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A comparison of displacement and reinforcer potency for typically developing children

Adam B. Carter and Kimberley L. M. Zonneveld

BROCK UNIVERSITY

Previous researchers found that individuals with intellectual and developmental disabilities tend to prefer edible over leisure stimuli, although leisure stimuli may still function as reinforcers. We replicated and extended previous research in a 2-part experiment with typically developing children. In Experiment 1, we evaluated 15 children's preference for leisure and edible stimuli. Five of 15 participants preferred edible over leisure stimuli, 3 of 15 participants preferred leisure over edible stimuli, and the remaining 7 of 15 participants did not show a preference for a stimulus class. In Experiment 2, we compared the reinforcer potency of the top-ranked stimulus from each class with 7 of the 8 participants who showed displacement of one stimulus class. Four of 7 participants allocated more responding to the task associated with the top-ranked stimulus and 3 of 7 participants showed no differences in responding to the task regardless of the stimulus rank.

Key words: displacement, edible stimuli, leisure stimuli, preference assessment, reinforcer assessment

The effectiveness of many behavioral interventions relies on the use of reinforcement (Killu, 2008); therefore, accurately identifying powerful reinforcers is critical for the development of effective behavioral interventions. Putative reinforcers are typically identified based on the outcome of a preference assessment, a tool used to systematically and directly assess an individual's preference for stimuli by measuring their responses to a variety of stimuli during brief and repeated presentations (e.g., Hagopian, Rush, Lewin, & Long, 2001; Piazza, Fisher, Hagopian, Bowman, & Toole, 1996). Researchers have demonstrated the predictive validity of preference assessments by conducting reinforcer assessments to determine if preferred stimuli maintain responding (e.g., Hagopian et al., 2001; Kodak, Fisher, Kelley, & Kisamore, 2009; Roane, Vollmer, Ringdahl, & Marcus, 1998).

Given the importance of reinforcement in behavioral interventions, researchers have conducted a considerable amount of research on refining preference assessment methodologies and identifying factors that may influence their outcomes. Some factors that may influence preference assessment outcomes include: (a) the number of stimuli included in an array (Fisher et al., 1992), (b) the type of response measure (engagement or approach; Rech, 2012), (c) motivating operations (Gottschalk, Libby, & Graff, 2000), and (d) the composition of the array. To date, five studies have examined the effects of array composition by assessing the preference for one stimulus class over another with individuals with intellectual and developmental disabilities (IDD; Andakyan, Fryling, & Benjamin, 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie, Iwata, & Jann, 2015).

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Address correspondence to: Kimberley L. M. Zonneveld, Department of Applied Disability Studies, Brock University, St. Catharines, Ontario, Canada, L2S 3A1.
E-mail: kzonneveld@brocku.ca

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DeLeon, Iwata, and Roscoe (1997) were the first to evaluate the displacement of one stimulus class over another. They first conducted 10 single-class, multiple-stimulus-without-replacement (MSWO) preference assessments with 14 adults with IDD (five consisted of edible stimuli and five consisted of leisure stimuli). The researchers then conducted five combined-class MSWO assessments with each participant in which they included the top three ranked edible stimuli and the top four ranked leisure stimuli from each single-class MSWO assessment. Edible stimuli displaced leisure stimuli for 11 of the 14 participants. Next, the researchers conducted a single-operant reinforcer assessment using a dense schedule of reinforcement to evaluate the reinforcing efficacy of the top-ranked displaced leisure stimulus for two of these 11 participants. For both, the leisure stimulus functioned as a reinforcer, suggesting that the combined-class MSWO assessment may mask the identification of reinforcing stimuli (i.e., the displaced stimuli). However, the relative reinforcing potency between the displaced leisure stimuli and the edible stimuli that displaced them remained unclear because the researchers did not compare the reinforcer potency of these stimuli.

Bojak and Carr (1999) conducted a similar series of single- and combined-class MSWO assessments with four adults with IDD and found that (a) leisure stimuli were displaced by edible stimuli across participants and (b) preference for these stimuli did not shift when assessments were conducted before or after meals. Similarly, Andakyan et al. (2016) conducted MSWO assessments before and after meals with four children diagnosed with autism spectrum disorder (ASD), a population that had not been studied by previous researchers. Interestingly, these researchers found that (a) a larger proportion of participants preferred leisure stimuli over edible stimuli and (b) as in Bojak and Carr, their participants' preference for these stimuli did not shift when assessments were conducted before or after meals.

Fahmie et al. (2015) extended this line of research with a more diverse population that included 12 individuals between 5 and 22 years of age with ASD, IDD, or Dandy Walker syndrome and Klinefelter syndrome. Edible stimuli displaced leisure stimuli for 10 of 12 participants. Next, they compared the reinforcing efficacy of the top four edible and top four leisure stimuli by conducting single-operant assessments using a leaner schedule than used in previous research with six of these participants. Edible stimuli functioned as a more potent reinforcer for five participants and both edible and leisure stimuli functioned as equally potent reinforcers for one participant.

Conine and Vollmer (2018) recently conducted a similar series of single- and combined-class MSWO assessments with 26 children with ASD who attended an applied behavior analytic treatment center. Whereas the majority of their participants showed a general preference for edible stimuli, a larger proportion of their participants showed a preference for leisure stimuli than had been observed in previous research. Their findings were most similar to those obtained by Andakyan et al. (2016), who also exclusively evaluated preference in children with ASD. Conine and Vollmer posited that children with ASD attending treatment centers may show a greater preference for leisure stimuli relative to other populations due to (a) characteristics associated with individuals with ASD (e.g., food selectivity, repetitive and restrictive play), (b) an abolishing operation for the selection of edible stimuli due to its increased rate of delivery in treatment for children with ASD, or (c) the forced inclusion of screen-based media in their preference assessments. The researchers included screen-based media devices for all participants (even if caregivers did not nominate these items) and found that a preference for a screen-based media device relative to edible stimuli seemed to be predictive of a general preference for leisure stimuli. It remains unknown if this same finding would hold for other populations.

