presentation, incorrect attention, and incorrect praise by dividing the number of agreements, both observers scored or both observers did not score an occurrence of the behavior in the interval, by the total number of agreements plus disagreements, one observer scored and one observer did not score the occurrence of the behavior in the interval, and converting this ratio to a percentage. Mean interobserver agreement across participants was 98% (range, 93% to 100%) for acceptance, 95% (range, 92% to 98%) for correct utensil placement, 97% (range, 95% to 98%) for incorrect attention, 98% (range, 96% to 99%) for incorrect praise. We calculated interobserver agreement for correct context by dividing the smaller number by the larger number and converting the ratio to a percentage. Mean interobserver agreement across participants was 100% for correct context. DataPal calculated exact agreement coefficients for inappropriate mealtime behavior by dividing the number of exact agreements, observers scored the same frequency of the behavior in the interval, by the number of exact agreements plus disagreements, observers scored a different frequency of the behavior in the interval, and converting this ratio to a percentage. Mean interobserver agreement across participants was 93% (range, 92% to 96%) for inappropriate mealtime behavior.

Experimental Design and Procedure

Functional analysis. We used a pairwise design (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994) in the functional analysis to compare levels of inappropriate mealtime behavior in the test (escape, attention, tangible) versus the control conditions.

Renewal analysis. We used a three-phase arrangement (i.e., ABA) embedded in a nonconcurrent multiple baseline design across participants during solids or liquids meals. During Context A, the child's caregiver delivered functional reinforcement contingent on inappropriate mealtime behavior in a simulated home setting. During Context B, the clinic therapist conducted function-based extinction in a standard clinic room. During a return to Context A, the child's caregiver conducted function-based extinction in the simulated home setting.

General Procedure

Each child followed an individualized schedule of five 40-min meals a day with at least 40 min between the end of one meal and the beginning of the next. The feeder presented solids in some meals and liquids in other meals, but did not present solids and liquids together in the same meal. The feeder conducted multiple four-bite or four-drink sessions in each meal. The number of sessions per meal depended on the duration of each meal and each session within the meal (i.e., the duration of a single session depended on the child's behavior). There were approximate 1-min breaks between sessions, during which feeders and observers prepared for the next session (e.g., recorded gram consumption, set up data-collection computer program).

Before each meal with solid food, the feeder randomly selected one food from each of the food groups of fruit, protein, starch, and vegetable to present during the sessions. The feeder randomly selected the order in which to present the four foods before each session. The feeder used the same foods and presented them in the same order when he or she alternated between conditions (e.g., pairwise functional analysis). The feeder presented every caregiver-selected food in each phase and in every condition to control for potential differences in the child's behavior as a function of food type (Patel, Piazza, Santana, & Volkert, 2002).

The feeder presented the bite or drink by touching the child's lips with the utensil and saying, "Take a bite (drink)." The feeder presented a bite or drink approximately 30 s after he or she had presented or deposited the previous bite or drink, depending on the child's behavior. The feeder provide praise for acceptance and activated a timer for 30 s. The feeder conducted a mouth check when 30 s elapsed by saying, "Show me, Ahh" while modeling an open mouth. The feeder inserted a rubber-coated baby spoon between the child's lips and turned it 90° if the child did not open his mouth within 3 s of the verbal and model prompt. The feeder provided praise (e.g., "Great job swallowing your bite!") for mouth clean, defined as no food or liquid in the mouth larger than the size of a pea. The feeder delivered a verbal prompt to "Swallow your bite (drink)" if any food or liquid larger than the size of a pea was in the child's mouth at the 30-s check. The feeder conducted a mouth check every 30 s until no food or liquid larger than the size of a pea was in the mouth or until 10 min elapsed from the start of the session if the child had food or liquid larger than the size of a pea in the mouth during the mouth check for the fourth bite or drink, but observers did not score mouth clean or pack for these subsequent mouth checks. The feeder provided no differential consequence for coughing, gagging, or vomiting.

Functional Analysis

We conducted a functional analysis of inappropriate mealtime behavior based on the procedure described by Bachmeyer et al. (2009) in which we compared control to test conditions. We asked each caregiver to feed her child as she would at home before we conducted the functional analysis, and we used our direct observations of caregiver-fed meals and caregiver report to inform the conditions of each child's functional analysis. For example, we conducted escape, attention, and tangible conditions if we observed that the caregiver delivered escape, attention, and a tangible after inappropriate mealtime behavior, but only escape and attention conditions if we observed the caregiver deliver escape and attention, but not a tangible. We conducted escape and attention functional analysis test conditions with all children. We also

conducted a tangible condition for Lorenzo based on observations of the caregiver-fed meal. We conducted a functional analysis of inappropriate mealtime behavior during solids for Carlos, Pierre, and Lorenzo and liquids for Carlos, Fernando, and Lorenzo. The feeder followed the general procedure described above in addition to the specific procedure described below. Across conditions, the utensil remained in its original presentation position in space for 30 s if the child did not accept the bite or drink and did not engage in inappropriate mealtime behavior.

Control. The feeder presented preferred stimuli based on the results of a paired-stimulus preference assessment (Fisher et al., 1992) on the tray or table at the beginning of the session and interacted (e.g., conversation, singing) with the child throughout the session with a relatively constant level of enthusiasm with respect to his or her facial expression and vocal quality. The purpose of this condition was to assess the frequency of inappropriate mealtime behavior when the child had free access to attention and preferred items, and the feeder provided no differential consequence for inappropriate mealtime behavior.

