HHS Public Access

Author manuscript

J Appl Behav Anal. Author manuscript; available in PMC 2023 April 12.

Published in final edited form as:

J Appl Behav Anal. 2022 June ; 55(3): 704–726. doi:10.1002/jaba.913.

Relapse During the Treatment of Pediatric Feeding Disorders

Sarah D. Haney[1], **Brian D. Greer**[2,3], **Daniel R. Mitteer**[2,3], **Kayla R. Randall**[4]

[1]Kennedy Krieger Institute

[2]Children's Specialized Hospital, Rutgers University Center for Autism Research, Education, and Services (CSH–RUCARES)

[3]Rutgers Robert Wood Johnson Medical School

[4]Center for Pediatric Behavioral Health

Abstract

Resurgence and renewal are treatment-relapse phenomena in which previously extinguished behavior returns after the conditions for an alternative response worsen or the context changes, respectively. Recently, researchers have evaluated the prevalence of resurgence and renewal when treating destructive behavior with functional communication training. However, resurgence of inappropriate mealtime behavior has yet to be evaluated; perhaps because treatments involve qualitatively different resurgence opportunities (e.g., increased bite-presentation rate). We evaluated the prevalence of resurgence and renewal of inappropriate mealtime behavior across 22 and 25 applications of extinction-based treatments, respectively. Resurgence occurred in 41% (9/22) of applications, most often following presentation-rate increases. Renewal occurred in 52% (13/25) of applications, most often following feeder changes from therapist to caregiver. We discuss these findings in terms of their ability to inform relapse-mitigation strategies for resurgence and renewal of inappropriate mealtime behavior.

Keywords

inappropriate mealtime behavior; pediatric feeding disorder; renewal; resurgence; treatment relapse

Children with feeding disorders often display high rates of inappropriate mealtime behavior (e.g., turning away, pushing away the utensil) that may interfere with the consumption of necessary calories or nutrients (Goday et al., 2019). Inappropriate mealtime behavior is often negatively reinforced by escape from bite- or drink-presentations or meal termination (Bachmeyer et al., 2019; Borrero et al., 2010; Piazza, Fisher, et al., 2003; Piazza et al., 2017). Thus, behavior analysts often use function-based treatments such as escape extinction (e.g., non-removal of the utensil, physical guidance) to decrease inappropriate mealtime behavior, which is often necessary to produce therapeutic effects (Patel et al., 2002; Piazza, Patel, et al., 2003; Reed et al., 2004). As such, escape extinction is the

Correspondence concerning this article should be addressed to Brian D. Greer, CSH–RUCARES, 888 Easton Ave., Somerset, NJ 08873. brian.greer@rutgers.edu.

most empirically supported intervention for inappropriate mealtime behavior (Volkert & Piazza, 2012) and has produced robust treatment effects across experimental designs and participant characteristics. However, the extent to which behavior-analytic treatments for pediatric feeding disorders are susceptible to treatment relapse remains unclear.

Treatment relapse refers to the recurrence of a target behavior (e.g., inappropriate mealtime behavior) following initially successful treatment (e.g., low rates of inappropriate mealtime behavior and high levels of acceptance; Wathen & Podlesnik, 2018). Relapse during patient care can represent a major setback in therapeutic progress, despite the extensive clinical time and family collaboration often necessary to establish initial treatment efficacy. Individuals experiencing relapse may require additional clinic visits or readmission to regain treatment effects, which can result in increased financial burden to families and third-party payers while delaying services for others. Additionally, pediatric feeding disorders may have significant long-term effects on the child (e.g., adverse intellectual outcomes related to failure to thrive; Corbett & Drewett, 2004) and caregivers (e.g., increased stress and depression; Kreipe & Palomaki, 2012). Thus, an examination of the extent to which feeding interventions remain durable appears warranted.

Several recent studies have examined the prevalence of relapse during the treatment of destructive behavior using consecutive controlled case-series designs. These designs are ideal for prevalence research because they minimize publication bias by reporting on each participant or application (i.e., treatment used for a certain function or a given situation) within a timespan so long as the scientific rigor for each application is high, regardless of treatment outcome (Hagopian, 2020). For example, Briggs et al. (2018) evaluated the prevalence of treatment relapse while thinning reinforcement schedules for communication responses during functional communication training using discriminative stimuli (e.g., multiple schedules; Greer et al., 2016). This type of relapse is called *resurgence* and involves the recurrence of a previously extinguished response (e.g., destructive behavior) when the conditions for an alternative response worsen, such as during reinforcement schedule thinning (e.g., decreased rate, magnitude, or quality of reinforcement; Briggs et al., 2018; Fisher et al., 2020; Wacker et al., 2011). Briggs et al. observed resurgence across 76% (19/25) of applications of functional communication training and 42% (47/111) of reinforcement schedule-thinning transitions. Replications by Muething, Pavlov, et al. (2020) and Mitteer et al. (in press) found comparable levels of resurgence using similar treatments for destructive behavior. Further, Shahan and Greer (2021) found that the magnitude of resurgence of destructive behavior across both studies was well predicted by the magnitude of the downshift in the availability of the alternative reinforcer, with larger downshifts producing more resurgence.

Opportunities for resurgence differ qualitatively when treating inappropriate mealtime behavior relative to destructive behavior. Whereas the latter often aims to make treatments more practical by gradually increasing the time in which the functional reinforcer is unavailable for an alternative behavior (e.g., a communication response; Hagopian et al., 2011), feeding interventions often increase meal efficiency to promote gram consumption (i.e., volume of food/liquid consumed) by modifying the bite or drink (a) presentation rate, (b) number (i.e., of bites/drinks presented), and (c) bolus size (i.e., amount of

food or liquid on the utensil; Peterson et al., 2018). Additionally, feeding interventions that include escape-extinction procedures may not arrange differential function-based reinforcement for alternative behavior like bite or drink acceptance, unlike most treatments for destructive behavior (e.g., functional communication training). Therefore, opportunities to observe resurgence of inappropriate mealtime behavior may not involve a worsening of reinforcement conditions for an alternative response (e.g., decreased reinforcement quality) but a general worsening of conditions for the alternative response (e.g., increased response effort associated with increased bolus size).

In a study demonstrating resurgence produced by punishment of an alternative behavior in rats, Fontes et al. (2018) reiterated that the conditions that produce resurgence need not require a worsening of reinforcement conditions for alternative behavior (e.g., reinforcement schedule thinning), but a general "worsening of conditions for the alternative behavior" is often sufficient (Fontes et al., 2018, p. 171). Fontes et al. is noteworthy because the introduction of punishment for alternative behavior coincided with no programmed change in alternative-reinforcement availability, and obtained reinforcement rates were similar before and after the introduction of punishment, yet target responding resurged. Nighbor et al. (2020) observed resurgence in pigeons when reinforcement-schedule changes (i.e., tandem to chained schedule) coincided with signaled periods of reinforcement availability and unavailability for the alternative response. Resurgence occurred despite obtained rates of reinforcement for the alternative response remaining unchanged across schedule changes, similar to Fontes et al. Overall, Fontes et al. and Nighbor et al. demonstrated that resurgence may occur when general conditions for alternative responding worsen (e.g., signaled extinction) and support the need for a broadened analysis of the conditions under which resurgence occurs. One implication of this broader view of resurgence is that feeding interventions that do not arrange differential function-based reinforcement for alternative behavior but introduce changes to increase meal efficiency (e.g., increasing the bite-presentation rate) may still be susceptible to resurgence, as these changes may represent a general worsening of conditions for alternative behavior (e.g., acceptance). For example, changes that promote meal efficiency, like increasing the bolus size or bite number, may represent a worsening of conditions for acceptance (i.e., taking the bite quickly) or mouth clean (i.e., swallowing the bite) because these modifications can increase the response effort associated with eating (Kerwin et al., 1995). This may be particularly true for children who have limited practice with oral eating (e.g., feeding-tube dependence) and/or oral-motor skill delays (e.g., difficulty with lip closure around the spoon).

Treatment relapse can also occur when conditions for the target and alternative behavior remain unchanged but the context changes (e.g., new implementor or setting). This type of relapse is called *renewal* and involves the recurrence of a previously extinguished response (e.g., inappropriate mealtime behavior) following a context change, such as when the caregiver first implements treatment (Bouton et al., 2011; Kelley et al., 2015; Podlesnik et al., 2017). Researchers have evaluated renewal using AAB (i.e., baseline and treatment in Context A followed by treatment in a novel context, Context B), ABA (i.e., baseline in Context A, treatment in Context B, followed by treatment in a return to Context A), and ABC (i.e., baseline in Context A, treatment in Context B, followed by treatment in a novel context, Context C) arrangements and some have found the most robust effects

with the ABA arrangement (cf. Bouton et al., 2011; see also Todd, 2013). In their analysis, Muething, Call, et al. (2020) found that ABA renewal of destructive behavior occurred across 67% (45/67) of participants and 42% (77/182) of context-change transitions, with equivalent prevalence across implementer and setting changes. A replication by Falligant et al. (2021) found similarly common ABA renewal effects with individuals admitted to an inpatient program for treatment of destructive behavior. Overall, these studies demonstrate that renewal commonly occurs during attempts to increase the generality of treatment effects to novel settings or implementers.

Three recent studies have demonstrated ABA renewal of inappropriate mealtime behavior following changes in the feeder, setting, or both with children with a feeding disorder (Haney et al., 2021; Ibañez et al., 2019; Kelley et al., 2018). For example, Ibañez et al. (2019) observed renewal of inappropriate mealtime behavior across participants when transitioning treatment from therapists in clinic rooms to caregivers in simulated homes. Kelley et al. (2018) observed renewal of inappropriate mealtime behavior for both participants when transitioning treatment from therapists to caregivers. Finally, Haney et al. (2021) observed renewal of inappropriate mealtime behavior when transitioning treatment from therapists to caregivers, clinic room to home, and during a combination of these transitions.