Two noteworthy gaps in this literature warrant further investigation. First, the five previous studies on this topic included participants with IDD (Andakyan et al., 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015). This area of research has not been evaluated with typically developing children; thus, it seems prudent to determine if typically developing children generally prefer one stimulus class over another. Second, previous researchers conducted reinforcer assessments with FR 1 (DeLeon, Iwata, & Roscoe, 1997) and FR 10 (Fahmie et al., 2015) schedules of reinforcement. However, FR schedules do not allow for identification of the full range (or break point) of reinforcer potency (Roane, 2008). Given that behavior analysts rely on potent reinforcers to implement effective behavioral interventions (Killu, 2008), it seems important to evaluate the potency of the top-ranked stimuli from both stimulus classes.

The purpose of Experiment 1 was to replicate previous research on the relative rankings of edible and leisure stimuli in MSWO assessments with a sample of 15 typically developing children. The purpose of Experiment 2 was to extend the work of DeLeon et al. (1997) and Fahmie et al. (2015) to determine the predictive validity of combined-class MSWO assessments under increasing response requirements. We conducted a single-operant reinforcer assessment with a progressive ratio (PR) schedule of reinforcement with seven of eight participants who showed a pattern of displacement to determine if (a) displaced stimuli functioned as reinforcers and (b) differences in reinforcer potency existed between the top-ranked stimuli from both stimulus classes.

EXPERIMENT 1: PREFERENCE ASSESSMENTS

Method

Participants, setting, and materials. We recruited 15 typically developing children between the ages of 5 to 9 years from two elementary schools in southern Ontario, Canada. Sessions occurred in a separate room near each participant's classroom two times per day, 3 to 5 days per week, lasting 3 to 6 min per session. For each participant, eight edible and eight leisure stimuli were included in the arrays based on the results of a caregiver-informed survey (see Table 1 for a list of all stimuli included in assessments).

Response measurement, reliability, and procedural integrity. Trained observers collected trial-by-trial data using paper and pencil on the occurrence of consumption during all preference assessments. For edible stimuli, the data collectors recorded consumption when the participant selected (i.e., touched, picked up, or asked for) one stimulus within 5 s of its presentation, placed the stimulus in his or her mouth, and swallowed the stimulus without expelling it. For leisure stimuli, the data collector recorded consumption when the participant selected (i.e., touched, picked up, or asked for) one stimulus within 5 s of presentation and interacted with the stimulus with his or her hands or held an eye gaze towards the stimulus for at least 3 s. We calculated the percentage of trials with consumption by dividing the number of times a participant consumed a stimulus by the number of times the stimulus was presented as a choice in the array. The stimuli were ranked based on the percentage of trials with consumption. If a participant consumed two or more stimuli on an equal percentage of trials, the experimenter calculated and ranked consumption percentages for the final three (of five) MSWO assessments.

No interobserver agreement (IOA) data were calculated for Jeroen. For all other participants, a second, independent observer collected data during 43% (range, 33% to 87%) of all sessions. We calculated trial-by-trial IOA by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. An agreement was defined as both observers scoring the same response within a given trial and a disagreement as both observers scoring a different response within a

Table 1
Rank Order of Stimuli Included in the Single-Class MSWO Assessments

Subject	Edible stimuli	Leisure stimuli
Auston	Raspberries, lettuce, cheese pizza, Kit-Kat, meat pizza, pink ice cream, chocolate ice cream, vanilla ice cream	Minecraft game, fidget spinner, helicopter, football, basketball, blue car, tan car, black car
Flore	White cheese, apples, cheddar popcorn, caramel popcorn, Smarties, plain popcorn, cheddar cheese, marble cheese	Blue Play-Doh, paint, doctor Barbie, crayons, Shopkins, Littlest Pet Shop video, Minecraft video, pink Play-Doh
Jeroen	Kit-Kat, Smarties, cheddar cheese, plain chips, marble cheese, white cheese, ketchup chips, all-dressed chips	Stranger Things video, hockey stick and puck, WWE figure, football, Star Wars figure, soccer ball, Spiderman figure, Ninja Turtle figure
Katrina	Chocolate chip cookies, Kit-Kat, Smarties, waffles, salt & vinegar chips, red peppers, cucumbers, oranges	Skating barbie, doctor Barbie, airplane Barbie, chef Barbie, crayons, Craft for Kids video, Smelly Bellyons, tennis Barbie
Marcus	Oreos, plain chips, Goldfish, plain popcorn, cheddar popcorn, all-dressed chips, ketchup chips, caramel popcorn	Blocks, Pokemon video, Pokemon book, Lego, Yu-Gi-Oh video, stuffed toy, black car, blue car
Morgan	Caramel popcorn, Oreos, plain popcorn, cheddar popcorn, Goldfish, all-dressed chips, plain chips, ketchup chips	Pokemon video, Pokemon book, Yu-Gi-Oh video, Lego, fidget spinner, blue car, stuffed toy, tan car
Sammy	Kit-Kat, Cheerios, plain chips, strawberries, ketchup chips, grapes, all-dressed chips, Oreos	Minecraft game, Connect 4, fidget spinner, playing cards, Minecraft video, purple Hatchimal, green Hatchimal, red Hatchimal
Tanya	Nibs, cheese pizza, granola bar, apples, plain chips, plain popcorn, Kit-Kat, pepperoni pizza	Paint, pink Play-Doh, blue Play-Doh, crayons, Littlest Pet Shop video, Cookie Swirl video, chef Barbie, doctor Barbie
Eric	Green sucker, red sucker, yellow sucker, green apple, red apple, grapes, cheddar cheese, white cheese	Mario video, Kizi video, blue Play-Doh, Spiderman figure, pink Play-doh, Lego, blue car, tennis ball
Elliott	Pears, strawberries, blueberries, Kit-Kat, Smarties, Aero, cheese pizza, pepperoni pizza	Nerf gun, crayons, paint, soccer ball, Lego, soccer video, blue car, tan car
Kyle	Pepperoni pizza, cheese pizza, strawberries, oranges, Cheerios, Fruit Loops, french fries, Smarties	Lego, Beyblades, blue car, tan car, soccer ball, stuffed animal, Stixbot, Star Wars video
Richard	Green apple, pineapples, broccoli, blueberries, red apple, corn, carrots, Cheerios	Crayons, paint, Lucky Blocks video, basketball, hockey stick and puck, Minecraft video, Minecraft book, football
Levi	Corn, broccoli, Aero, Kit-Kat, ketchup chips, plain chips, BBQ chips, Smarties	Roblox video, Pokemon handbook, Teen Titans video, blocks, playing cards, Lego, stuffed animal, blue car
Curtis	Gum, Oreo, Aero, rice, Nibs, plain chips, Fruit Loops, Cheerios	Hockey stick and puck, Dude Perfect video, basketball, football, soccer ball, WWE figure, blue car, hockey cards
Stewart	Chocolate chip cookies, lady finger cookies, Tostitos, french fries, Fruit Roll-up, Nerds, Rockets, gum	Stampy video, Teen Titans video, Lego, blocks, Star Wars figure, crayons, paint, Minecraft book