Escape. The feeder removed the utensil for 30 s if the child engaged in inappropriate mealtime behavior and presented the next bite or drink after the 30-s escape interval. The purpose of this condition was to assess the sensitivity of inappropriate mealtime behavior to negative reinforcement in the form of escape from bite or drink presentations.

Attention. The feeder delivered 30 s of the same quality and type of attention the caregiver delivered during caregiver-fed meals (e.g., coaxing, reprimands statements of concern) and presented the next bite or drink after the 30-s attention interval. The purpose of this condition was to assess the sensitivity of inappropriate mealtime behavior to positive reinforcement in the form of attention.

Tangible. The feeder delivered 30 s of tangible access if Lorenzo engaged in inappropriate mealtime behavior and presented the next bite or drink after the 30-s tangible-

access interval. The purpose of this condition was to assess the sensitivity of inappropriate mealtime behavior to positive reinforcement in the form of tangible access.

Renewal Evaluation

The feeder followed the general procedure described above in addition to the specific procedure described below. Only the child and feeder were in the room during sessions in each context.

Context A reinforcement. Caregivers served as feeders in the solids sessions with Carlos, Pierre, and Lorenzo in the solids simulated home setting and the liquids sessions with Carlos, Fernando, and Lorenzo in the liquids simulated home setting described above. The feeder followed the general procedure and delivered functional reinforcement for 30 s if the child engaged in inappropriate mealtime behavior in a manner like that described for the functional analysis. Functional reinforcement was escape for Lorenzo liquids; escape and attention for Carlos, Fernando, and Pierre; and escape, attention, and tangible for Lorenzo solids. Before the caregiver and child transitioned to the simulated home setting, therapists prepared the materials for the meal (e.g., food) and placed them in the room. Next, a therapist placed the Bluetooth equipment and Ipad in the room, opened the virtual room in the telehealth software, and tested the Bluetooth and telehealth equipment. Caregivers transitioned the child to the room in the absence of the therapist so that the therapist would not be associated with the simulated home context.

Context B extinction. Clinic therapists conducted sessions in the standard clinic setting described above. The feeder conducted the general procedure and escape extinction for Lorenzo liquids; escape and attention extinction for Carlos, Fernando, and Pierre; and escape, attention, and tangible extinction for Lorenzo solids based on the results of the child's functional analysis. During escape extinction, the feeder kept the utensil touching the child's lips until the child opened his mouth and allowed the feeder to deposit the bite or drink inside the mouth or until 10 min from the start of the session elapsed. The feeder gently scraped the bite on the child's teeth

with the spoon if the child failed to close his mouth around the spoon when the feeder placed the spoon into the mouth. The feeder used the utensil to re-present expelled food or liquid, defined as any food or drink larger than the size of a pea that exited the child's mouth past the plane of the lips after entering the child's mouth, by scooping up the food or liquid as quickly as possible and placing it back in the mouth. If the child was expelling at the presentation interval for the next bite or drink, the feeder re-presented while prompting the child to, "Swallow your bite (drink)" approximately every 30 s until the bite or drink remained in the mouth for at least 3 s or the time-cap elapsed. The feeder kept the utensil touching the child's cheek and did not deposit the bite or drink if the child was coughing, gagging, or vomiting during the presentation until the child stopped coughing, gagging, or vomiting. Attention and tangible extinction consisted of the feeder no longer delivering attention or the tangible item when the child engaged in inappropriate mealtime behavior. The caregiver was not present in the session room, but had the opportunity to watch sessions in the adjacent observation room.

Context A extinction. The therapist prepared and the caregiver transitioned the child to the room as described for the initial A phase. Caregivers conducted function-based extinction as described for Context B, but conducted sessions in the solids and liquids simulated home settings.

Results

Figure 1 displays inappropriate mealtime behavior per minute for Carlos solids (top), Carlos liquids (middle), and Fernando liquids (bottom). Mean inappropriate mealtime behavior per minute was 101 (range, 80 to 123), 95 (range, 44 to 142), and 14 (range, 0 to 42) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based reinforcement with the caregiver feeding in Context A. Mean inappropriate mealtime behavior per minute was 32 (range, 0 to 133), 5 (range, 0 to 29), and 5 (range, 0 to 24) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based extinction with the therapist feeding in Context B. Mean inappropriate mealtime behavior per minute was 5 (range, 0 to 37), 4 (range, 0

to 33), and 20 (range, 0 to 63) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based extinction with the caregiver feeding in a return to Context A.

Figure 2 displays percentage of acceptance for Carlos solids (top), Carlos liquids (middle), and Fernando liquids (bottom). Mean percentage of acceptance was 0%, 0%, and 50% (range, 0% to 100%) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based reinforcement with the caregiver feeding in Context A. Mean percentage of acceptance was 54% (range, 0% to 100%), 75% (range, 0% to 100%), and 90% (range, 50% to 100%) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based extinction with the therapist feeding in Context B. Mean percentage of acceptance was 88% (range, 25% to 100%), 82% (range, 25% to 100%), and 22% (range, 0% to 100%) for Carlos solids, Carlos liquids, and Fernando liquids, respectively, during function-based extinction with the caregiver feeding in a return to Context A.