The purpose of the present study was to extend the findings of previous researchers who examined relapse during the treatment of destructive behavior (e.g., Briggs et al., 2018; Mitteer et al., in press; Muething, Call, et al., 2020) by evaluating relapse during the treatment of inappropriate mealtime behavior. This is the first study to describe relapse of inappropriate mealtime behavior within a resurgence framework. Additionally, although researchers have demonstrated that renewal of inappropriate mealtime behavior occurs (Haney et al., 2021; Ibañez et al., 2019; Kelley et al., 2018), no studies have examined its prevalence, and it is unclear whether previous findings on the prevalence of relapse of destructive behavior extend to treatments for inappropriate mealtime behavior. The current experimenters conducted a consecutive controlled case-series analysis of applications of extinction treatment from an intensive outpatient clinic specializing in the treatment of pediatric feeding disorders. The experimenters examined the prevalence, persistence, and magnitude of resurgence and renewal to understand the conditions under which resurgence and renewal of inappropriate mealtime behavior occur.

Method

Participants and Setting

The experimenters reviewed the clinical treatment records of children who participated in an intensive day-treatment admission at a pediatric feeding disorders program between 2017–2019. All participants were referred for the treatment of inappropriate mealtime behavior, met criteria for pediatric feeding disorder (Goday et al., 2019), and were cleared as safe oral feeders by a pediatrician or speech-language pathologist before admission. Participants attended the program 5 days per week from 9:00 a.m. to 5:00 p.m. for 8 weeks. See Table 1 for participant demographic information.

Record Review Procedures

The experimenters began the record review by reviewing a spreadsheet containing a list of admitted children, with demographic information and treatment outcomes for each fiscal year, to identify children who were admitted to the intensive day treatment feeding program from 2017–2019. Next, the experimenters reviewed each child's file to determine their eligibility for inclusion. Each file contained a session log, gram-consumption log, assessment and treatment protocols and graphs, progress notes, raw data, interobserver-agreement (IOA) spreadsheets, and feeding goals met during the admission. The experimenters numbered the first participant as the first child admitted for services in January 2017 and progressed sequentially through admissions as they occurred throughout 2017 and into 2019 until they obtained 25 treatment applications of either resurgence or renewal, whichever came first.

The experimenters used a multi-step process to select treatment applications for inclusion. First, the experimenters identified participants who met the following eligibility criteria: functional analyses indicated that inappropriate mealtime behavior was maintained at least partially by escape and treatment included extinction of inappropriate mealtime behavior (e.g., non-removal of the utensil, physical guidance for self-feeding). Participants were not eligible for further analysis if they did not meet this criterion or if they were discharged from the program before meeting their feeding goals due to poor attendance, caregiver preference, or for medical or insurance purposes.

Second, the experimenters analyzed applications of extinction treatment (e.g., treatment of solids refusal, treatment of liquids refusal) for eligible participants and proceeded to further analysis if the participant had at least one treatment application that met the following criteria: (a) included at least one transition opportunity for resurgence (i.e., change in bite-presentation rate, bolus size, or number of bites/drinks presented) or one transition opportunity for renewal (i.e., change in implementor or setting), (b) had IOA data for at least 25% of sessions, and (c) consisted of the procedures recommended at discharge from the program (or final treatment protocol). The experimenters included this latter criterion because initial treatments may have displayed relapse related to an ineffective treatment, rather than variables relevant to resurgence or renewal. Exclusion criteria for treatment applications were that the treatment: (a) did not meet the above criteria, (b) did not include at least one transition opportunity for resurgence or renewal or only included transitions with co-occurring opportunities for resurgence and renewal (e.g., bolus increase and feeder change), (c) lacked information to determine whether transition(s) occurred, (d) did not include baseline data, (e) included an antecedent-based manipulation to the food or liquid (e.g., simultaneous presentation; Patel et al., 2001; Piazza et al., 2002), utensil (e.g., spoon-to-cup fading; Groff et al., 2011), or feeding demand, or (f) included treatment components to address packing (i.e., holding food or liquid in the mouth without swallowing) or expulsion (i.e., food exiting the mouth).

The experimenters analyzed treatment applications for resurgence and renewal simultaneously for each participant and stopped analyzing treatment applications when they identified 25 applications for either resurgence or renewal (the experimenters reached 25 applications for renewal first). The experimenters considered treatment applications that had

an opportunity to detect resurgence and renewal within the same application (i.e., during two different transitions) separately (i.e., one analyzed for resurgence and one analyzed for renewal). For example, if a participant's non-self-fed solids treatment included a resurgence and renewal opportunity that did not co-occur (e.g., presentation-rate change then feeder change), the experimenters considered the non-self-fed solids treatment to be one treatment application for resurgence and one for renewal. The experimenters included four types of treatment applications: (a) non-self-fed solids treatment (i.e., participant is fed), (b) self-fed solids treatment (i.e., participant feeds themselves), (c) non-self-fed liquids treatment, and (d) self-fed liquids treatment.

Third, the experimenters analyzed all sessions within each included application for transitions (i.e., opportunities for resurgence or renewal). A transition consisted of a progression from a previous condition (hereafter referred to as Condition A) to a subsequent condition (hereafter referred to as Condition B), which entailed a worsening of conditions for the alternative response, acceptance (i.e., an opportunity for resurgence) or a change in context (i.e., an opportunity for renewal). Final inclusion criteria for transitions were that: (a) Condition A included at least two sessions, (b) inappropriate mealtime behavior remained at or below an 85% reduction from baseline rates during both sessions of Condition A, and (c) Condition B included at least one session. Exclusion criteria for transitions were that: (a) the transition did not meet inclusion criteria, (b) more than one change occurred during the same transition (e.g., therapist presenting bites every 30 s to caregiver presenting bites every 15 s), (c) procedural integrity fell below 80% during any of the Context A or Context B sessions, and (d) the experimenters could not determine whether an opportunity for resurgence or renewal occurred due to insufficient information (e.g., missing condition label in session log). In general, the experimenters analyzed the final two sessions before the transition (i.e., Condition A) and the first three sessions after the transition (i.e., Condition B), similar to studies by Briggs et al. (2018), Mitteer et al. (in press), and Muething, Call et al. (2020). However, because clinicians might end a programmed transition early (e.g., removing the caregiver after a single session following a burst of inappropriate mealtime behavior) or introduce a transition after fewer than three sessions following the previous transition (e.g., increase the drink bolus two sessions after increasing the presentation rate), the experimenters only required transitions to have one session in Condition B. Only one transition for one participant had fewer than three Condition-B sessions. In this one situation, the therapist introduced a new transition two sessions after the previous transition (i.e., increased the drink bolus to 1 oz two sessions after increasing to 10 cc). Figure 1 provides a flow diagram showing the participant-selection process and the inclusion process for applications and transitions.

Response Measurement—The experimenters further labeled transitions as being opportunities to observe resurgence or renewal by classifying what the transition entailed. The experimenters included transitions for the resurgence evaluation when the transition entailed increases in the: (a) number of bites/drinks presented (e.g., three drinks to four drinks), (b) bolus size (e.g., 1 cc of puree to 2 cc of puree), or (c) bite- or drink-presentation rate (e.g., fixed time [FT] 30 s to FT 15 s).

The experimenters included transitions for the renewal evaluation when the transition entailed a context change from Condition A to Condition B. Similar to Mitteer et al. (in press), Muething, Call, et al. (2020), and Falligant et al. (2021), a contextual change consisted of either: (a) introduction of a novel feeder implementing the treatment (e.g., caregiver, nanny), or (b) a familiar feeder implementing treatment in a novel setting (e.g., new clinic room, home). The experimenters used the same criteria as Briggs et al. (2018), Mitteer et al., and Falligant et al. to determine whether resurgence or renewal of inappropriate mealtime behavior occurred during each transition. Specifically, the experimenters identified resurgence or renewal if the highest rate of inappropriate mealtime behavior during Condition B exceeded the highest rate of inappropriate mealtime behavior during Condition A.

Finally, to analyze the within-transition trends of inappropriate mealtime behavior during instances of relapse, the experimenters converted rates of inappropriate mealtime behavior during each session of a transition with relapse into a proportion of baseline responding. The experimenters divided the rate of inappropriate mealtime behavior during each session of a transition with relapse by the average rate of inappropriate mealtime behavior during the last five sessions from the most recent baseline phase. This transformation is helpful when comparing data across participants with different baseline response rates.

Reliability and Interrater Agreement—The experimenters took several steps to ensure accurate application of the inclusion and exclusion criteria, data collection, implementation of treatment procedures, and data analysis. When disagreements occurred at any of these stages, the experimenters reviewed the raw data and transcribed an agreed-upon value. The experimenters applied the Strengthening the Reporting of Observational Studies in Epidemiology statement (STROBE; von Elm et al., 2008), and the consecutive controlled case series included clear definitions for inclusion, exclusion, and participant characteristics, as well as a structured protocol for data extraction and transcription. One experimenter reviewed assessment (i.e., functional analysis) and treatment graphs, session logs, gram-consumption logs, raw data, and IOA spreadsheets to determine whether applications and transitions met inclusion criteria and cross-checked this information across at least two of these documents. For example, to determine whether a transition met the inclusion criteria, the experimenter reviewed the session log and treatment graph to ensure that session information matched (e.g., presentation rate change during Session 47).

We conducted initial procedural-fidelity checks on the clinical records and safeguarded the data-transcription process to ensure a valid analysis. To determine whether the feeder presented the same foods across transitions, one experimenter reviewed the session log and gram-consumption log to ensure they matched and found 100% agreement between these documents. Observers scored *not seen* if they could not determine whether a mouth clean occurred (e.g., could not see inside participant's mouth). Therefore, the experimenters ensured that decrements in mouth clean were not a result of observers scoring not seen more often. A second experimenter independently reviewed all treatment applications and transitions identified as appropriate for inclusion to confirm that all applications and transitions met inclusion criteria. Next, two experimenters transcribed data from clinical records into a spreadsheet. Data transcription from clinical records always entailed one

experimenter reading aloud the raw data with a second experimenter transcribing the data or a second experimenter reviewing the raw data transcribed by another experimenter.

