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ASSESSING FACTORS THAT INFLUENCE YOUNG CHILDREN'S FOOD PREFERENCES AND CHOICES

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Researchers have identified an unbalanced diet as a key risk factor in the etiology of many chronic diseases (World Health Organization, 2003). Although researchers have found that numerous factors influence children's food choices, no assessment exists to identify these factors. In Experiment 1, we established preliminary empirical evidence of children's preferences for healthier and less-healthy foods, and found that 16 of 21 children preferred less-healthy foods to healthier foods. In Experiment 2, we established the utility of an analogue, competing parameters assessment designed to approximate children's food choices in the natural environment. We identified either quality or immediacy as the most influential parameters governing four of four childrens' food choices. We found that effort influenced the efficacy of these reinforcer parameters in a predictable manner for one of four children.

Key words: competing parameters assessment, reinforcer parameters, parameters of responding, food choices, food preferences

Diet and nutrition are critical variables that affect an individual's health across the lifespan (World Health Organization [WHO], 2003). Researchers have identified an unbalanced diet as a key risk factor in the etiology of many chronic diseases, including cardiovascular diseases, certain types of cancers, chronic respiratory diseases, diabetes, and obesity (WHO, 2003). This is troublesome considering that young children show preferences for less-healthy foods (Skinner, Carruth, Bounds, & Ziegler, 2002; Skinner et al., 1998), and non-preference for vegetables and, to a lesser extent, fruits (Domel, Baranowski, Davis, Leonard, Riley, & Baranowski, 1993; Kirby, Baranowki, Reynolds, Taylor, & Binkley, 1995; Skinner et al., 1998). The problematic nature of these unhealthy preferences is exacerbated by the fact that food preferences learned early in life are likely to influence long-term patterns of dietary intake (e.g., Birch, 1999). Therefore, it seems prudent to identify risk factors, such as an unbalanced diet, at an early age to mitigate the onset of chronic diseases.

Most research assessing the food preferences of young children has focused on the type of food consumed by children. These researchers have found several important preference patterns in children, as they relate to food type. For example, infants display an apparent innate preference (as determined by their facial expressions) for sweet and salty tastes, and an avoidance of bitter and sour tastes (e.g., Benton, 2004; Rosenstein & Oster, 1988). These innate preferences (or lack thereof) presumably serve an evolutionary function. That is, sweet flavors are associated with a source of energy and bitter flavors are associated with toxins (Benton, 2004).

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Researchers have identified several environmental factors that influence young children's food preferences and consumption of previously unfamiliar or nonpreferred foods, including (a) adult modeling (Addessi, Galloway, Visalberghi, & Birch, 2005), (b) peer modeling plus positive statements about the food (Greenhalgh et al., 2009), (c) exposure to taste (e.g., Aldridge, Dovey, & Halford, 2009; Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Horne, Lowe, Fleming, & Dowey, 1995; Osborne & Forestell, 2012), and (d) food availability.

Although these findings provide important information about common aspects of young children's food preferences, many of these studies rely on child (e.g., Skinner et al., 2002) and parent questionnaires (e.g., Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Kratt, Reynolds, & Shewchuk, 2000; Skinner et al., 2002; Skinner et al., 1998). Although some research has suggested that parents can predict their child's food choices with *reasonable* accuracy (e.g., Mata, Scheilbehenne, & Todd, 2008), a relatively large body of literature has demonstrated a lack of correspondence between the direct assessment of preference and child-reported preference (e.g., Northup, 2000), caregiver-reported preference (e.g., Green et al., 1988), and pictorial preference assessments (e.g., Higbee, Carr, & Harrison, 1999). Because diet is a known risk factor for several chronic diseases (WHO, 2003), a more systematic, direct method of assessing children's food preferences, choices, and factors that influence both seems warranted.

In the natural environment, children typically make food choices among multiple concurrently available food options; therefore, it is important to consider factors that influence choice responding. The efficacy of a given reinforcer is contextual and depends, in part, on the availability of alternative reinforcers and different parameters of the same reinforcers (e.g., Green & Freed, 1993; Neef & Lutz, 2001). For example, researchers have observed higher rates of responding toward response alternatives associated with higher quality reinforcers (e.g., Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996), higher magnitudes of reinforcers (e.g., Trosclair-Lasserre, Lerman, Call, Addison, & Kodak, 2008), and more immediate access to reinforcers (e.g., Neef, Mace, & Shade, 1993). In addition, researchers have observed higher rates of responding toward less effortful response alternatives (e.g., DeLeon, Iwata, Goh, & Worsdell, 1997).