given trial. Mean IOA for the consumption of stimuli was 99% (range, 88% to 100%).

A second, trained observer scored procedural integrity on a trial-by-trial basis during 43% (range, 33% to 87%) of all sessions. Data were collected on the accuracy with which the primary experimenter delivered the stimulus, delivered the prompt, and terminated the session. The observers scored correct stimulus delivery if the experimenter placed the correct stimulus directly in front of the participant, correct prompt delivery if the experimenter re-administered the correct prompt (i.e., “Pick one”) while pointing to all stimuli in the array, and correct session termination if the experimenter ended the session if the participant (a) did not approach a stimulus after 30 s on two consecutive prompts or (b) consumed all stimuli. Procedural integrity was calculated by dividing the number of accuracies by the number of accuracies plus inaccuracies and multiplying by 100. Mean procedural integrity was 100% for correct stimulus delivery, 99% (range, 75% to 100%) for correct prompt delivery, and 100% for correct session termination across all preference assessments.

Procedure. First, the experimenter asked each caregiver to list their child’s: (a) 10 most-preferred edible stimuli, (b) 10 most-preferred leisure stimuli, (c) food allergies, and (d) any stimuli to avoid for use in the study. Although only eight stimuli were included in each single-class assessment, caregivers provided two additional stimuli in the event that stimuli could not be used (e.g., we could not obtain a stimulus, other individuals’ allergies in the area prohibited inclusion of a stimulus). Participants did not have access to the stimuli used in this study outside of research sessions during the school day.

The experimenter conducted all preference assessments using an MSWO presentation format similar to that described by DeLeon and Iwata (1996). The Experimenter conducted one single-class MSWO assessment per session, at two sessions per day, until the participant completed five edible-MSWO and five leisure-MSWO assessments. The edible-MSWO assessment contained eight edible stimuli and the leisure-MSWO assessment contained eight leisure stimuli. We quasirandomly determined the order of MSWO assessments each day such that the same type of single-class MSWO assessment was not conducted first on more than two consecutive days. Next, the experimenter included the top four stimuli from each single-class MSWO assessment in the combined-class MSWO assessment and conducted one session per day until the participant completed five combined-class MSWO assessments.

Prior to conducting all MSWO assessments, the experimenter provided participants with presession exposure to each stimulus included in the upcoming assessment. Presession exposure consisted of the experimenter presenting the participant with a dime-sized (i.e., 17.91 mm in diameter) piece of an edible stimulus or a leisure stimulus, labeling the stimulus, and asking the participant to try the stimulus. The experimenter gave the participant access to the stimulus for 30 s if the participant reached for the stimulus or vocally indicated that he or she would try it (e.g., “Alright”). Although all participants tried all foods during presession exposure, if the participant did not reach for the food or vocally indicated that he or she would not try it (e.g., “I don’t want to”) within 30 s of its presentation, the experimenter would have removed the stimulus and omitted it from all subsequent assessments.

During all MSWO assessments, the experimenter presented all eight stimuli to the participant by placing each stimulus equally spaced apart and prompting the participant to select a stimulus (i.e., “Pick your favorite”). If the participant selected one stimulus within 5 s of the prompt, the experimenter gave him or her 30 s of access to the stimulus and removed all other stimuli. If the participant consumed the edible stimulus within 30 s, the participant and experimenter remained in their position until 30 s lapsed. The experimenter rearranged and re-presented the array of remaining stimuli after 30 s lapsed. We included this 30-s intertrial interval to equate session duration across all MSWO assessments. If the participant did not make a selection within 30 s of the prompt, the experimenter provided a second (identical) prompt to select a stimulus. The experimenter blocked attempts to approach two or more stimuli at the same time and re-administered the prompt to select one stimulus. This process continued until the participant chose all stimuli or did not approach a stimulus within 30 s following two consecutive prompts.

Results and Discussion

Figure 1 shows the consumption percentages for the edible and leisure stimuli during the single-class and combined-class MSWO assessments. We categorized each participant's consumption during the combined-class MSWO assessments into one of three displacement patterns previously reported in the literature as (a) participants selected all stimuli from one stimulus class prior to selecting all stimuli from another stimulus class (Andakyan et al., 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015), (b) participants selected two stimuli from one stimulus class prior to selecting all stimuli from another class (Andakyan et al., 2016; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997), and (c) participants selected all stimuli from one stimulus class prior to selecting all but one stimulus from another stimulus class (Andakyan et al., 2016; Conine & Vollmer, 2018; Fahmie et al., 2015). If a participant's consumption behavior did not meet one of these three criteria, we determined that the participant did not display displacement of one stimulus class over the other.