Interrater reliability for transcribed baseline and transition sessions was 97% (392/405) for the resurgence analysis and 92% (290/314) for the renewal analysis. Next, one experimenter calculated the percentage of relapse and acceptance and mouth-clean decrements across participants, applications, and transitions from the transcribed data and entered this information into a summary spreadsheet. Finally, two experimenters reviewed transcribed summary data for 35% of participants included in the resurgence analysis and 37% of participants included in the renewal analysis to ensure that summary data matched raw clinical data. For transcribed summary data, the experimenters scored an agreement as 100% and a disagreement as 0% for the purposes of IOA reporting. Interrater reliability for transcribed summary data was 100% for participants, applications, and transitions across dependent variables (i.e., inappropriate mealtime behavior, acceptance, and mouth clean) for the resurgence analysis, 100% for participants and applications across dependent variables, 100% for transitions for inappropriate mealtime behavior and acceptance, and 94% (range, 0–100%) for transitions for mouth clean for the renewal analysis.

Assessment and Treatment Procedures

Response Measurement—Observers scored *inappropriate mealtime behavior* each time the utensil was within arm's reach of the participant and the participant covered their mouth or threw the utensil. Observers scored inappropriate mealtime behavior during non-self-fed sessions each time the participant turned or moved their head away or pushed away the utensil or feeder's arm holding the utensil. Observers scored inappropriate mealtime behavior during self-fed sessions each time the participant turned their body away or moved the utensil away from their mouth. Observers recorded second-by-second session data using BDataPro (Bullock et al., 2017). BDataPro converted the frequency of inappropriate mealtime behavior to a rate (responses per minute) by dividing the number of inappropriate mealtime behaviors by the duration that the utensil was within arm's reach of the participant. Observers scored *acceptance* when the entire bite or drink except for a pea-sized amount entered the participant's mouth within a specified time following each bite or drink presentation. During non-self-fed sessions, the feeder deposited the bite or drink in the participant's mouth when the participant leaned forward in the absence of crying or leaned forward and opened their mouth if crying occurred. BDataPro converted acceptance into a percentage by dividing the number of acceptances by the total number of bite or drink presentations and multiplying by 100. Observers scored *mouth clean* if no food or liquid larger than a pea-sized amount remained in the participant's mouth within a specified time following acceptance. BDataPro converted mouth clean into a percentage by dividing the number of mouth cleans during the session by the total number of acceptances and multiplying by 100.

Procedural Integrity—To evaluate the extent to which the programmed independent variables (e.g., changes in presentation rate, bolus size, number of bites or drinks presented, changes in context) were responsible for treatment relapse, the experimenters analyzed the extent to which other variables (e.g., integrity errors) coincided with these

programmed changes (Saini & Mitteer, 2020). Thus, the experimenters calculated procedural integrity during all transitions included in the analysis of resurgence and renewal. The current integrity measures encompassed the precision with which feeders implemented the extinction intervention and broader procedures of the session including the feeder adhering to programmed antecedent conditions and contingencies for appropriate feeding behavior.

During each day-treatment admission, observers calculated procedural integrity by analyzing correct procedure, correct utensil placement, and incorrect attention for each session. Observers scored *correct procedure* once per bite- or drink-presentation interval if the feeder: (a) presented the correct amount of food or liquid on the correct utensil, which was determined by observing the feeder prepare the food or liquid on the utensil (e.g., feeder used an oral syringe to measure 4 cc of milk before putting the liquid in the cup); (b) delivered a vocal prompt to, “Take a bite/drink” while touching the utensil to the participant’s lips during non-self-fed sessions or put the utensil on the table in front of the participant during self-fed sessions within 5 s of each scheduled presentation; (c) delivered behavior-specific praise within 5 s of acceptance and mouth clean; (d) delivered a vocal prompt to, “Show me” at the mouth-clean check; (e) delivered a vocal prompt to, “Swallow the bite/drink” if the participant had food or liquid larger than a pea-sized amount in their mouth at the mouth-clean check; and (f) delivered no differential consequences for coughing, gagging, or vomiting. Observers scored correct procedure when the feeder deposited the bite or drink in the participant’s mouth within 5 s if they met acceptance criteria during non-self-fed sessions or when the feeder used physical guidance (i.e., placed their hand over the participant’s hand on the utensil and brought it to their lips) within a specified time if they did not meet acceptance criteria during self-fed sessions. BDataPro divided occurrences of correct procedure by the total number of bite/drink presentations and multiplied by 100 to produce a percentage.

Observers scored duration of *correct utensil placement* when the feeder: (a) touched the utensil to the participant’s lips during non-self-fed sessions or put the utensil on the table in front of the participant during self-fed sessions at the scheduled presentation, and (b) removed the utensil after acceptance or at the end of the presentation interval. Observers scored correct utensil placement during baseline when the feeder removed the utensil after inappropriate mealtime behavior. Observers scored correct utensil placement during non-self-fed treatment when the feeder: (a) held the utensil touching the participant’s lips until acceptance or until a specified time (e.g., 10 min); (b) moved the utensil to the side of the participant’s mouth if they coughed, gagged, or vomited; and (c) used the utensil to re-present the bite or drink into the participant’s mouth within 3 s of an expulsion (i.e., food exiting the mouth). Observers used these criteria during self-fed sessions when the feeder used physical guidance (i.e., feeder put their hand over the participant’s hand on the utensil and lifted the utensil to the participant’s lips) within a specified time following presentation. BDataPro divided the duration of correct utensil placement by the total session duration and multiplied by 100 to produce a percentage.

Observers scored *incorrect attention* once per bite/drink-presentation interval if the feeder: (a) did not provide praise within 5 s of acceptance and mouth clean, (b) delivered praise if the participant did not meet acceptance criteria or mouth-clean criteria, and (c) delivered

attention within 5 s of inappropriate mealtime behavior during extinction. BDataPro divided occurrences of incorrect attention by the total number of bite/drink presentations in a session and multiplied by 100 to produce a percentage.

The experimenters computed mean correct procedure, correct utensil placement, and incorrect attention across all transitions (i.e., Context A and B sessions) included in the analysis and computed these averages separately for transitions evaluated for resurgence and those evaluated for renewal. Resurgence means were 99% (range, 80–100%) for correct procedure, 99% (range, 98–100%) for correct utensil placement, and 0% for incorrect attention. Renewal means were 99% (range, 80–100%) for correct procedure, 99% (range, 91–100%) for correct utensil placement, and 0% for incorrect attention.

Interobserver Agreement—The experimenters assessed IOA for inappropriate mealtime behavior, acceptance, mouth clean, correct procedure, correct utensil placement, and incorrect attention during 47% (104/295) and 38% (72/190) of transition sessions for the resurgence and renewal evaluations, respectively, by analyzing data from two independent observers during each session of each application. BDataPro calculated IOA coefficients for inappropriate mealtime behavior using exact agreement by dividing the number of exact agreements (i.e., observers scored the same frequency of the behavior in an interval) by the total number of exact agreements plus disagreements within each 10-s interval and multiplying by 100. Next, the experimenters divided the sum of these percentage-agreement coefficients by the total number of agreement coefficients for the resurgence and renewal evaluations. The mean IOA for inappropriate mealtime behavior was 98% (range, 75–100%) for the resurgence evaluation and 97% (range, 67–100%) for the renewal evaluation. Agreement was 67% during one session for the renewal evaluation.

BDataPro calculated IOA coefficients for acceptance, mouth clean, correct procedure, correct utensil placement, and incorrect attention using total agreement by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. For the resurgence evaluation, the mean IOA was 97% (range, 80–100%) for acceptance, 98% (range, 80–100%) for mouth clean, 96% (71–100%) for correct procedure, 99% (range, 98–100%) for correct utensil placement, and 99% (80–100%) for incorrect attention. For the renewal evaluation, the mean IOA was 97% (range, 80–100%) for acceptance, 97% (range, 78–100%) for mouth clean, 96% (range, 79–100%) for correct procedure, 99% (range, 97–100%) for correct utensil placement, and 99% (80–100%) for incorrect attention.

Feeders

Feeders were trained therapists who also served as observers. Therapists were employees with a bachelor's or master's degree in psychology or a related field, predoctoral interns in an American Psychological Association-approved doctoral program, students in an applied behavior analysis doctoral program, practicum students in an undergraduate psychology program or related field, or a combination of these. The clinical team systematically trained therapists on preparation of pureed foods and protocol implementation using behavioral skills training until they implemented each protocol component with 80% or higher integrity

with another therapist before implementing the protocol with a participant. The clinical team provided feedback and re-training as necessary to ensure that integrity maintained at 80% or higher. The clinical team trained therapists on data-collection procedures until achieving 80% or higher IOA coefficients for all dependent variables for three consecutive sessions. The clinical team conducted re-training if IOA coefficients decreased below 80% for three consecutive sessions. Based on review of session logs, notes, graphs, and IOA spreadsheets, feeders and observers never met criteria for re-training on feeding procedures or data collection, respectively.

Setting and Materials

Session rooms measured 4 m by 4 m and contained a rectangular table, chair for the feeder, weight-appropriate seating for the child (e.g., booster seat, highchair), food tray, bowls, utensils (e.g., bowl, spoon, cup), timer, gloves, sanitizer, and a food scale. Each room was connected to an adjacent observation room equipped with a one-way observation window and a two-way audio and sound system. For the treatment of solids refusal, caregivers selected 16 foods consisting of four proteins, four starches, four vegetables, and four fruits that the participant did not currently eat. For the treatment of liquids refusal, the program's registered dietitian selected a liquid based on the participant's age and caloric and nutrient needs.

Assessment

For each participant, therapists conducted an unstructured observation with the caregiver presenting preferred and nonpreferred food to the participant. Next, therapists conducted a structured observation in which the caregiver attempted to feed the participant bites and drinks and prompted the participant to self-feed bites and drinks. Third, therapists conducted a functional analysis to determine the variables maintaining inappropriate mealtime behavior (Bachmeyer et al., 2009; Piazza, Fisher, et al., 2003). Therapists conducted separate functional analyses for solids and liquids refusal.