Figure 3 displays inappropriate mealtime behavior per minute for Pierre solids (top), Lorenzo liquids (middle), and Lorenzo solids (bottom). Mean inappropriate mealtime behavior per minute was 29 (range, 14 to 50), 18 (range, 3 to 36), and 43 (range, 6 to 57) for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during function-based reinforcement with the caregiver feeding in Context A. Mean inappropriate mealtime behavior per minute was 3 (range, 0 to 23), 4 (range, 0 to 15), and 6 (range, 0 to 30) for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during function-based extinction with the therapist feeding in Context B. Mean inappropriate mealtime behavior per minute was 9 (range, 0 to 31), 5 (range, 0 to 48), and 18 (range, 6 to 42) for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during function-based extinction with the caregiver feeding in a return to Context A.

Figure 4 displays percentage of acceptance for Pierre solids (top), Lorenzo liquids (middle), and Lorenzo solids (bottom). Mean percentage of acceptance was 1% (range, 0% to 25%), 0%, and 0% for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during

function-based reinforcement with the caregiver feeding in Context A. Mean percentage of acceptance was 89% (range, 0% to 100%), 50% (range, 0% to 100%), and 47% (range, 0% to 100%) for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during function-based extinction with the therapist feeding in Context B. Mean percentage of acceptance was 75% (range, 25% to 100%), 53% (range, 0% to 100%), and 19% (range, 0% to 50%) for Pierre solids, Lorenzo liquids, and Lorenzo solids, respectively, during function-based extinction with the caregiver feeding in a return to Context A.

Proportion of Baseline Analysis

Figure 5 displays individual data during extinction and renewal test sessions as proportion of baseline response rates for Carlos solids (top left), Pierre solids (top right), Carlos liquids (middle left), Lorenzo liquids (middle right), Fernando liquids (bottom left), and Lorenzo solids (bottom right). We calculated proportion of baseline to allow researchers to make relative comparisons across studies that may not be possible with absolute measures such as the response rate we used in the current study.

First, we calculated the proportion of baseline rates during extinction with the following formula. We calculated the mean of inappropriate mealtime behavior during function-based reinforcement in Context A. We used that value as the denominator with which we divided the rate of inappropriate mealtime behavior in the last session of function-based extinction in Context B. This value represents inappropriate mealtime behavior during function-based extinction in Context B relative to inappropriate mealtime behavior during function-based reinforcement in Context A.

Next, we calculated the proportion of baseline rates during the renewal test with the following formula. We divided the first 21 sessions of function-based extinction in Context A by the mean of inappropriate mealtime behavior during function-based reinforcement in Context A.

We used 21 to equate the number of function-based extinction sessions in Context A across participants because that was the fewest number of those sessions for any participant. These values represent the rate of inappropriate mealtime behavior during function-based extinction in Context A relative to the rate of inappropriate mealtime behavior in function-based reinforcement in Context A.

Carlos solids and liquids, Fernando liquids, and Lorenzo liquids showed the highest proportion of baseline response rates during the renewal test within the first five sessions. Of these children, the proportion of baseline response rates eventually decreased to zero only for Carlos solids, but not for his liquids or for Fernando liquids. Alternatively, Pierre solids and Lorenzo solids showed the highest proportion of baseline response rates during the renewal test within the last five sessions. Across all children, the range of the proportion of baseline response rates was between 0 and 4.6.

Discussion

Clinicians have long recognized the renewal phenomenon in daily practice, often referred to as treatment relapse. In fact, researchers have reported relapse rates as high as 80% for some behavioral health disorders (Sahakin, 1983). Thus, renewal or treatment relapse is a common barrier to long-term maintenance of intervention across time, places, and individuals. Results of basic and translational research suggest that operant renewal is a robust phenomenon when context changes occur during implementation of extinction. These context changes parallel what may occur in clinical settings when professionals attempt to transfer an intervention from one setting, such as a clinic, to another setting, such as the home. Thus, renewal serves as a paradigm for studying treatment relapse (e.g., Bouton, Todd, Vurbic, & Winterbauer, 2011; Bouton, Todd, & Leon, 2014; Kelley, Liddon, Ribeiro, Greif, & Podlesnik, 2015; Podlesnik, Kelley, Jimene-Gomez, & Bouton, 2017).

The current results replicate the findings of previous operant renewal studies (e.g., Bouton, Todd, Vurbic, & Winterbauer, 2011; Kelley, Liddon, Ribeiro, Greif, & Podlesnik, 2015) and extend those results to a problem of social significance, pediatric feeding disorders. Our interest was to evaluate renewal in the context of our typical clinical model, which other researchers also use, to assess intervention effectiveness for children with feeding disorders. That is, most pediatric feeding disorders studies use trained therapists as the initial change agent and train caregivers after demonstrating that the intervention decreases inappropriate mealtime behavior and increases acceptance.

Results of our direct observations of caregiver-fed meals were consistent with those of descriptive studies (Borrero et al., 2010; Piazza, Fisher, et al., 2003) and showed that caregivers delivered putative reinforcement for inappropriate mealtime behavior such as escape from bites or drinks, attention, and tangible items. We conducted functional analyses to test whether these consequences functioned as reinforcement for inappropriate mealtime behavior. The results of the functional analyses informed our renewal evaluation. In the A phase of the renewal evaluation, caregivers delivered functional reinforcement for inappropriate mealtime behavior in a simulated home setting. We used a simulated rather than the actual home because families lived more than 50 miles from our clinic, so long-term in-home assessment and intervention was not practical. The B phase replicated our standard intervention practice in which clinic therapists implemented function-based extinction of inappropriate mealtime behavior in a standard clinic setting, which decreased inappropriate mealtime behavior and increased acceptance. Our renewal test simulated the goal of any pediatric feeding disorders intervention. That is, caregivers in the current study continued extinction in the original simulated home setting associated with reinforcement for inappropriate mealtime behavior in the final renewal-test phase. We observed a recurrence of previously extinguished inappropriate mealtime behavior and a decrease in previously high and stable levels of acceptance after a context change in which caregivers continued extinction in the

simulated home setting. Therapists and caregivers implemented extinction with high levels of integrity; thus, renewal occurred when the context changed in the absence of a contingency change.