Overall, eight of 15 participants (53.3%) showed one of the three patterns of displacement reported by previous researchers. Five (33.3%) participants showed a general preference for edible over leisure stimuli and three (20.0%) participants showed a general preference for leisure over edible stimuli. Of the eight participants who showed a preference for one stimulus class over the other, Flore and Morgan ranked all edible stimuli higher than all leisure stimuli in the combined-class MSWO assessment, and Jeroen ranked all leisure stimuli higher than all edible stimuli. Richard and Levi ranked two edible stimuli higher than all other stimuli, and Eric and Kyle ranked two leisure stimuli higher than all other stimuli. One participant (Sammy) ranked all edible stimuli higher than all but one leisure stimulus. The remaining seven participants (Auston, Katrina, Marcus, Tanya, Elliott, Curtis, and Stewart; 46.7% of participants) did not show a preference for one stimulus class over the other.

This study was the first to investigate the displacement of one stimulus class over another with typically developing children. Eight of 15 participants showed a general preference for one stimulus class over the other in the combined-class MSWO assessments. Of these eight participants, five showed a preference for edible stimuli and three showed a preference for leisure stimuli. These findings are similar to those reported by Andakyan et al. (2015) and Conine and Vollmer (2018), both of whom studied this phenomenon exclusively with children with ASD. While previous researchers examined the reinforcer potency of stimuli obtained from a combined-class MSWO assessment under fixed-ratio schedules of reinforcement (DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015), it seems prudent to determine the reinforcer potency of the top-ranked edible and leisure stimuli under increasing response requirements.

EXPERIMENT 2: REINFORCER ASSESSMENT

Method

Participants, setting, and materials. Seven participants from Experiment 1 participated in Experiment 2 because they (a) showed displacement of one stimulus class over the other and (b) were available for participation. All sessions took place in a research room located near the participant's classroom. The experimenter assigned each participant one of four free operant tasks (i.e., cleaning up popsicle sticks, lining up popsicle sticks, cleaning up playing cards, or flipping playing cards) that was in the participant's repertoire but did not occur at high rates in the absence of reinforcement. The experimenter included each participant's top-ranked edible and top-ranked leisure stimulus from the combined-class MSWO assessments in Experiment 1 in these reinforcer assessments.

Response measurement, reliability, procedural integrity. Trained observers collected frequency