General Procedure

Therapists presented bites and drinks in separate meals and conducted five 40-min meals per day with at least 40 min between each meal. During solids meals, therapists presented four foods per session, one protein, one starch, one vegetable, and one fruit, and presented all foods at a puree texture (i.e., food blended with liquid until smooth). Therapists randomly selected the order of food presentation for each session and presented the same foods across all transition opportunities within a treatment application for resurgence and renewal to control for changes in participant behavior as a result of changes in food type (Patel et al., 2002). During solid meals, therapists initially presented 0.5 cc of pureed food on a rubber-coated baby spoon for three participants, 1 cc of pureed food on a small Maroon spoon for eight participants, and 2 cc of pureed food on a large Maroon spoon for one participant. During liquid meals, therapists initially presented 2 cc in a pink cut-out cup for nine participants and 6 cc in a pink cut-out cup for one participant. Therapists initially presented five bites or drinks on an FT 30-s schedule during each session and conducted multiple sessions per meal. During each session, the therapists presented a bite or drink to the participant's lips or on the table in front of the participant and prompted them to, "Take

a bite or drink." The therapists provided behavior-specific praise (e.g., "Good job taking your drink!") and a 30-s break from bite or drink presentation following acceptance. The therapists conducted a mouth check after the 30-s break by prompting the participant to open their mouth and delivered behavior-specific praise (e.g., "Good job swallowing your drink!") following a mouth clean. The therapists presented the next scheduled bite or drink following a mouth clean until they presented five bites or drinks. If the participant did not have a mouth clean, the therapists presented the next scheduled bite unless the participant had a pre-determined maximum number of bites or drinks in their mouth (e.g., three bites). If this occurred, the therapists checked for a mouth clean every 30 s until the participant had a mouth clean or until the end of the session, after which the therapists removed the food or liquid from the participant's mouth. The clinical team established a maximum number of bites or drinks allowed in the participant's mouth based on their age and the bolus size of the food or liquid (i.e., amount of food on the spoon or liquid in the cup) presented to ensure the participant's safety.

Treatment Evaluation

The clinical team evaluated the efficacy of treatment in an ABAB design prior to arranging opportunities for resurgence or renewal of inappropriate mealtime behavior. During baseline, the therapists provided the functional reinforcer (i.e., escape, attention, or both) for 30 s contingent on inappropriate mealtime behavior. The therapists delivered the type of attention (e.g., coaxes, reprimands) that caregivers delivered following inappropriate mealtime behavior during prior unstructured and structured observations. During function-based extinction of escape-maintained and multiply maintained inappropriate mealtime behavior, the therapists withheld escape via non-removal of the utensil and attention following inappropriate mealtime behavior. Non-removal of the utensil involved presenting the bite or drink to the participant's lips and keeping it there until acceptance or for a pre-determined time (Hoch et al., 1994). For all participants, the therapists also used re-presentation, which involved gathering food or liquid that exited the mouth (i.e., participant expelled or spit out) and re-depositing the food or liquid into the participant's mouth. For two participants (i.e., P2 and P4), the therapists provided noncontingent attention in the form of statements unrelated to food or mealtime behavior during the session. Bite or drink acceptance resulted in praise and removal of the spoon or cup for all participants.

Promoting Meal Efficiency and Volume

After demonstrating the efficacy of treatment (i.e., clinically acceptable rates of inappropriate mealtime behavior and levels of acceptance and mouth clean), the therapists gradually increased the bite- or drink-presentation rate and bolus size to promote meal efficiency and increase gram consumption (i.e., volume of food or liquid; Peterson et al. 2018). The clinical team used visual inspection when making meal-efficiency changes and generally increased the presentation rate and bolus size when participants demonstrated stable and clinically acceptable levels of acceptance and mouth clean (i.e., 80% or greater) and low rates of inappropriate mealtime behavior (e.g., range, 0–2 responses per min) for at least three consecutive sessions (M = 16 sessions; range, 3–65 sessions). The therapists increased the bite- or drink-presentation rate from FT 30 s to FT 15 s and then to FT 5 s. This manipulation results in a shorter break from bite or drink presentations following

acceptance, with each break duration equaling the interval of the FT schedule (e.g., a 15-s break when bite presentations occur according to an FT 15-s schedule). Therefore, the break duration following acceptance decreased with each change to the bite or drink presentation rate (30-s break to 15-s break). The therapists also increased the bolus size or amount presented on the utensil (e.g., 2 cc to 4 cc) or increased the number of bites or drinks presented (e.g., five bites to 10 bites). The order of meal-efficiency changes varied across participants.

Following improvements in inappropriate mealtime behavior with the introduction of treatment, the clinical team determined when to transition participants to a self-feeding format, wherein therapists presented food in a bowl or plate with a spoon and liquid in a cup on the table within the participant's reach and prompted them to self-feed. During self-feeding sessions, the therapists progressively increased the number of bites or volume of the drink towards age-appropriate portions, determined by the program's registered dietitian and based on the participant's age, weight, and activity level.

Caregiver Training

After acquiring stable treatment effects using the criteria described above, the therapists trained the caregiver(s) on the treatment procedures using behavioral skills training. After the caregivers observed a therapist implement the treatment with the participant, the therapist modeled the treatment on another therapist who served as a confederate participant. The confederate participant followed a script and engaged in behavior that the participant engaged in during meals. The caregiver practiced implementing the treatment with the confederate participant until the caregiver implemented the treatment with 80% or greater integrity, after which the caregiver implemented the treatment with the participant. The therapist provided corrective feedback as necessary during treatment sessions to ensure that caregivers maintained high levels of integrity such that changes in the participant's behavior were not a function of integrity decrements. After acquiring stable treatment effects with the caregiver, they implemented the treatment in a new setting (e.g., participant's home). It is important to note that all participants achieved clinically acceptable rates of inappropriate mealtime behavior and levels of appropriate behavior (e.g., acceptance, mouth clean) both in the clinic with therapists and in the home with caregivers prior to discharge from the feeding program. Additionally, when possible, the clinical team continued to monitor the participants and their families on an outpatient basis (e.g., 1 hr weekly or biweekly appointments) to work on age-typical feeding goals.

Results

Figure 1 provides a flow diagram showing the participant-selection process and the inclusion process for applications and transitions. The experimenters screened 38 children for eligibility (18 from 2017, 17 from 2018, three from 2019). Of the participants screened, 37 were eligible for the analysis of treatment applications. Sixteen participants met exclusion criteria during the treatment-application analysis, which led to the inclusion of 21 participants aged 1–11 years. Fifty-eight potentially eligible treatment applications were included within the 21 eligible participants. Of the 58 eligible treatment applications, 22

included resurgence, 25 included renewal, and 11 applications met exclusion criteria. Of the 22 resurgence applications, 12 were non-self-fed solids treatments, eight were non-self-fed liquids treatments, and two were self-fed liquids treatments. Of the 25 renewal applications, 14 were non-self-fed solids treatments, 10 were non-self-fed liquids treatments, and one was self-fed liquids treatment. All but two of these treatment applications addressed escape-maintained inappropriate mealtime behavior. The remaining two treatment applications addressed multiply maintained inappropriate mealtime behavior.

Review of the applications led to the inclusion of 59 transitions for resurgence and 38 for renewal (97 total transitions). For resurgence transitions, 31 were changes to the bite or drink presentation rate (e.g., FT 30 s to FT 15 s), six were changes to the number of bite or drinks presented (e.g., two drinks to three drinks), and 22 were changes to the bolus size or amount per spoon or cup (e.g., 2 cc to 4 cc). For renewal transitions, 31 were feeder changes (e.g., therapist to caregiver), and seven were setting changes (e.g., clinic to home).

Figure 2 shows the number of participants, treatment applications, and transitions with resurgence and renewal. Resurgence and renewal occurred across every level of analysis. Resurgence of inappropriate mealtime behavior occurred in 41% (7/17) of participants, 41% (9/22) of treatment applications, and 25% (15/59) of transitions. Renewal of inappropriate mealtime behavior occurred in 63% (12/19) of participants, 52% (13/25) of treatment applications, and 47% (18/38) of transitions.

Figure 3 shows resurgence and renewal of inappropriate mealtime behavior when analyzed by transition type. All transition types produced relapse in at least a portion of the transitions. Resurgence occurred following 33% (2/6) of transitions with a bite- or drink-presentation-number change, 27% (6/22) of transitions with a bolus-size change, and 23% (7/31) of transitions with a bite- or drink-presentation-rate change. Renewal occurred following 48% (15/31) of transitions with a feeder change from therapist to caregiver and 43% (3/7) of transitions with a setting change from clinic to home or another clinic room.

Figure 4 shows resurgence (left panel) and renewal (right panel) of inappropriate mealtime behavior and decrements in alternative behavior (i.e., acceptance and mouth clean) across participants, treatment applications, and transitions. Data on inappropriate mealtime behavior from Figure 2 are replotted in Figure 4 to facilitate comparisons across the dependent measures. For the resurgence evaluation, decrements in acceptance occurred in 47% (8/17) of participants, 36% (8/22) of treatment applications, and 15% (9/59) of transitions. Decrements in mouth clean occurred in 36% (4/11) of participants, 29% (4/14) of treatment applications, and 19% (6/31) of transitions. For the renewal evaluation, decrements in acceptance occurred in 50% (9/18) of participants, 48% (11/23) of treatment applications, and 49% (17/35) of transitions and decrements in mouth clean occurred in 15% (2/13) of participants, 12% (2/17) of applications, and 9% (2/23) of transitions.

Figure 5 shows the magnitude and persistence of inappropriate mealtime behavior during resurgence (left panel) and renewal (right panel) evaluations represented as a proportion of baseline responding. The experimenters calculated proportional values for 100% of transitions with each line representing a transition in which relapse occurred, and the

weighted line indicates mean responding. Proportional values above 1.0 indicate when responding exceeded the baseline average. The general patterns of resurgence and renewal were highly similar, with both transition types capable of showing considerable increases in responding. Plotting the transition data in this way also shows that inappropriate mealtime behavior did not always decrease across sessions of Condition B, suggesting that repeated exposure following such transitions (e.g., continuing sessions with a larger bolus or with a novel feeder despite relapse) may not reduce inappropriate mealtime behavior quickly.