Rosas, Todd, and Bouton (2013) suggested that context affects renewal, in part, because context provides information about the arranged contingencies. Podlesnik et al. (2017) noted that context typically refers to global features of the environment such as visual, olfactory, and tactile stimuli. In the current study, we defined context based on the feeder and the location and content of the room in which feeding occurred. We established the caregiver and the simulated home setting as a signal for reinforcement of inappropriate mealtime behavior in the A phase. By contrast, we established the therapists and the standard clinic setting as a signal for extinction in the B phase. The occurrence of renewal when we returned the child to the simulated home setting with the caregiver feeding should not be that surprising when we consider responding from the standpoint of discriminative control. The information that the renewal context had provided the child up to that point was that reinforcement was available for inappropriate mealtime behavior when the caregiver fed the child in the simulated home setting.

Another factor that may have affected renewal in the current study is the length of the acquisition period (Todd, Winterbauer, & Bouton, 2012). Todd, Winterbauer, and Bouton (2012) showed that longer acquisition periods were associated with more renewal. They trained rats for 12 and 4 days, respectively. Renewal occurred for the rats in the 12- and 4-day training groups, but the rate of responding was approximately double for the rats in the 12- relative to the 4-day training group. In the current study, caregivers conducted 24 to 156 bite or drink presentations during the A (acquisition) phase. Unlike the rats in Todd et al. who had no additional history with the experimental manipulation, however, children in the current study had received reinforcement for inappropriate mealtime behavior from their caregivers for at least 2 years before the study began, which may have affected the magnitude of observed renewal. Because we could not

control the child's history of reinforcement given that caregivers had already delivered reinforcement for inappropriate mealtime behavior before the study began, conclusions about the effect of the acquisition period on magnitude of responding in the current study are speculative.

We examined the patterns of responding during the renewal test to evaluate how those in the current study compared to those of other studies. Results for the renewal test for Carlos' solids and liquids and Lorenzo's liquids were like those of Kelley et al. (2015) in which previously extinguished behavior returned immediately and temporarily. By contrast, renewal occurred in the fourth session of the renewal test for Fernando's liquids. Recall that we conducted multiple sessions in each 40-min meal. Thus, even though renewal did not occur in the first session, it did occur in the first meal of the renewal test. Unlike other participants, inappropriate mealtime behavior persisted for Pierre and Lorenzo's solids and Fernando's liquids across the 62, 21, and 24 sessions of the renewal test, respectively. We could not find basic studies that demonstrated comparable persistence, and we do not know if inappropriate mealtime behavior would have decreased had we continued function-based extinction. This could be a topic for future investigations.

Proportion of baseline calculations provide information about the extent to which responding recovers relative to baseline during the renewal test. Responding during the renewal test in the current study recovered up to 463% of baseline rates. To our knowledge, this is the first demonstration of operant renewal for a socially significant problem, pediatric feeding disorders. Thus, we do not know how our proportion of baseline data from the operant renewal test compare with proportion of baseline data from renewal tests with other problems of social significance. Bouton (2002) suggests that the magnitude of respondent renewal in clinical studies does not appear to be as large as that reported in basic animal studies, perhaps because these studies typically assess respondent renewal in an ABC paradigm, which does not produce as robust

renewal as an ABA paradigm. It is not clear, however, whether magnitudes for clinical operant renewal are like those of clinical respondent renewal.

What is clear is that children feed many times a day in a variety of environments. Thus, context changes for children with feeding disorders are inevitable. In addition, results of intervention-outcome studies suggest that extinction is an empirically supported and often necessary intervention for pediatric feeding disorders. Taken together, results of current and previous studies suggest that we should anticipate renewal during intervention for a child with a feeding disorder. But more importantly, we should assess strategies for mitigating renewal.

An obvious renewal mitigation strategy is for the caregiver rather than a therapist to implement function-based extinction initially. The results of the current study show that introduction of the caregiver as feeder in a simulated home setting was associated with robust, and in some cases, high levels of sustained renewal. Perhaps we could eliminate or at least reduce the increases in inappropriate mealtime behavior and the decreases in acceptance if the caregiver initially implemented function-based extinction. Werle, Murphy, and Budd (1993), Anderson and McMillan (2001), and Luiselli, Ricciardi, and Gilligan (2005) reported that caregivers could serve as the initial change agents and implement pediatric feeding disorders interventions with high integrity. Future studies should evaluate the generality of this finding and its effects on renewal.

Another strategy is to train in the multiple contexts in which the child is likely to feed such as the home or school. For example, Gunther, Denniston, and Miller (1998) showed that rats exposed to extinction in three contexts exhibited less renewal than rats exposed to extinction in one context. If we train sufficient exemplars, we might increase the probability that generalization will occur to contexts not exposed to intervention (Stokes & Baer, 1977). When intervention in the home is not practical, increasing the similarity between contexts may be an alternative, as context similarity is another method to mitigate renewal (Podlesnik, Kelley, Jimenez-Gomez, & Bouton, 2017; Todd, Winterbauer, & Bouton, 2012). For example, caregivers could bring

personal items such as the child's highchair to clinic to enhance context similarity. We do not know, however, to which aspects of a context young children attend and which aspects control behavior. Identification of those components could be helpful for programming similarity between contexts.