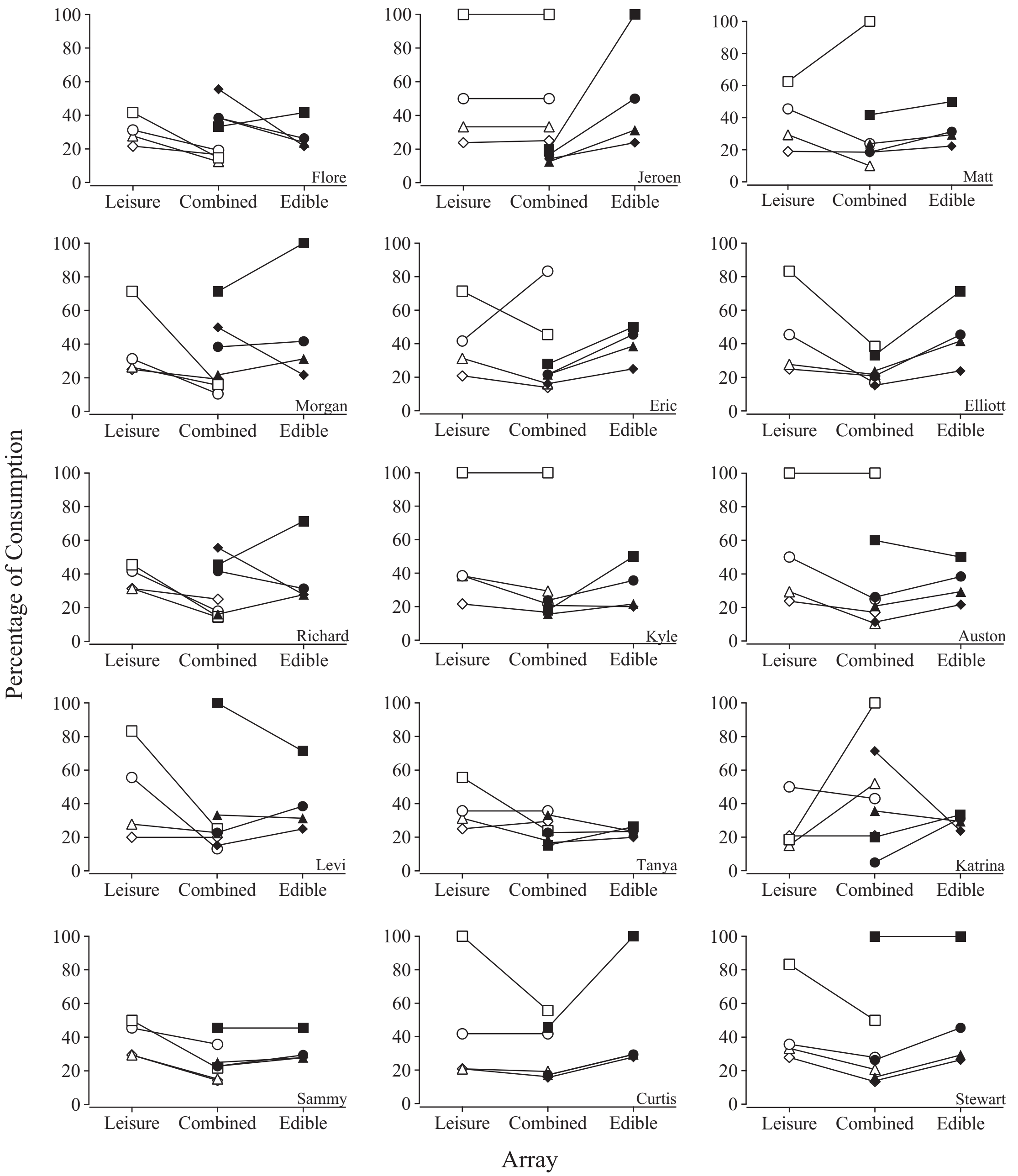

Figure 1. Percentage of consumption for each participant's top four ranked edible and top four ranked leisure stimuli in the single-class and combined-class MSWO assessments. Closed data points depict these percentages for edible stimuli and open data points depict these percentages for leisure stimuli.

of independent responding to the individually assigned free operant task using Countee™ software on Apple iPhones™ or Samsung Galaxy™ smartphones. The experimenter assigned cleaning up popsicle sticks to Morgan and Eric and defined it as placing a popsicle stick one at a time inside a plastic bag. The experimenter assigned lining up popsicle sticks to Levi and defined it as placing two popsicle sticks on the table such that the tip of one popsicle stick contacted the tip of the other popsicle stick. The experimenter assigned cleaning up playing cards to Richard and defined it as placing a playing card one at a time inside a rectangular box and assigned flipping playing cards to Flore, Jeroen, and Kyle and defined it as picking up a card one at a time faced down and flipping it over such that the back of card contacted the table. Data were analyzed as responses per minute by dividing the total number of target responses by the total duration of task presentation.

No IOA data were collected for Jeroen. For all other participants, a second, independent observer collected data during 37% (range, 33% to 42%) of sessions. The experimenter divided sessions into 10-s intervals and compared observers' records within each interval. Proportional IOA was calculated by dividing the smallest recorded number of independent target responses by the largest recorded number for each interval. All fractions were summed and added to the difference between the total number of intervals and the number of intervals for which there was a disagreement and this integer was divided by the total number of intervals and multiplied by 100 (Mudford, Martin, Hui, & Taylor, 2009). Mean proportional agreement across participants was 98% (range, 94% to 100%).

Trained observers scored the accuracy with which the experimenter delivered the stimulus and terminated the session. We defined correct stimulus delivery as the experimenter placing the correct stimulus directly in front of the participant according to the schedule of reinforcement in effect for that session. We defined correct termination of the session as the experimenter ending the session if the participant (a) did not complete a target response within 1 min or (b) 30 min lapsed. Procedural integrity was calculated by dividing the number of accuracies by the number of accuracies plus inaccuracies and multiplying by 100. Procedural integrity scores across participants were 100% for correct stimulus delivery and 100% for correct termination of the session.

Procedure. We used a single-operant arrangement within a multielement design to compare the reinforcer potency of the top-ranked edible and the top-ranked leisure stimulus from the combined-class MSWO assessments. For all sessions, the experimenter placed a free operant task in front of the participant. Prior to each baseline session, the experimenter described the contingencies associated with the task (e.g., "If you put the cards in the bag one at a time [while modeling the response], nothing will happen. If you don't put the cards in the bag, nothing will happen"). Prior to each PR schedule of reinforcement session, the experimenter described the contingencies associated with the task (e.g., "If you put the cards in the bag one at a time [while modeling the response], you will get one piece of X food [edible condition] or you will get to play with X toy for a little bit [leisure condition]. If you don't put the cards in the bag, nothing will happen"). The experimenter then prompted the participant to begin the assessment and told him or her, "You can do _____ [task] as much or as little as you like." Experimenters did not provide additional prompts throughout the session and terminated the session if the participant did not engage in the target task for 1 full minute or if the participant engaged in the target task for 30 min.

During baseline, the experimenter did not provide a programmed consequence for engaging in the task. During the PR schedule of reinforcement phase, the experimenter arranged identical additive PR schedules in which the response requirement to contact reinforcement increased by 2 following two completions of the current schedule requirement (e.g., PR 1, PR 1, PR 3, PR 3, PR 5, PR 5, and so on). The experimenter provided 30 s of access to the stimulus evaluated in that condition after the participant completed each PR requirement. If the participant consumed the stimulus before 30 s lapsed (e.g., the participant consumed the edible within 10 s), the experimenter did not re-present the task until 30 s lapsed. This 30-s intertrial interval equated the reinforcer-access period across all sessions and conditions.

If the participant engaged in the task for 30 min across two consecutive edible and two consecutive leisure sessions, the experimenter arranged a multiplicative PR schedule (i.e., the response requirement doubled following one completion of the schedule requirement). If the participant continued to engage in the task for 30 min across two consecutive sessions after the introduction of a more stringent PR schedule, the experimenter continued to double the response requirement following one completion of the schedule requirement. The order of the conditions was quasirandomized such that there were no more than two consecutive sessions of the same condition.