Discussion

The present study contributes to the burgeoning area of treatment relapse in several ways. This is the first study to describe the scope or characteristics of resurgence of inappropriate mealtime behavior, and the first to evaluate the prevalence of renewal of inappropriate mealtime behavior in a consecutive controlled case series. The experimenters evaluated the prevalence, persistence, and magnitude of resurgence and renewal within each transition, which sometimes demonstrated that relapsed inappropriate mealtime behavior maintained or worsened with continued exposure to the transition. The experimenters also analyzed alternative behavior (i.e., acceptance and mouth clean) and found that relapse of inappropriate mealtime behavior often co-occurred with decrements in acceptance and mouth clean. The results of the current study support previous research highlighting the need for a broadened analysis of resurgence (e.g., Fontes et al., 2018; Nighbor et al., 2020).

Resurgence occurred across all transition types and was most likely to occur following changes to the number of bites or drinks presented, followed by the bolus size, then the bite- or drink-presentation rate. Interestingly, resurgence of inappropriate mealtime behavior was not as ubiquitous (i.e., 41% of participants and applications and 25% of transitions) as the prevalence of resurgence of destructive behavior reported by Briggs et al. (2018) and Muething, Pavlov, et al. (2020), in which resurgence occurred in 76% (19/25) of applications and 91% (29/32) of participants, respectively. Across these two studies, resurgence occurred in 42% (47/111) and 41% (97/239) of transitions, respectively. However, opportunities for resurgence of destructive behavior have generally entailed decreases in reinforcer availability for alternative behavior (e.g., increases in extinction duration or number of demands), whereas opportunities for resurgence of inappropriate mealtime behavior in the present study entailed similar changes (e.g., increases in number of bites presented) but also increases in demand rate (e.g., bite-presentation rate) and response effort (e.g., bolus-size increase). Conceptually, these procedural differences may be described as a general worsening of conditions for alternative behavior (i.e., acceptance and mouth clean) that may precipitate resurgence (Fontes et al., 2018; Greer & Shahan, 2019; Nighbor et al., 2020; Shahan & Craig, 2017).

During feeding treatment, meal-efficiency changes (e.g., increasing the bite number, presentation rate, or bolus size) may be conceptualized as a worsening of conditions for acceptance and mouth clean for several reasons. First, these changes may represent increased response effort associated with eating (Kerwin et al., 1995). Kerwin et al. (1995) found that acceptance and mouth clean varied as a function of food volume such that participants were less likely to accept and swallow bites as the bolus size increased. The

experimenters postulated that increases in food volume may represent increased response effort for some children with a feeding disorder. This may be especially relevant to consider for children with limited oral-eating histories (e.g., feeding-tube dependence) who have minimal opportunities to develop and practice oral-motor skills necessary for efficient eating. Eating may be more effortful for these children as they may need to compensate for skill deficits (e.g., tongue weakness interfering with efficiently propelling the bolus back to swallow). In the current study, mouth-clean decrements occurred slightly more often during resurgence transitions (19%) relative to renewal transitions (9%), and all decrements were due to packing (i.e., holding the bite/drink in the mouth). Thus, some participants with oral-motor delays may have had difficulty initially managing some meal-efficiency changes (e.g., packing as a result of difficulty with swallowing a larger bolus). Alternatively, meal-efficiency changes may increase an aversive property of the feeding demand (e.g., quantity) for some children. Studies have shown that children with a feeding disorder may chose not to eat when given the choice between self-feeding one bite or not eating (Rivas et al., 2014; Vaz et al., 2011). Thus, eating may be a less-preferred alternative to not eating for some children, and requiring increased meal efficiency may further increase the aversiveness of feeding-related demands. However, this is speculative and should be further examined.

Although resurgence did not occur universally across treatment applications, the present data suggest that clinicians should anticipate resurgence of inappropriate mealtime behavior at least once in approximately half of their admissions when using similar treatments. Further, about one quarter of attempts to increase meal efficiency (e.g., increase presentation rate) or volume of consumption (e.g., bolus size or bite/drink number) might produce resurgence of inappropriate mealtime behavior. However, additional research in this area is needed to determine the generality of these findings across other participant characteristics (e.g., picky eaters), textures (e.g., regular-textured foods), and treatments (e.g., function-based differential reinforcement).

The current findings closely approximate those reported by Muething, Call, et al. (2020) who observed renewal of destructive behavior in 67% (45/67) of participants and 42% (77/182) of transitions and differ slightly from Falligant et al. (2021), who observed renewal of destructive behavior in 59% of participants and 24% of transitions. However, renewal occurred more often following a change in implementer (i.e., feeder) than setting, similar to Falligant et al., whereas Muething, Call, et al. found equal prevalence of renewal across context changes. Overall, the current data corroborate the growing literature demonstrating that changes in implementers and settings may occasion renewal regardless of participant characteristics, contextual stimuli, intervention type, or target behavior (Saini & Mitteer, 2020).

A limitation of the present study is that some participants experienced similar transitions across treatment applications (e.g., FT 30-s to FT 15-s presentation rate during non-self-feeding solids and non-self-feeding liquids treatment). Therefore, exposure to the same transition type across treatment applications may have influenced the likelihood of relapse. However, resurgence occurred regardless of the transition order (e.g., rate before a bolus-size change and vice versa). Additionally, correct procedure decreased to 80% during six resurgence (6/295) and renewal (6/210) transition sessions. Thus, relapse may have

been influenced by these procedural-integrity decrements. However, inappropriate mealtime behavior recurred during zero and two of these transition sessions for resurgence and renewal evaluations, respectively, limiting the likelihood that such procedural variation impacted the findings. Additionally, although transitions did not co-occur (e.g., simultaneous bolus-size and feeder change), feeders did not hold the overall meal volume constant during some meal-efficiency changes for some participants. For example, increasing the bolus size may have also increased the meal volume (e.g., 2-cc bolus with 10-cc meal volume to 4-cc bolus with 20-cc meal volume) for some participants. Although resurgence occurred regardless of whether the meal volume changed, evaluating the separate and combined effects of transition changes such as these could be an area for future research. For example, researchers could evaluate super-resurgence when opportunities for resurgence and renewal co-occur (Kincaid et al., 2015). This may be particularly relevant to examine during feeding treatments as multiple transitions may co-occur in the natural environment (e.g., bolus and feeder change). Another limitation of the study was that the range of sessions conducted to meet stability criteria for introducing a meal-efficiency change ranged from three to 65. Although resurgence could have been influenced by the phase duration that preceded the transition, this did not appear likely as resurgence occurred regardless of the phase duration preceding a meal-efficiency change (e.g., after three sessions or 21 sessions). Finally, all data were transcribed and reviewed by the authors, who were not blind to the study's purpose.

Overall, the current findings suggest that resurgence and renewal of inappropriate mealtime behavior are common and clinicians should consider evaluating relapse-mitigation strategies to offset their occurrence. It is often necessary to introduce changes during feeding treatments that may produce resurgence (e.g., increasing bolus size or presentation rate) or renewal (e.g., introducing novel feeders and meal settings) to ensure treatment progress and generality. As such, researchers have begun evaluating procedures to mitigate renewal of inappropriate mealtime behavior (Haney et al., 2021; Kelley et al., 2018) and have found that stimulus fading (e.g., pairing caregiver with treatment cues) and arranging common stimuli (e.g., arranging room like home) may lessen the magnitude of renewal.

However, research on the resurgence of inappropriate mealtime behavior is limited, and no analogous resurgence-mitigation procedures have been investigated. Researchers have evaluated the utility of resurgence-mitigation techniques for other behavior with humans and non-human animals, including: (a) using discriminative stimuli to signal extinction and reinforcement (Craig et al., 2017; Fisher et al., 2020; Fuhrman et al., 2016; Shvarts et al., 2020; Trask, 2019), (b) conducting treatment in unique contexts (e.g., Suess et al., 2020), and (c) teaching multiple alternative behaviors (e.g., Lambert et al., 2015). It is currently unclear to what extent these procedures may prevent resurgence of inappropriate mealtime behavior. Thus, resurgence-mitigation procedures for inappropriate mealtime behavior should be evaluated. For example, researchers could evaluate whether programming variability in bolus size earlier in treatment could reduce the number of otherwise discriminable increases in bolus size later on. It is unclear whether gradually increasing the bolus size (e.g., 2 cc to 4 cc to 8 cc) or presentation rate (i.e., FT 30 s to FT 15 s to FT 5 s) in the current study was necessary or if larger increases (e.g., 2 cc to 8 cc or FT 30 s to FT 5 s) could have produced similar treatment effects. Future research could also evaluate whether the transition presentation order (e.g., sequential [rate then

bolus] vs. simultaneous [rate and bolus]) differentially influences resurgence and whether these resurgence-mitigation strategies are efficacious for children with oral-motor delays. Clinicians should consider that effectively mitigating relapse may require a combination of strategies. Future researchers should investigate the generality of promising strategies for mitigating the resurgence of inappropriate mealtime behavior while also focusing on procedures for mitigating its renewal.

Acknowledgments

Clinical data for this project were collected at the University of Nebraska Medical Center's Munroe-Meyer Institute. Grants 2R01HD079113, 5R01HD083214, and 5R01HD093734 from the National Institute of Child Health and Human Development provided partial support for this work.