After the renewal evaluation, each child's caregiver continued to implement the child's feeding intervention with at least 90% accuracy in the clinic and other settings. For Fernando, Pierre, and Lorenzo, who showed persistent renewal in solids or liquids, we modified the feeding protocol to include access to tangible items continuously, which resulted in a reduction of inappropriate mealtime behavior (Reed et al., 2004). Subsequently, each child transitioned to the outpatient feeding program to continue to progress towards age-typical feeding.

Results of the current study provide another demonstration that extinction is an effective intervention for decreasing inappropriate mealtime behavior and increasing acceptance when a clinic therapist served as feeder. These results also show that the effects of extinction are specific to the context in which it occurs (Bouton, Todd, Vurbic, & Winterbauer, 2011). Failure to account for renewal in the intervention of pediatric feeding disorders may determine whether the child continues to eat and drink over the long term. On a larger scale, pediatric feeding disorders can have devastating physical, psychological, and financial consequences for the child, the child's family, and society (Freedman, Dietz, Srinivasan, & Berenson, 1999; Graves & Ware, 1990; Greer, Gulotta, Masler, & Laud, 2007; Ludwig, Majzoub, Al-Zahrani, Dallal, Blanco, & Roberts, 1999; Singer, Song, Hill, & Jaffe, 1990). Therefore, it is even more imperative that behavior analysts conduct research that will refine our ability to deliver long-lasting interventions that result in (a) improved health, (b) improved quality of life for the child and family, (c) decreased mental health problems in families, (d) reduced risk of long-term eating disorders, and (e) reduced health-care costs. These long-term outcomes are dependent on methods for ensuring generalization and maintenance of feeding interventions. We echo Kelley et al. (2015) and hope

the current study also occasions translational research on recurrence phenomena like renewal during behavior-analytic interventions for pediatric feeding disorders.

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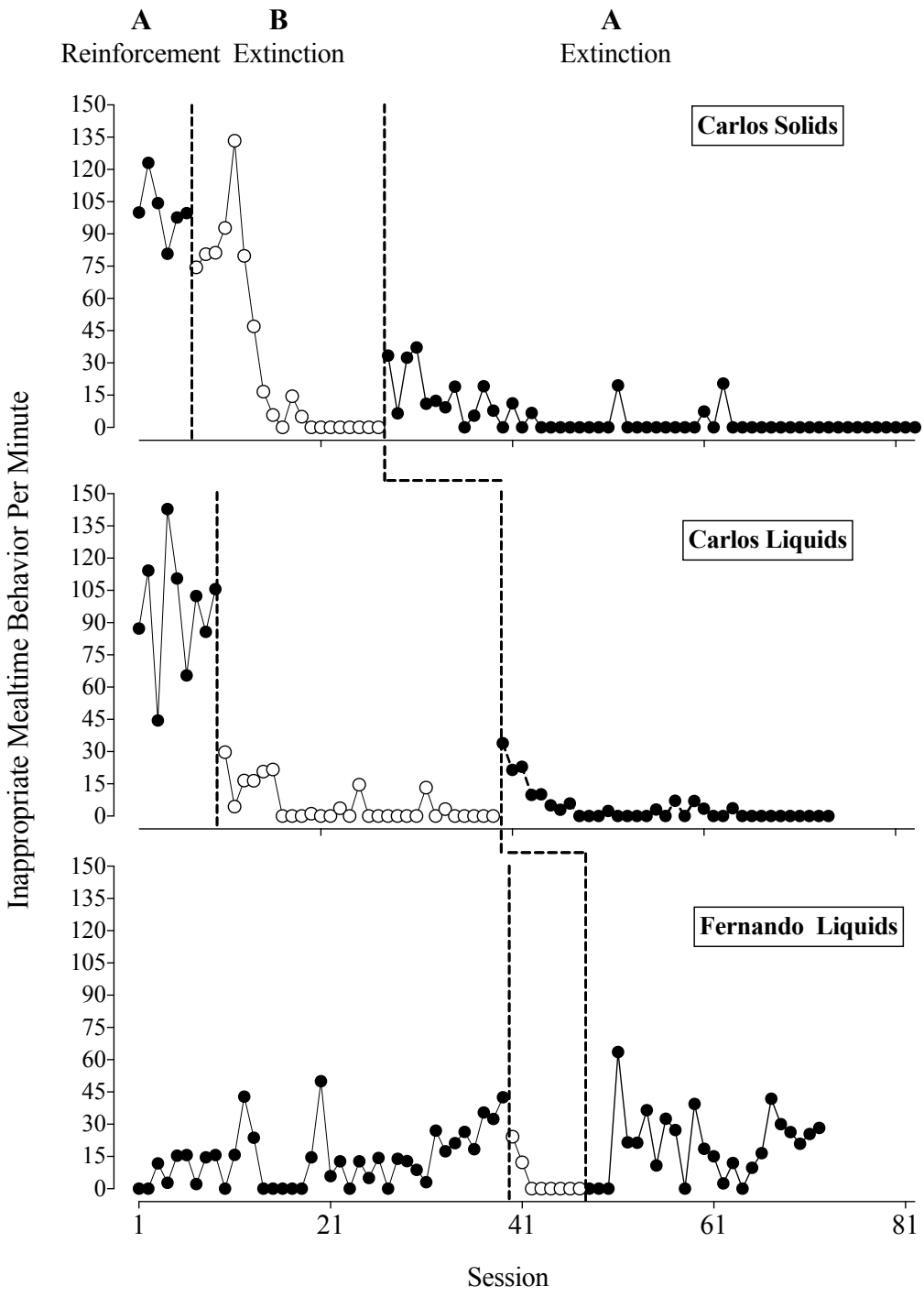

Figure 1. Inappropriate mealtime behavior per minute for Carlos solids (top), Carlos liquids (middle), and Fernando liquids (bottom).