Results and Discussion

Figures 2 and 3 depict the rate of target responses and the last completed schedule requirement for all seven participants. All participants showed little to no responding in baseline and higher levels of responding in the PR schedule of reinforcement phase, suggesting that both stimuli functioned as reinforcers for all participants (except for Eric, whose top-ranked displaced stimulus did not function as a reinforcer during the last two sessions). We observed congruent results between the combined-class MSWO assessments and PR reinforcer assessments for four (Flore, Eric, Kyle, and Richard) of seven participants (Figure 2). That is, these participants allocated more responding to the task when responding resulted in the top-ranked stimulus identified in the combined-class MSWO assessment relative to the top-ranked displaced stimulus. For two (Flore and Richard) of these four participants, the top-ranked edible stimulus was a slightly more potent reinforcer. Flore engaged in a higher rate of responding in the edible condition (M = 10.6, range: 5.7 to 20.1) relative to the leisure condition (M = 6.2, range: 1.7 to 10.1). Richard also engaged in a higher rate of responding in the edible condition (M = 20.6, range: 15.6 to 24.3) relative to the leisure condition (M = 15.2, range: 4.6 to 18.0). For the remaining two (Eric and Kyle) of these four participants, the top-ranked leisure stimulus was the more potent reinforcer. During the PR schedule of reinforcement phase, similar rates of responding occurred across both conditions during the first 14 sessions for Eric and the first 27 sessions for Kyle. However, following these sessions, the leisure stimulus emerged as the more potent reinforcer for both participants. Despite this initial undifferentiated responding, Eric engaged in a higher mean rate of responding in the leisure condition (M = 10.7, range: 3.3 to 16.0) relative to the edible condition (M = 8.2, range: 1.3 to 16.9). Similarly, Kyle's mean rate of responding was higher in the leisure condition (M = 14.3, range: 0.8 to 28.3) relative to the edible condition (M = 9.9, range: 0.8 to 26.9). These four participants' relative break point data corresponded with their response rate data. That is, higher break points were obtained for these participants' top-ranked stimulus relative to their top-ranked displaced stimulus from the combined-class MSWO assessment.

The remaining three of seven (Jeroen, Morgan, and Levi) participants allocated similar rates of responding to the task when responding resulted in the top-ranked stimulus from either stimulus class during the PR reinforcer assessment (Figure 3). Under the final PR schedule phase, Jeroen engaged in a similar rate of responding in the edible condition (M = 46.9, range: 40.4 to 51.8) and the leisure condition (M = 46.7, range: 39.3 to 51.0). Under the final PR schedule phase, Morgan engaged in a similar rate of responding in the edible condition (M = 14.1, range: 8.2 to 19.7) and the leisure condition (M = 14.7, range: 8.9 to 19.2). Levi engaged in a similar rate of responding in the edible condition (M = 16.9,

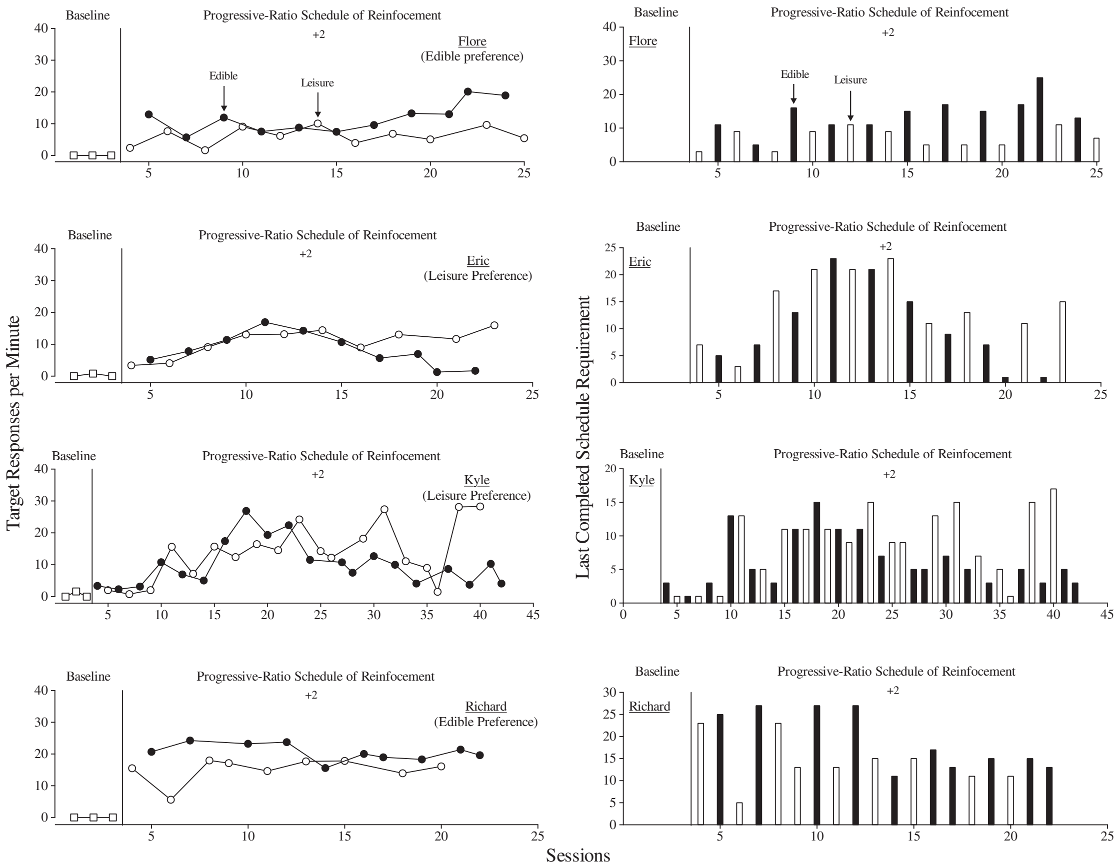

Figure 2. Responses per minute (left panels) and last completed schedule requirement (right panels) during the progressive-ratio (PR) reinforcer assessment for the four participants whose top-ranked stimulus from the combined-class MSWO assessment functioned as the most potent reinforcer. Squares denote response rates during baseline. Black circles denote response rates during the edible condition and white circles denote response rates during the leisure condition. Black bars denote the last completed schedule requirement during the edible condition and white bars denote the last completed schedule requirement during the leisure condition. Mathematical symbols and values (i.e., +2) indicate the manner in which the PR schedule increased.

range: 14.6 to 18.3) and the leisure condition (*M* = 16.3, range: 15.4 to 18.8). These three participants' relative break point data corresponded with their response rate data. That is, similar break points were obtained for these participants' top-ranked stimulus and top-ranked displaced stimulus from the combined-class MSWO assessment.