References

Bachmeyer MH, Kirkwood CA, Criscito AB, Mauzy CR IV., & Berth DP (2019). A comparison of functional analysis methods of inappropriate mealtime behavior. Journal of Applied Behavior Analysis, 52(3), 603–621. 10.1002/jaba.556 [PubMed: 30912579]

Bachmeyer MH, Piazza CC, Fredrick LD, Reed GK, Rivas KD, & Kadey HJ (2009). Functional analysis and treatment of multiply controlled inappropriate mealtime behavior. Journal of Applied Behavior Analysis, 42(3), 641–658. 10.1901/jaba.2009.42-641 [PubMed: 20190924]

Borrero CSW, Woods JN, Borrero JC, Masler EA, & Lesser AD (2010). Descriptive analysis of pediatric food refusal and acceptance. Journal of Applied Behavior Analysis, 43(1), 71–88. 10.1901/jaba.2010.43-71 [PubMed: 20808496]

Bouton ME, Todd TP, Vurbic D, & Winterbauer NE (2011). Renewal after the extinction of free operant behavior. Learning & Behavior, 39(1), 57–67. 10.3758/s13420-011-0018-6 [PubMed: 21279496]

Briggs AM, Fisher WW, Greer BD, & Kimball RT (2018). Prevalence of resurgence of destructive behavior when thinning reinforcement schedules during functional communication training. Journal of Applied Behavior Analysis, 51(3), 620–633. 10.1002/jaba.472 [PubMed: 29774545]

Bullock CE, Fisher WW, & Hagopian LP (2017). Description and validation of a computerized behavioral data program: "BDataPro." The Behavior Analyst, 40(1), 275–285. 10.1007/s40614-016-0079-0 [PubMed: 31976934]

Corbett SS, & Drewett RF (2004). To what extent is failure to thrive in infancy associated with poorer cognitive development? A review and meta-analysis. The Journal of Child Psychology and Psychiatry, 45(3), 641–654. 10.1111/j.1469-7610.2004.00253.x [PubMed: 15055382]

Craig AR, Browning KO, Nall RW, Marshall CM, & Shahan TA (2017). Resurgence and alternative-reinforcer magnitude. Journal of the Experimental Analysis of Behavior, 107(2), 218–233. 10.1002/jeab.245 [PubMed: 28194793]

Falligant JM, Kranak MP, McNulty MK, Schmidt JD, Hausman NL, & Rooker GW (2021). Prevalence of renewal of problem behavior: Replication and extension to an inpatient setting. Journal of Applied Behavior Analysis, 54(1), 367–373. 10.1002/jaba.740 [PubMed: 32578889]

Fisher WW, Fuhrman AM, Greer BD, Mitteer DR, & Piazza CC (2020). Mitigating resurgence of destructive behavior using the discriminative stimuli of a multiple schedule. Journal of the Experimental Analysis of Behavior, 113(1), 263–277. 10.1002/jeab.552 [PubMed: 31621919]

Fontes RM, Todorov JC, & Shahan TA (2018). Punishment of an alternative behavior generates resurgence of a previously extinguished target behavior. Journal of the Experimental Analysis of Behavior, 110(2), 171–184. 10.1002/jeab.465 [PubMed: 30063073]

Fuhrman AM, Fisher WW, & Greer BD (2016). A preliminary investigation on improving functional communication training by mitigating resurgence of destructive behavior. Journal of Applied Behavior Analysis, 49(4), 884–899. 10.1002/jaba.338 [PubMed: 27449566]

Goday PS, Huh SY, Silverman A, Lukens CT, Dodrill P, Cohen SS, Delaney AL, Feuling MB, Noel RJ, Gisel E, Kenzer A, Kessler DR, Kraus de Camargo O, Browne J, & Phalen JA (2019).

Pediatric feeding disorder: Consensus definition and conceptual framework. Journal of Pediatric Gastroenterology and Nutrition, 68(1), 124–129. 10.1097/MPG.0000000000002188 [PubMed: 30358739]

Greer BD, Fisher WW, Saini V, Owen TM, & Jones JK (2016). Functional communication training during reinforcement schedule thinning: An analysis of 25 applications. Journal of Applied Behavior Analysis, 49(1), 105–121. 10.1002/jaba.265 [PubMed: 26482103]

Greer BD, & Shahan TA (2019). Resurgence as Choice: Implications for promoting durable behavior change. Journal of Applied Behavior Analysis, 52(3), 816–846. 10.1002/jaba.573 [PubMed: 31049954]

Groff RA, Piazza CC, Volkert VM, & Jostad CM (2011). Syringe fading as treatment for feeding refusal. Journal of Applied Behavior Analysis, 44(4), 949–954. 10.1901/jaba.2011.44-949 [PubMed: 22219546]

Hagopian LP (2020). The consecutive controlled case series: Design, data-analytics, and reporting methods supporting the study of generality. Journal of Applied Behavior Analysis, 53(2), 596–619. 10.1002/jaba.691 [PubMed: 32125716]

Hagopian LP, Boelter EW, & Jarmolowicz DP (2011). Reinforcement schedule thinning following functional communication training: Review and recommendations. Behavior Analysis in Practice, 4(1), 4–16. 10.1007/BF03391770

Haney SD, Piazza CC, Peterson KM, & Greer BD (2021). An evaluation of a renewal-mitigation procedure for inappropriate mealtime behavior. Journal of Applied Behavior Analysis, 54(3), 903–927. 10.1002/jaba.815 [PubMed: 33570178]

Hoch TA, Babbitt RL, Coe DA, Krell DM, & Hackbert L (1994). Contingency contacting: Combining positive reinforcement and escape extinction procedures to treat persistent food refusal. Behavior Modification, 18(1), 106–128. 10.1177/01454455940181007 [PubMed: 8037643]

Ibañez VF, Piazza CC, & Peterson KM (2019). A translational evaluation of renewal of inappropriate mealtime behavior. Journal of Applied Behavior Analysis, 52(4), 1005–1020. 10.1002/jaba.647 [PubMed: 31642527]

Kelley ME, Jimenez-Gomez C, Podlesnik CA, & Morgan A (2018). Evaluation of renewal mitigation of negatively reinforced socially significant operant behavior. Learning and Motivation, 63, 133–141. 10.1016/j.lmot.2018.05.003

Kelley ME, Liddon CJ, Ribeiro A, Greif AE, & Podlesnik CA (2015). Basic and translational evaluation of renewal of operant responding. Journal of Applied Behavior Analysis, 48(2), 390–401. 10.1002/jaba.209 [PubMed: 25891414]

Kerwin ME, Ahearn WH, Eicher PS, & Burd DM (1995). The costs of eating: A behavioral economic analysis of food refusal. Journal of Applied Behavior Analysis, 28(3), 245–260. 10.1901/jaba.1995.28-245 [PubMed: 7592142]

Kincaid SL, Lattal KA, & Spence J (2015). Super-resurgence: ABA renewal increases resurgence. Behavioural Processes, 115, 70–73. 10.1016/j.beproc.2015.02.013 [PubMed: 25712040]

Kreipe RE, & Palomaki A (2012). Beyond picky eating: Avoidant restrictive food intake disorder. Current Psychiatry Reports, 14(4), 421–431. 10.1007/s11920-012-0293-8 [PubMed: 22665043]

Lambert JM, Bloom SE, Samaha AL, Dayton E, & Rodewald AM (2015). Serial alternative response training as intervention for target response resurgence. Journal of Applied Behavior Analysis, 48(4), 765–780. 10.1002/jaba.253 [PubMed: 26404022]

Mitteer DR, Greer BD, Randall KR, & Haney SD (in press). On the scope and characteristics of relapse when treating destructive behavior. Journal of Applied Behavior Analysis.

Muething C, Call N, Pavlov A, Ringdahl J, Gillespie S, Clark S, & Mevers JL (2020). Prevalence of renewal of problem behavior during context changes. Journal of Applied Behavior Analysis, 53(3), 1485–1493. 10.1002/jaba.672 [PubMed: 31907921]

Muething C, Pavlov A, Call N, Ringdahl J, & Gillespie S (2020). Prevalence of resurgence during thinning of multiple schedules of reinforcement following functional communication training. Journal of Applied Behavior Analysis, 54(2), 813–823. 10.1002/jaba.791 [PubMed: 33103244]

Nighbor TD, Oliver AC, & Lattal KA (2020). Resurgence without overall worsening of alternative reinforcement. Behavioural Processes, 179, 104219. 10.1016/j.beproc.2020.104219 [PubMed: 32777262]

Patel MR, Piazza CC, Kelly ML, Ochsner CA, & Santana CM (2001). Using a fading procedure to increase fluid consumption in a child with feeding problems. Journal of Applied Behavior Analysis, 34(3), 357–360. 10.1901/jaba.2001.34-357 [PubMed: 11678534]

Patel MR, Piazza CC, Martinez CJ, Volkert VM, & Santana CM (2002). An evaluation of two differential reinforcement procedures with escape extinction to treat food refusal. Journal of Applied Behavior Analysis, 35(4), 363–374. 10.1901/jaba.2002.35-363 [PubMed: 12555908]

Peterson KM, Ibañez VF, Kirkwood CA, Crowley JG, & Piazza CC (2018). Assessment of pediatric feeding disorders. In Matson J (Ed.), Handbook of childhood psychopathology and developmental disabilities assessment: Autism and child psychopathology series. (pp. 415–431). Springer. 10.1007/978-3-319-93542-3_22

Piazza CC, Fisher WW, Brown KA, Shore BA, Patel MR, Katz RM, & Blakely- Smith A (2003). Functional analysis of inappropriate mealtime behaviors. Journal of Applied Behavior Analysis, 36(2), 187–204. 10.1901/jaba.2003.36-187 [PubMed: 12858984]

Piazza CC, Ibañez VF, Ney HM, Kirkwood CA, & Crowley JG (2017). Assessment and treatment of pediatric feeding disorders. Archives of Practitioner Resources for Applied Behavior Analysts. Western Michigan University.