To further evaluate the influence of reinforcer parameters on responding, numerous researchers have conducted competing parameters assessments in which various reinforcer parameters are placed in direct competition with each other such that the most influential parameter governing choice responding is identified. For example, in a series of studies conducted between 1992 and 2005, Neef and colleagues refined the competing parameters assessment procedure while evaluating the relative influence of rate and quality (Neef, Mace, Shea, & Shade, 1992); rate, quality, and immediacy (Neef et al., 1993); and rate, quality, immediacy, and effort (Neef & Lutz, 2001; Neef, Shade, & Miller, 1994) on the responding of children diagnosed with emotional disturbances, learning difficulties, and behavioral difficulties. In doing so, Neef and colleagues demonstrated the utility of the competing parameters assessment to (a) identify the most influential parameter governing participants' choices among concurrently available reinforcers, and (b) develop effective treatments based on the results of the competing parameters assessment.

Other researchers have used the competing parameters assessment procedure to evaluate the relative influence of magnitude and quality (Glover, Maltzman, & Williams, 1996) and magnitude and immediacy (Joseph, Egli, Koppekin, & Thompson, 2002) on the food choices made by individuals with intellectual disabilities with and without Prader-Willi syndrome. Taken together, these results suggest that there may be unique characteristics of certain populations of individuals who exhibit specific behavioral disorders (e.g., impulsivity, overeating) that increase the likelihood that one reinforcer parameter may be more influential than other parameters.

The purpose of this translational study was to extend the competing parameters assessment procedure to identify the relative influence of various parameters of food in typically developing children who show unhealthy food preference profiles.

EXPERIMENT 1: FOOD-PREFERENCE ASSESSMENTS

We assessed preferences for 40 foods across five food groups during two paired-choice preference assessments (Fisher et al., 1992). First, we conducted a within-food group paired-choice preference assessment to determine whether children showed a relative preference for healthier or less-healthy foods within the snack, grain, protein, fruit, and vegetable food groups. Next, we conducted a between-food group paired-choice preference assessment to (a) determine whether children showed a relative preference for one food group, and (b) identify children's high-preference and low-preference foods among their most preferred foods from each of the five food groups for use during Experiment 2.

Method

Participants, setting, and materials. Twenty-one typically developing children, ranging in age from 14 to 58 months, participated. Participants attended a university-run child development center. We conducted sessions in a segregated area of the participants' classroom or in a small therapy room.

Foods. The U.S. Department of Agriculture (USDA, 2017) recommends that children consume grains, proteins, fruits, vegetables, and dairy to achieve or maintain good health. Therefore, we assessed healthier and less-healthy foods from all groups except dairy. We omitted dairy because several participants had specific dairy allergies, sensitivities, or their parents required that they consume dairy substitutes (e.g., almond milk, coconut milk), making it difficult to identify eight foods that all or most participants could consume. We included snack foods because many children have shown strong preferences for snacks (Skinner et al., 2002; Skinner et al., 1998; Wardle, Carnell, & Cooke, 2005). Each food group consisted of four healthier foods and four less-healthy versions of the healthier foods (e.g., steamed broccoli versus broccoli with cheese and butter). We obtained parent approval for the inclusion of cheese and butter for all participants with specific dairy allergies or restrictions.

We included food items that were served regularly at the center in which we conducted this study to ensure participants were familiar with the foods. We identified the healthier foods by referencing the USDA's food group recommendations (2017) and the USDA's general dietary guidelines (2016). The USDA recommends that (a) less than 10% of calories come from added sugar, (b) at least half of consumed grains are whole grain, (c) consumed protein is lean, and (d) less than 10% of calories come from saturated fat. Therefore, our healthier and less-healthy foods, respectively, were snacks with lower sugar content versus snacks with higher sugar content, whole grains versus refined grains, lean protein versus non-lean protein, whole fruit versus canned fruit in heavy syrup, and vegetables without added saturated fat versus vegetables with added saturated fat such as cheese and butter. Healthy foods included pretzels, plain popcorn, Baked Doritos™ or Baked Lays™, and raisins for *snacks*; whole wheat bread, Saltine Crackers™, fat-free vanilla wafers, and cheerios for *grains*;

ground turkey, turkey bacon, grilled chicken, and 1% cheese for *proteins*; plum or peach, pineapple, orange, and pear for *fruits*; and steamed broccoli, steamed cauliflower, steamed green beans, and baked yam for *vegetables.* Less-healthy foods included chocolate pretzels, buttered popcorn, Doritos™ or Lays™, and chocolate raisins for *snacks*; Wonder Bread™, Club Crackers™, vanilla wafers, and Captain Crunch™ for *grains*; ground beef, bacon, chicken nuggets, and whole cheese for *proteins*; canned plum or canned peach, canned pineapple, canned orange, and canned pear for *fruits*; and broccoli with butter and cheese, cauliflower with butter and cheese, green beans with butter and cheese, and Tater Tots™ for *vegetables.* Nutrition facts for the foods in the assessments are available from the first author.