When we assessed the predictive validity of the combined-class MSWO assessments, the results of the combined-class preference assessment accurately predicted the relative reinforcer potency of the top-ranked stimuli from both classes for four of seven participants. Further, the break point data corresponded with the response rate data for all participants. Recording the break point data via a PR schedule of reinforcement allowed us to directly assess each participant's response persistence and the durability of these stimuli as reinforcers because the response requirement increased until the participant met termination criteria. When a participant (Jeroen, Morgan) continued to respond for the maximum session duration, we changed the manner in which the schedule increased to a more

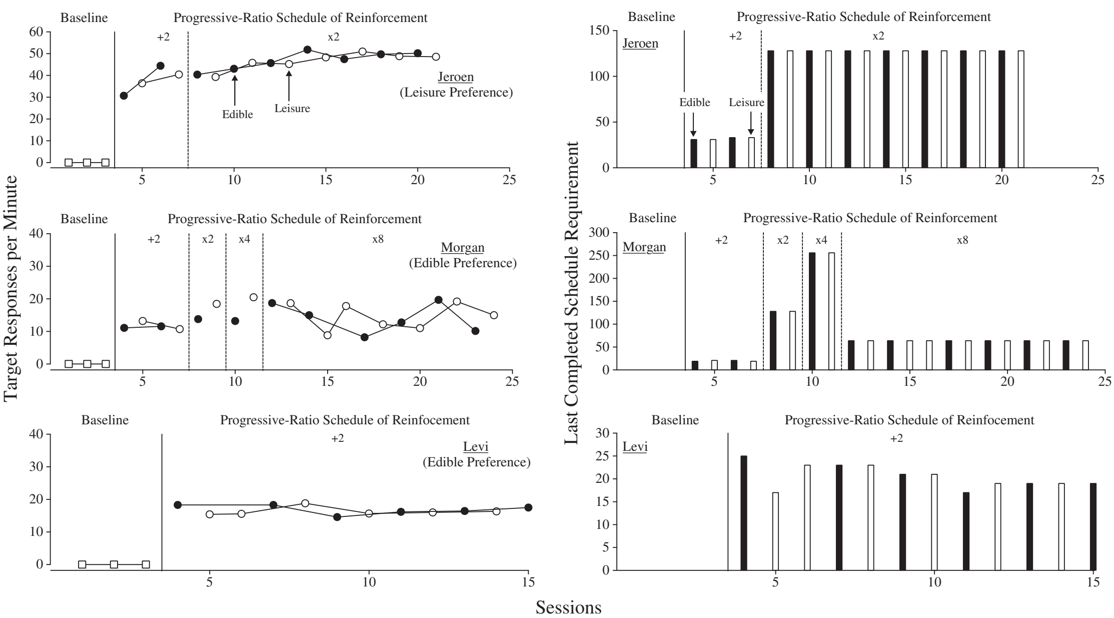

Figure 3. Responses per minute (left panels) and last completed schedule requirement (right panels) during the progressive-ratio (PR) reinforcer assessment for the three participants whose top-ranked stimulus from the combined-class MSWO assessment functioned as an equally potent reinforcer as the top-ranked displaced stimulus from the combined-class MSWO assessment. Black circles denote response rates during the edible condition and white circles denote response rates during the leisure condition. Black bars denote the last completed schedule requirement during the edible condition and white bars denote the last completed schedule requirement during the leisure condition. Mathematical symbols and values (e.g., +2) indicate the manner in which the PR schedule increased.

stringent requirement to allow us to identify the exact conditions under which the stimuli functioned as effective and ineffective reinforcers. These break point data are particularly useful because PR schedules of reinforcement more closely approximate the conditions under which typically developing children contact reinforcement in their natural environment. That is, these children are often presented with a variety of tasks, some of which are more effortful or difficult than others. As such, it is important for clinicians and teachers to identify potent reinforcers that will maintain responding toward more effortful or difficult tasks to promote learning.

GENERAL DISCUSSION

Several features of the data are noteworthy in comparison to previous research in this area. First, during combined-class MSWO assessments, a larger proportion of our participants' (56%) most-preferred stimulus was a leisure stimulus relative to the findings of previous researchers (*M* = 23% of participants, range: 0% to 50%; Andakyan et al., 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015). Second, a smaller proportion of participants (53%) showed a preference for one stimulus class over the other relative to the results found by previous researchers (*M* = 85% of participants, range: 75% to 100%; Andakyan et al., 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015). Of those participants who showed a preference for one stimulus class over the other, a smaller proportion of our participants (63%) showed a preference for edible stimuli over leisure stimuli relative to the results of previous researchers (*M* = 87% of participants, range: 67% to 100%; Andakyan et al., 2016; Bojak & Carr, 1999; Conine & Vollmer, 2018; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015).

In addition, our results were more consistent with those studies that exclusively evaluated children's preferences (i.e., Andakyan et al., 2016; Conine & Vollmer, 2018). For example, 27% of participants in Conine and Vollmer (2018) and 25% of participants in Andakyan et al. (2016) showed a general preference for leisure stimuli. However, it should be noted that when we reanalyzed the data in Andakyan et al. based on the three patterns of displacement used in the current study, we found that two of four (50%) participants preferred leisure to edible stimuli. Therefore, it may be the case that children, regardless of their diagnosis, are more likely than adults with IDD to show a preference for leisure stimuli. This remains an empirical question.