Piazza CC, Patel MR, Gulotta CS, Sevin BM, & Layer SA (2003). On the relative contributions of positive reinforcement and escape extinction in the treatment of food refusal. Journal of Applied Behavior Analysis, 36(3), 309–324. 10.1901/jaba.2003.36-309 [PubMed: 14596572]

Piazza CC, Patel MR, Santana CM, Goh H, Delia MD, & Lancaster BM (2002). An evaluation of simultaneous and sequential presentation of preferred and nonpreferred food to treat food selectivity. Journal of Applied Behavior Analysis, 35(3), 259–270. 10.1901/jaba.2002.35-259 [PubMed: 12365739]

Podlesnik CA, Kelley ME, & Jimenez-Gomez C, & Bouton ME. (2017). Renewed behavior produced by context change and its implications for treatment maintenance: A review. Journal of Applied Behavior Analysis, 50(3), 675–697. 10.1002/jaba.400 [PubMed: 28608584]

Reed GK, Piazza CC, Patel MR, Layer SA, Bachmeyer MH, Bethke SD, & Gutshall KA (2004). On the relative contributions of noncontingent reinforcement and escape extinction in the treatment of food refusal. Journal of Applied Behavior Analysis, 37(1), 27–42. 10.1901/jaba.2004.37-27 [PubMed: 15154213]

Rivas KM, Piazza CC, Roane HS, Volkert VM, Stewart V, Kadey HJ, & Groff RA (2014). Analysis of self-feeding in children with feeding disorders. Journal of Applied Behavior Analysis, 47(4), 710–722. 10.1002/jaba.170 [PubMed: 25311615]

Saini V, & Mitteer DR (2020). A review of investigations of operant renewal with human subjects: Implications for theory and practice. Journal of the Experimental Analysis of Behavior, 113(1), 105–123. 10.1002/jeab.562 [PubMed: 31758573]

Shahan TA, & Craig AR (2017). Resurgence as Choice. Behavioural Processes, 141, 100–127. 10.1016/j.beproc.2016.10.006 [PubMed: 27794452]

Shahan TA, & Greer BD (2021). Destructive behavior increases as a function of reductions in alternative reinforcement during schedule thinning: A retrospective quantitative analysis. Journal of the Experimental Analysis of Behavior, 116(2), 243–248. 10.1002/jeab.708 [PubMed: 34219242]

Shvarts S, Jimenez-Gomez C, Bai JYH, Thomas RR, Oskam JJ, & Podlesnik CA (2020). Examining stimuli paired with alternative reinforcement to mitigate resurgence in children diagnosed with autism spectrum disorder and pigeons. Journal of the Experimental Analysis of Behavior, 113(1), 214–231. 10.1002/jeab.575 [PubMed: 31856325]

Suess AN, Schieltz KM, Wacker DP, Detrick J, & Podlesnik CA (2020). An evaluation of resurgence following functional communication training conducted in alternative antecedent contexts via telehealth. Journal of the Experimental Analysis of Behavior, 113(1), 278–301. 10.1002/jeab.551 [PubMed: 31617951]

Todd TP (2013). Mechanisms of renewal after the extinction of instrumental behavior. Journal of Experimental Psychology: Animal Behavior Processes, 39(3), 193–207. 10.1037/a0032236 [PubMed: 23627796]

Trask S (2019). Cues associated with alternative reinforcement during extinction can attenuate resurgence of an extinguished instrumental response. Learning & Behavior, 47(1), 66–79. 10.3758/s13420-018-0339-9 [PubMed: 30054852]

Vaz PCM, Volkert VM, & Piazza CC (2011). Using negative reinforcement to increase self-feeding in a child with food selectivity. Journal of Applied Behavior Analysis, 44(4), 915–920. 10.1901/jaba.2011.44-915 [PubMed: 22219540]

Volkert VM, & Piazza CC (2012). Pediatric feeding disorders. In Sturmey P & Hersen M (Eds.), Handbook of evidence-based practice in clinical psychology: Vol 1. Child and adolescent disorders (pp. 323–337). John Wiley & Sons. 10.1002/9781118156391.ebcp001013

von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, & Vandenbroucke JP (2008). The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. Journal of Clinical Epidemiology, 61(4), 344–349. 10.1016/j.jclinepi.2007.11.008 [PubMed: 18313558]

Wacker DP, Harding JW, Berg WK, Lee JF, Schieltz KM, Padilla YC, Nevin JA, & Shahan TA (2011). An evaluation of persistence of treatment effects during long-term treatment of destructive behavior. Journal of the Experimental Analysis of Behavior, 96(2), 261–282. 10.1901/jeab.2011.96-261 [PubMed: 21909168]

Wathen SN, & Podlesnik CA (2018). Laboratory models of treatment relapse and mitigation techniques. Behavior Analysis: Research and Practice, 18(4), 362–387. 10.1037/bar0000119

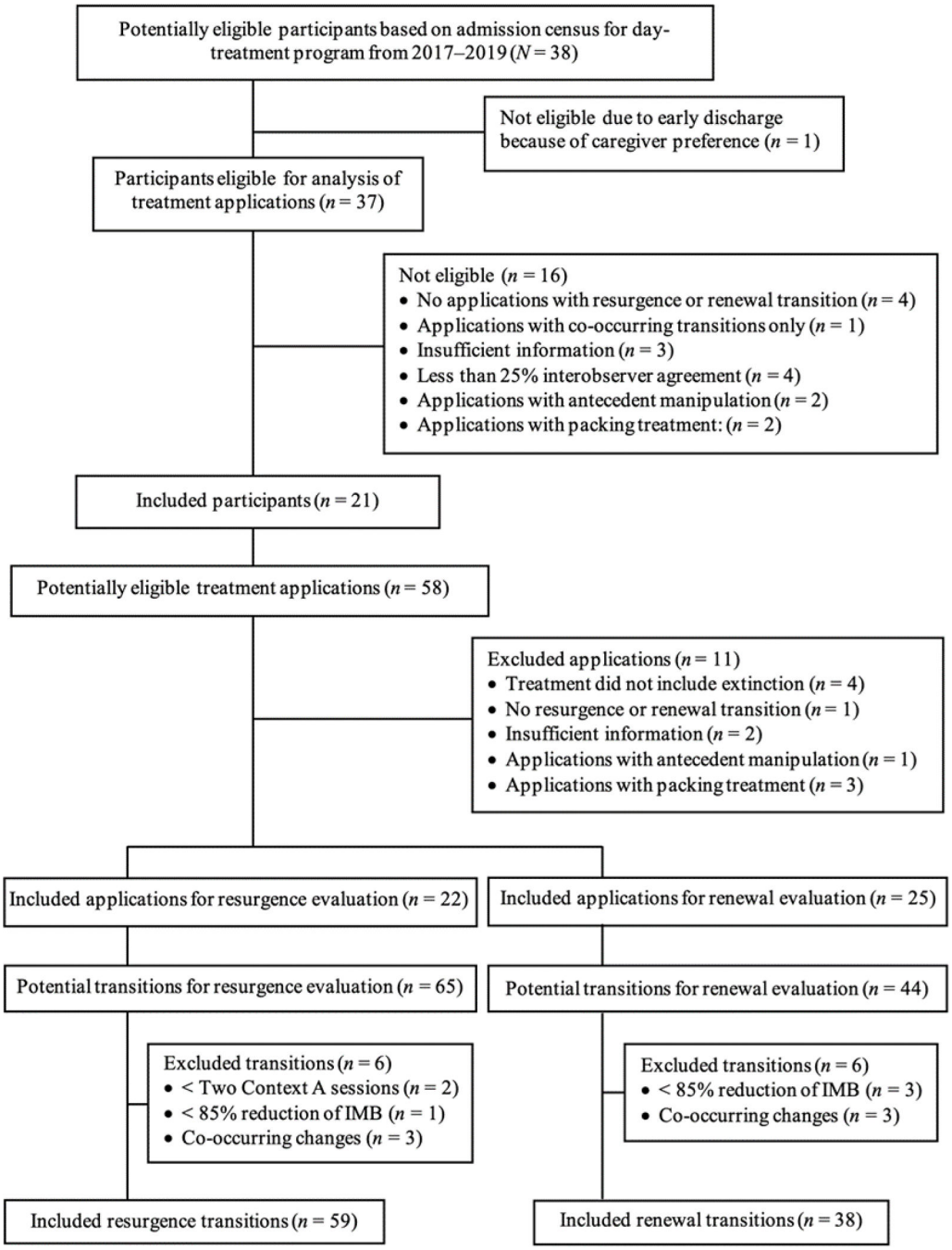

Figure 1.

Flow Diagram of Inclusion and Exclusion Process

Note. IMB = inappropriate mealtime behavior.