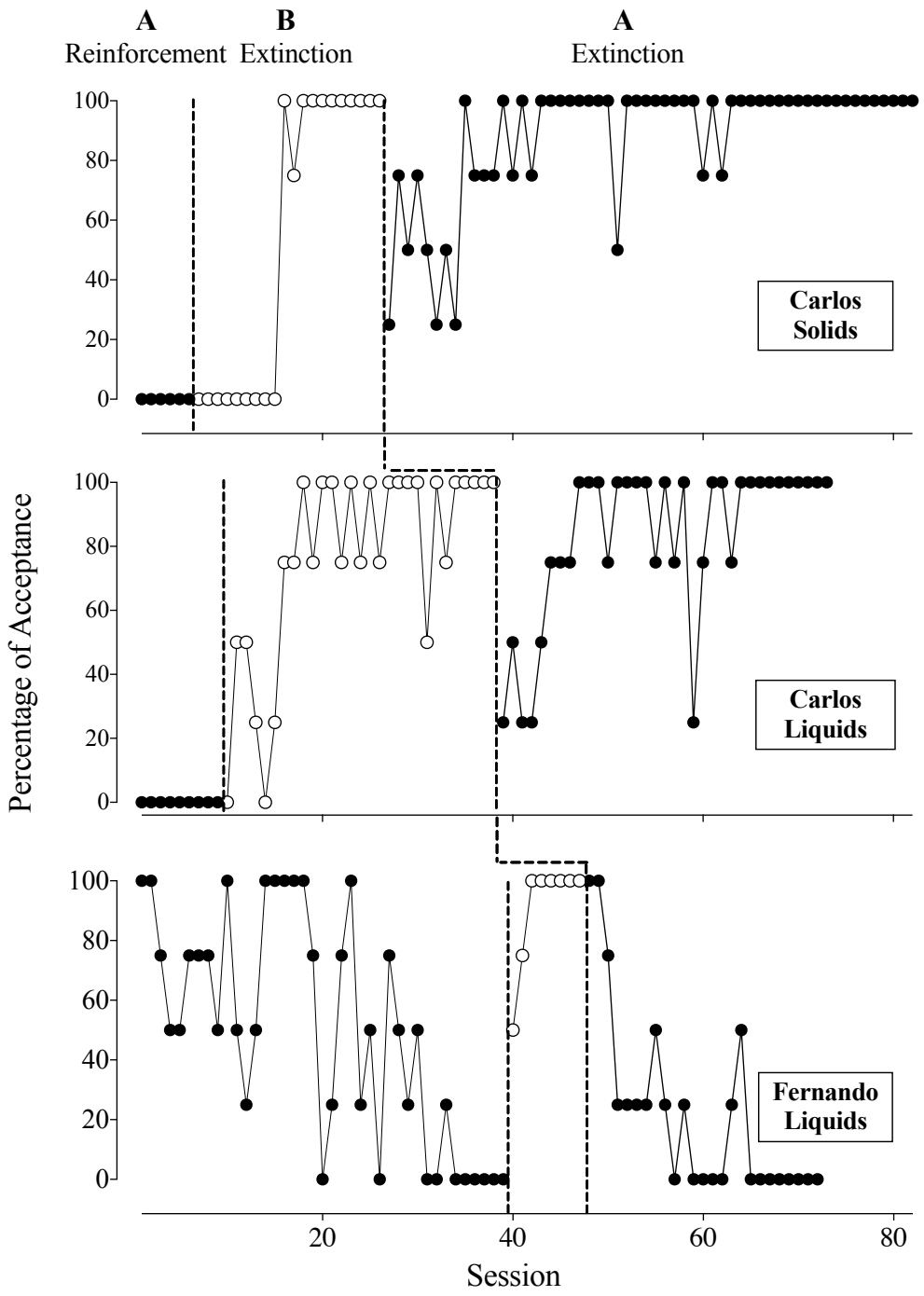

Figure 2. Percentage of acceptance for Carlos solids (top), Carlos liquids (middle), and Fernando liquids (bottom).