Conine and Vollmer (2018) hypothesized that they may have obtained a higher proportion of participants who preferred leisure stimuli to edible stimuli because they included screen-based media devices (e.g., iPads) for all participants, even if caregivers did not nominate these devices. In the current study, all caregivers nominated screen-based media as highly preferred; thus, we included at least one of these devices for each participant. Our results were partially consistent with those of Conine and Vollmer. Specifically, in the single-class MSWO assessment, Conine and Vollmer found that screen-based devices were ranked as the most preferred stimulus for 15 of 26 participants (58%) and this was the case for 7 of 15 (47%) of our participants. The results were far more discrepant when considering the ranking of screen-based media among other leisure stimuli in the combined-class MSWO assessment. Specifically, whereas Conine and Vollmer reported that of the nine participants who ranked a leisure stimulus above all other stimuli, eight (89%) ranked a screen-based device the highest, only three of eight (38%) of our participants who ranked a leisure stimulus above all other stimuli ranked a screen-based device highest. Therefore, future research may benefit from further evaluating preference for screen-based devices and the extent to which these devices displace other leisure stimuli among children with ASD and typically developing children.

Taken together, these findings seem to suggest that, at least initially, participant characteristics may influence responding in a combined-class MSWO assessment. One possible rationale for these disparate findings may be the preexisting differences in these participants' characteristics. For example, although play skills develop without the use of explicit instruction in typically developing children, they often require explicit instruction to emerge in children with IDD (Morrison, Sainato, Benchaaban, & Endo, 2002). Although we did not systematically assess for age-appropriate play skills, anecdotally, all participants engaged in age-appropriate play. For example, participants would roll a car along the table and say, "Vroom vroom" when presented with a car and shoot a basketball in the air when presented with a basketball. If play was more likely to function as an automatic reinforcer for our typically developing participants compared to participants of previous research, this may have contributed to the higher proportion of participants in our study who showed a preference for leisure stimuli.

In Experiment 2, we extended the work of previous researchers who found that displaced stimuli arranged on an FR 1 (DeLeon, Iwata, & Roscoe, 1997) and FR 10 (Fahmie et al., 2015) schedule functioned as reinforcers. Specifically, we compared the reinforcer potency of the top-ranked stimuli from both classes by arranging PR schedules in a single operant format. PR schedules of reinforcement may be particularly useful to assess reinforcer potency for several reasons. First, behavior is not likely reinforced on dense schedules (e.g., FR 1) in the natural environment (Fisher & Mazur, 1997); therefore, it seems prudent to assess reinforcer potency under more naturalistic schedules. Second, previous researchers have shown that the reinforcing potency of stimuli changes as response requirements increase (e.g., DeLeon, Iwata, Goh, & Worsdell, 1997; Francisco, Borrero, & Sy, 2008; Glover, Roane, Kadey, & Grow, 2008; Roane, Lerman, & Vorndran, 2001; Tustin, 1994). Specifically, stimuli equally effective under low response requirements were differentially effective under increasing response requirements; therefore, it is important to use schedules that are ideal for detecting reinforcer potency (e.g., Hodos, 1961).

We observed two interesting patterns in the data produced by the PR schedules. First, the top-ranked stimulus (i.e., the stimulus that displaced the other stimulus) identified in the combined-class MSWO assessment functioned as the most potent reinforcer for four of seven participants. For the other three participants, both stimuli functioned as equally potent reinforcers. Therefore, for all seven participants, the top-ranked stimulus was either the most potent reinforcer (for four of seven participants) or was an equally potent reinforcer (for three of seven participants) relative to the top-ranked displaced stimulus. Given that the top-ranked stimulus never functioned as the less potent reinforcer relative to the top-ranked displaced stimulus, it seems reasonable to conclude that combined-class MSWO assessments are suitable for use with typically developing children.

Second, for the three participants who showed a preference for leisure stimuli over edible stimuli in Experiment 1, the edible stimulus was similarly potent to the leisure stimulus for the entire assessment for one (Jeroen) of three participants or for a majority of the assessment for two (Eric and Kyle) of three participants. This finding is interesting because we did not observe this same pattern for two of the four participants who showed a preference for edible stimuli. It is possible that the edible stimuli were similarly potent reinforcers to the leisure stimuli for these participants because edible stimuli are unconditioned reinforcers. That is, despite leisure stimuli displacing edible stimuli for these participants, the value of the unconditioned reinforcers could have been sufficiently high to match that of the leisure stimuli. That said, leisure stimuli displaced edible stimuli for only three participants; therefore, researchers may consider comparing the reinforcing potency of edible and leisure stimuli for a greater number of participants who show a general preference for leisure over edible stimuli.

There are at least two noteworthy limitations of our study. First, the use of simple free operant tasks in Experiment 2 may have limited the generality of our results. Although these tasks permitted an analysis of the potency of the reinforcers in a contrived environment, they did not represent the range of tasks a typically developing child may encounter in the natural environment. Therefore, researchers may consider comparing the reinforcer potency of edible and leisure stimuli with tasks more representative of those typically developing children may contact in the natural environment. Second, the preference assessment procedures may not have accurately captured participants' preference for leisure stimuli. Specifically, we provided participants with 30 s of access to the selected leisure stimulus. Previous researchers have found that individual preferences for leisure stimuli may shift as a function of the duration of stimulus access during preference assessments (e.g., Kodak et al., 2009; Steinhilber & Johnson, 2007; for a discussion, see Conine & Vollmer, 2018). Thus, it may be fruitful for researchers to identify characteristics of stimuli that influence preference for shorter or longer durations of access.

Overall, these findings indicate that the combined-class MSWO assessment may be well suited for use with typically developing children. First, we observed displacement between stimuli belonging to separate classes in the combined-class MSWO assessment that would not otherwise have been detected in a single-class MSWO assessment. Second, we found congruent results between the combined-class MSWO assessment and a PR reinforcer assessment for a majority of participants. These findings may be particularly useful given that combined-class MSWO assessments reduce the amount of time practitioners need to devote to assessing a participant's preference for edible and leisure stimuli, which may subsequently increase the amount of time they can devote to other activities (e.g., teaching academic or social skills).

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