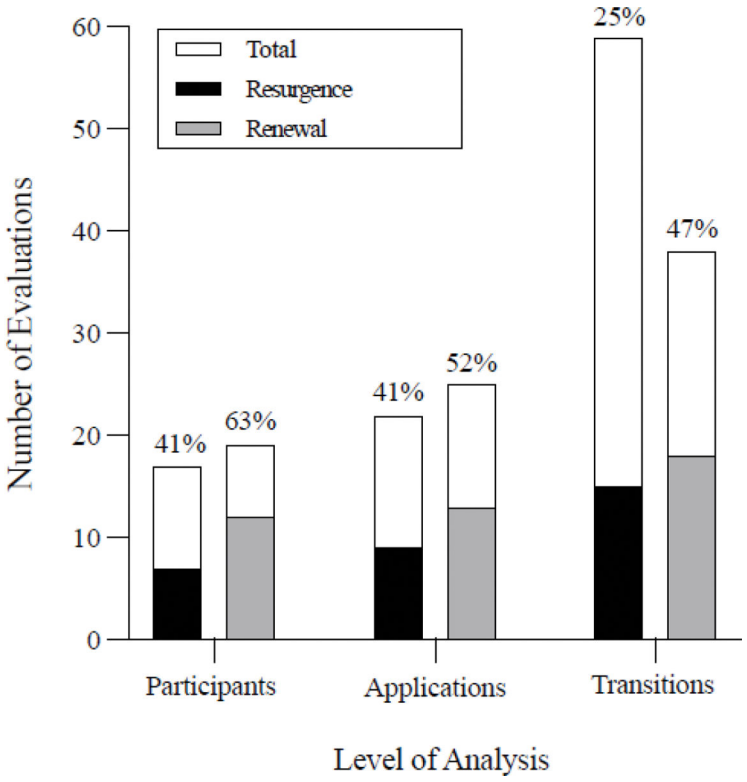

Figure 2.
Relapse Across Participants, Applications, and Transitions

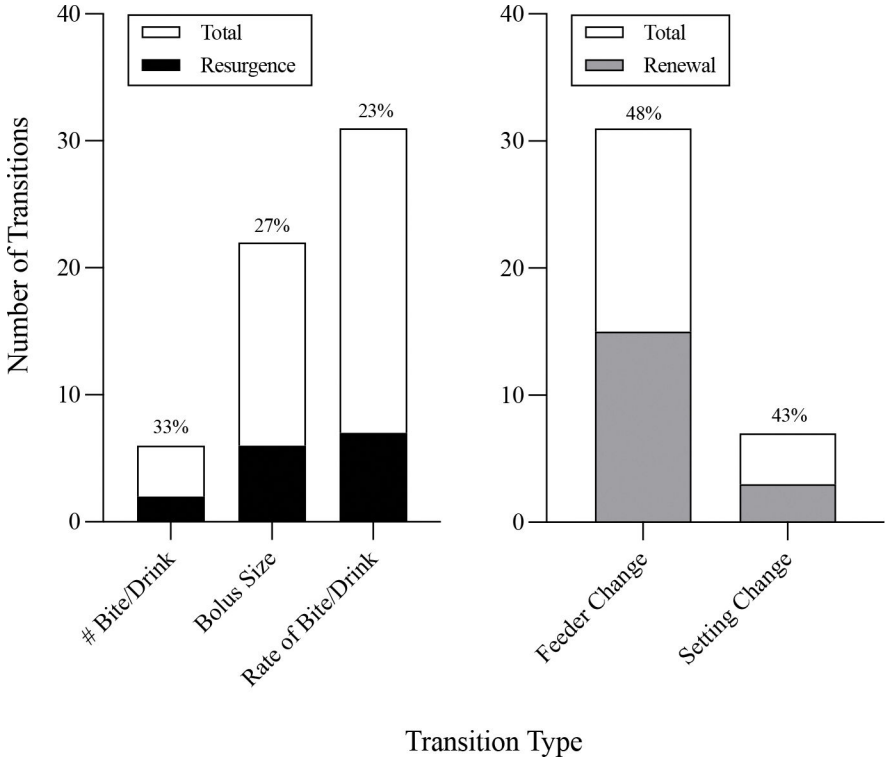

Figure 3.
Relapse by Transition Type

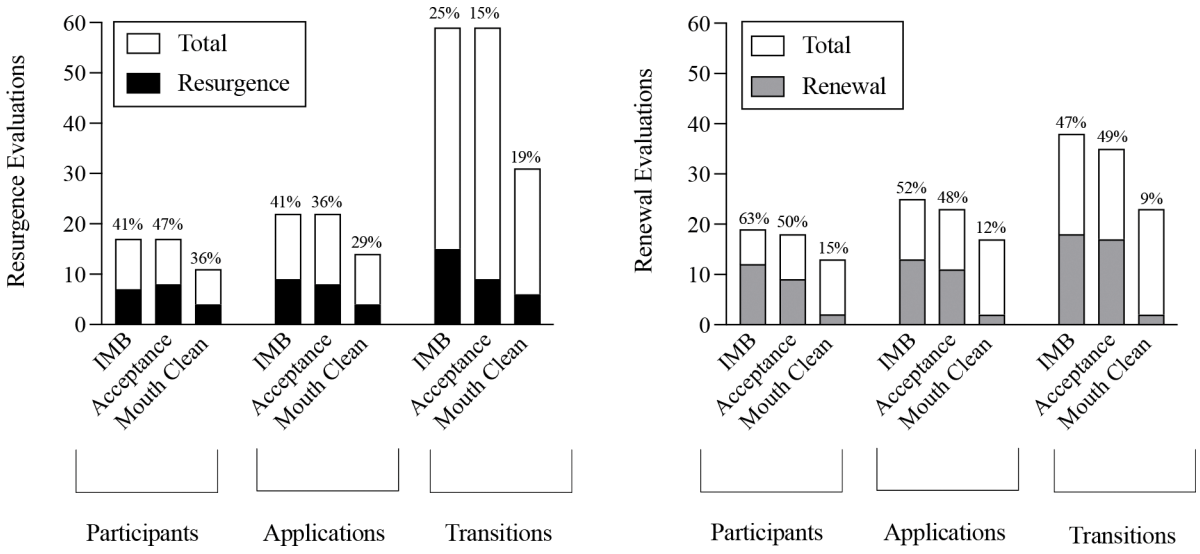

Figure 4.

Relapse by Dependent Variable Across Participants, Applications, and Transitions

Note. IMB = inappropriate mealtime behavior.

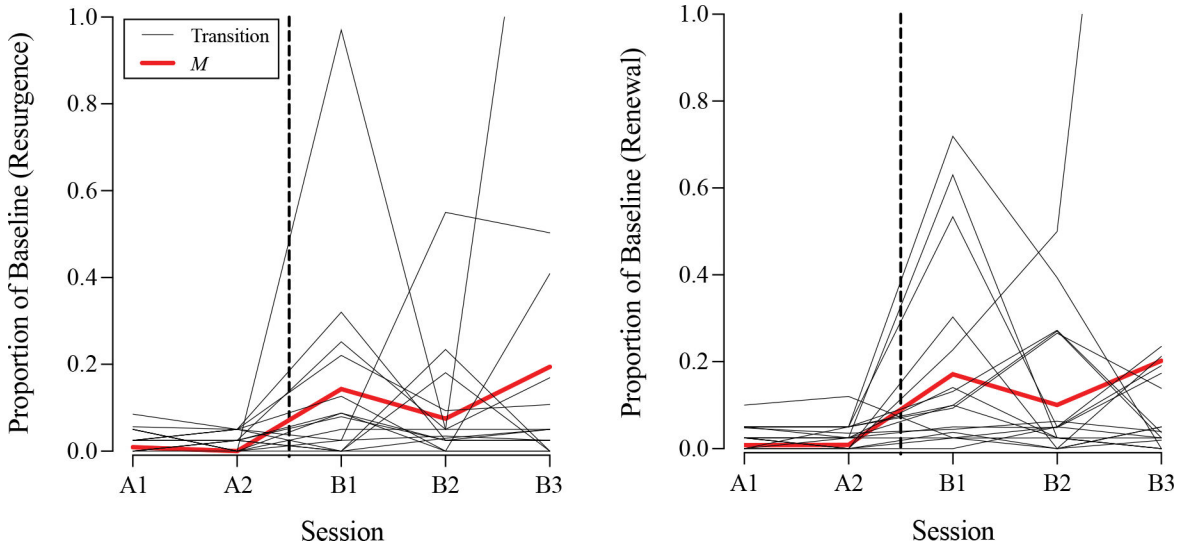

Figure 5.

Magnitude and Persistence of Relapse

Note. Resurgence (left panel) and renewal (right panel) of inappropriate mealtime behavior expressed as a proportion of baseline responding across transitions with relapse. The weighted line indicates mean responding at each session. A1 and A2 represent sessions immediately preceding the transition. B1, B2, and B3 represent sessions immediately following the transition. To facilitate inspection of all transitions, we nudged duplicate values across transitions by up to +/−0.05. However, mean lines reflect computation of the actual values from each session.

J Appl Behav Anal. Author manuscript; available in PMC 2023 April 12.

Table 1

Participant Demographics

Participant	Age	Diagnoses	Treatment Applications w/ Resurgence Possible	Treatment Applications w/ Renewal Possible	Resurgence Transition Type (*n*)	Renewal Transition Type (*n*)
1	2	ASD, food allergies, food selectivity, eosinophilic colitis	1	2	Rate (1)	Setting (1), Feeder (1)
2	11	ASD, Down syndrome, feeding tube dependence, food refusal, poor growth	0	1	—	Feeder (1)
3	5	ASD, food allergies, feeding tube dependence, food refusal, failure to thrive	1	1	Rate (2), Bolus (2), Bite Number (3)	Feeder (1)
4	3	IDD, feeding tube dependence, food refusal, reflux, oral motor delays, poor growth	1	1	Rate (2), Bolus (1)	Feeder (2), Setting (1)
5	4	Oral motor delays, food selectivity	1	1	Rate (1)	Feeder (2)
6	1	Shwachman-Diamond syndrome, feeding tube dependence, food and liquid refusal, oral motor delays	1	3	Rate (1)	Feeder (2), Setting (1)
7	6	Food selectivity	0	1	—	Feeder (1)
8	3	Feeding tube dependence, food refusal, oral motor delays	1	1	Rate (1)	Feeder (1)
9	6	ASD, food selectivity	1	0	Rate (1), Bolus (1)	—
10	4	ASD, food allergies, feeding tube dependence, oral motor delays, vitamin D deficiency	2	0	Rate (3), Bolus (1)	—
11	4	Congenital heart disease, food allergies, reflux, food selectivity	1	1	Rate (2)	Feeder (2)
12	5	ASD, Down syndrome, food allergies, food selectivity, poor growth, low oral intake, oral motor delays	1	1	Bolus (1)	Feeder (2)
13	5	Denys-Drash syndrome, kidney disease, feeding tube dependence	2	1	Rate (4), Bolus (4)	Feeder (1)
14	5	ASD, food selectivity	0	1	—	Feeder (1)
15	6	ASD, food selectivity	2	2	Bolus (2), Rate (2)	Feeder (2)
16	3	Feeding tube dependence, reflux, oral motor delays, poor growth	1	1	Bolus (1)	Feeder (1)
17	5	ASD, food selectivity	2	1	Drink Number (3), Bolus (5)	Feeder (1)
18	4	Food allergies, oral motor delays, food selectivity	0	2	—	Feeder (2)
19	4	DiGeorge syndrome, feeding tube dependence, food and liquid refusal, reflux, oral motor delays, low oral intake, poor growth	2	2	Rate (4)	Feeder (5)
20	3	Intestinal failure, short-bowel syndrome, total parenteral nutrition dependence, feeding tube dependence, reflux	1	1	Bolus (1), Rate (4)	Feeder (2), Setting (1)
21	4	ASD, oral motor delays, food selectivity	1	1	Rate (3), Bolus (3)	Feeder (1), Setting (3)

Note. ASD = autism spectrum disorder. Table includes the number of treatment applications and transition opportunities for resurgence and renewal that met the inclusion criteria.