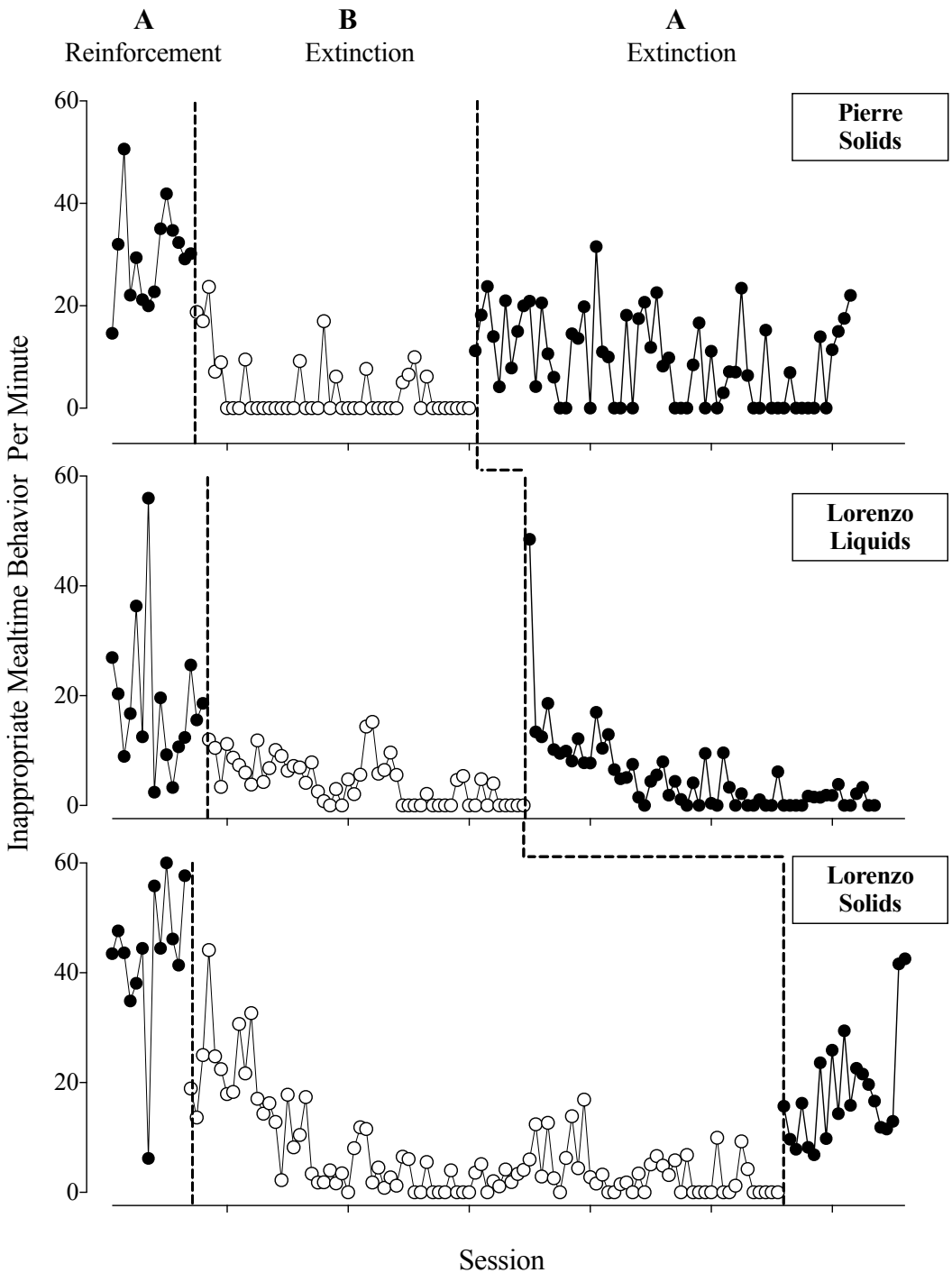

Figure 3. Inappropriate mealtime behavior per minute for Pierre solids (top), Lorenzo liquids (middle), and Lorenzo solids (bottom).

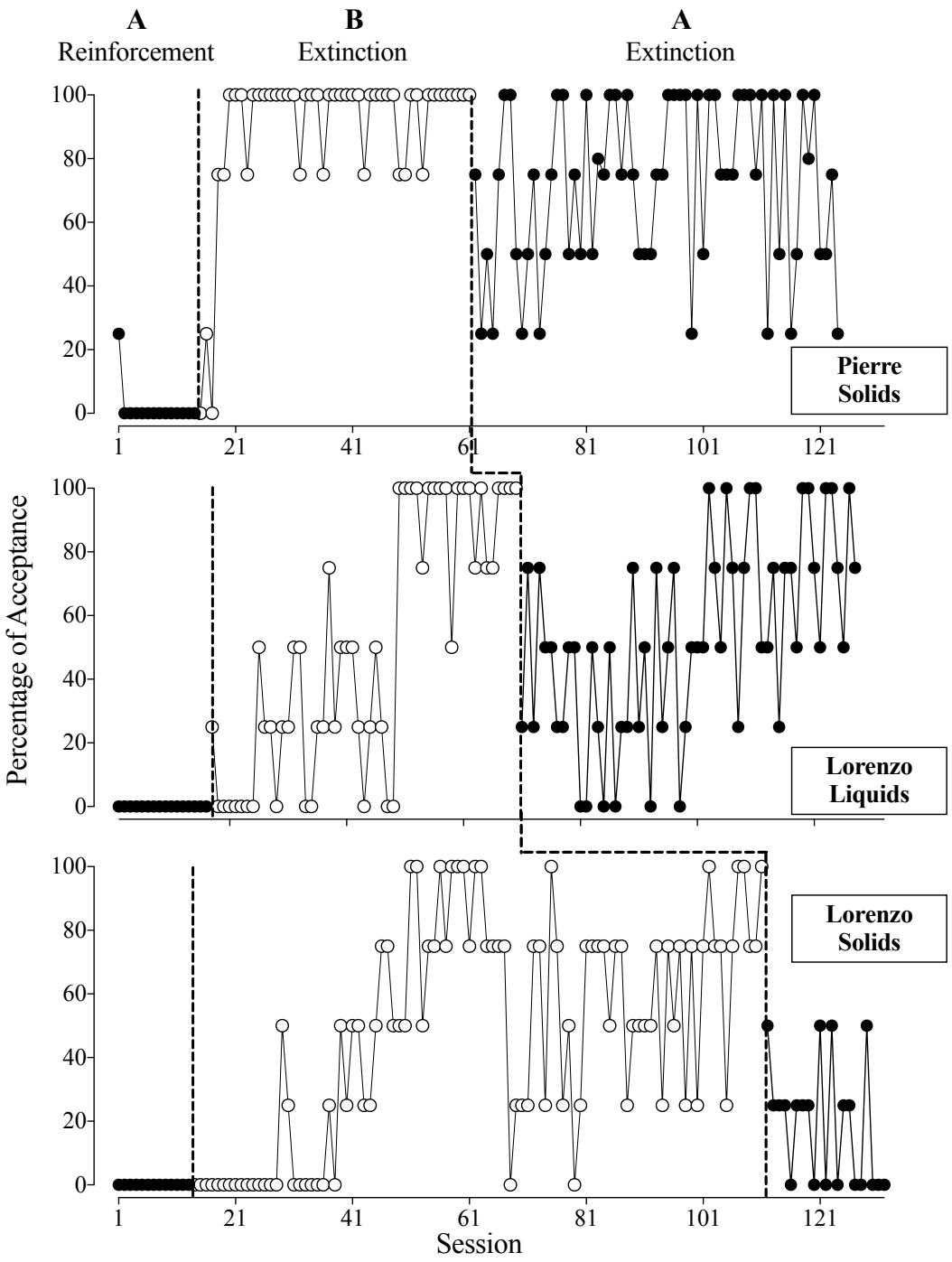

Figure 4. Percentage of acceptance for Pierre solids (top), Lorenzo liquids (middle), and Lorenzo solids (bottom).

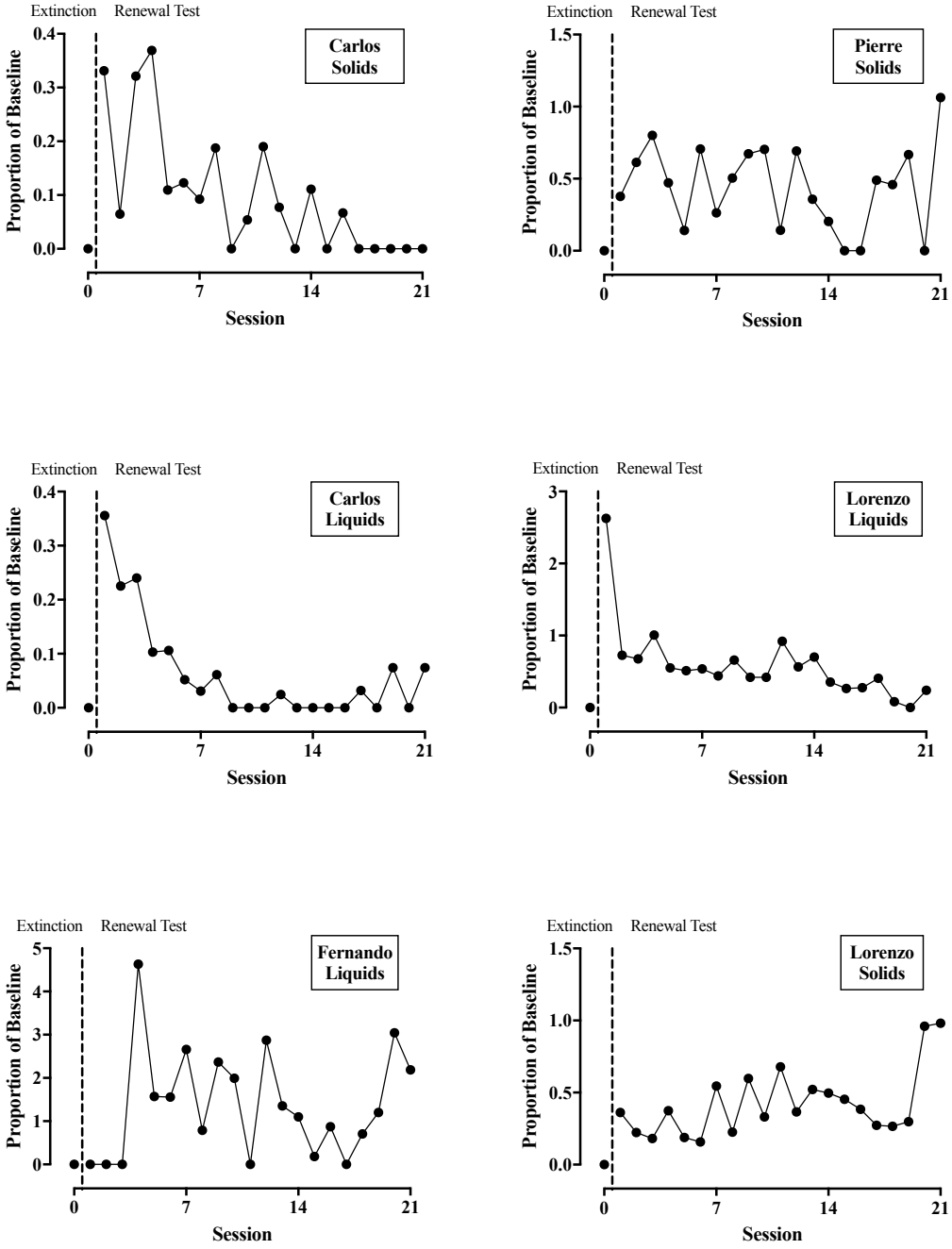

Figure 5. Proportion of baseline response rates during extinction and renewal test sessions for Carlos solids (top left) and Pierre solids (top right), Carlos liquids (middle left) and Lorenzo liquids (middle right), and Fernando liquids (bottom left) and Lorenzo solids (bottom right).