Response measurement, reliability, and data analysis. Observers recorded the trial-by-trial frequency of the dependent variables using paper and pencil. Observers scored *consumption* when participants selected one of the two presented foods and consumed the selected food without expelling it. Observers scored *selection* when participants grasped one food. The experimenter blocked attempts to select both foods. Observers scored *no selection* when participants did not select one food after a second prompt to do so. Observers scored *expulsion* when the participant removed food from his or her mouth using his or her fingers or tongue.

A second independent observer collected data on a mean of 49% (range, 36% to 100%) of within- and 47% (range, 32% to 100%) of between-food group preference assessments. We compared observers' records on a trial-by-trial basis. We calculated interobserver agreement by dividing the number of agreements by the total number of agreements plus disagreements and converting the ratio to a percentage. An agreement was defined as both observers scoring the same responses within a given trial. A disagreement was defined as the two observers scoring different responses within a given trial. Mean interobserver agreement for consumption, selection, and expulsion across participants was 99% (range, 96% to 100%) and 99% (range, 95% to 100%) for the within- and between-food group preference assessments, respectively.

We developed *healthy eating indices* to provide an index of the strength of participant's preference by showing the difference between percentage of consumption of healthier and less-healthy foods. We analyzed trials that compared one healthier and one less-healthy food for each food group. We first calculated separate percentages of consumption of healthier foods and less-healthy foods by dividing the total number of trials with consumption of healthier food and less-healthy food, respectively, by the total number of trials in which one healthier and one less-healthy food were compared, and converted the ratio to a percentage. We then subtracted the percentage of consumption of less-healthy foods from the percentage of consumption of healthier foods. Positive and negative values indicate preference for healthier and less-healthy foods, respectively; zeros indicate no preference. We defined no preference as less than a 3% difference between a participant's preference for healthier and less-healthy foods, and we defined preference as a 3% or greater difference between a participant's preference for healthier and less-healthy foods. For example, if there were eight trials in which one healthier and one-less healthy food were compared, and on three of those trials the participant selected the healthier item, we converted this to a percentage of consumption of healthier food by dividing 3 by 8 and multiplying this by 100% ([3/8] x 100% = 37.5%). If the participant selected the less-healthy food on the remaining five trials, we converted this to a percentage of consumption of less-healthy food by dividing 5 by 8 ([5/8] x 100% = 62.5%). Finally, we subtracted the 37.5% from 62.5% (37.5% - 62.5% = -25%).

Procedure

Preassessment food exposure. Before the start of each within- and between-food group preference assessment, the experimenter exposed participants to each food by presenting a spoon, a fork, and a dime-sized piece of food on a plate. The experimenter said the name of the food and asked the participant to try it using his or her hands, the spoon, or the fork. The experimenter gave the participant the food if he or she reached for the food or vocally indicated that he or she would try it (e.g., "ok"). The experimenter delivered no programmed consequences 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.

General procedure for paired-choice preference assessment. The experimenter used the following procedure for the within- and between-food group assessments. The experimenter placed a spoon and fork on the table in front of the participant and stated that the participant could use his or her hands, the spoon, or the fork to eat the food. The experimenter presented each food with every other food, in a randomized order, until he or she had presented all possible food pairs. The experimenter placed two dime-sized pieces of food on a plate in front of the participant, labelled both foods, and prompted the participant to select a food. The experimenter gave the participant the food if he or she selected a food and removed the other food. The experimenter presented the next pair of foods after ensuring the child had swallowed the selected food (e.g., "say 'ahh'" or "show me your mouth"). If the participant had food remaining in his or her mouth, the experimenter told the participant to swallow the food, rechecked the participant's mouth every 10 s, and waited until the participant swallowed the food before presenting the next pair of foods. The experimenter blocked all attempts to select both foods by removing the plate, asking the participant to place his or her hands on the table or in his or her lap, re-presenting the pair of foods, and prompting the participant to select one food. The experimenter provided a second prompt if the participant did not select a food within 30 s of the initial prompt. The experimenter removed the pair of foods if the participant did not select a food after the second prompt and presented the next pair of foods. The experimenter provided no programmed consequence and presented the next pair of foods if the participant pushed the plate away or vocally indicated that he or she would not try a food (e.g., "I don't want it").

Within-food group assessment. We conducted one paired-choice preference assessment for each food group: snack, grain, protein, fruit, and vegetable for a total of five paired-choice preference assessments. We included eight foods in each paired-choice preference assessment, four of the healthier foods and four of the less-healthy foods.

Between-food group assessment. We conducted one paired-choice preference assessment with each participant. We used the results of the within-food group preference assessments to select each participant's top three ranked foods from each food group (snack, grain, protein, fruit, and vegetable) for this assessment, for a total of 15 foods in each assessment.

Results

Individual graphs depicting each participant's within- and between-food group preference assessment results are available from the first author.

Within-food group assessment. Figure 1 depicts participants' healthy eating indices for snacks (top), grains (second), proteins (third), fruits (fourth), and vegetables (fifth). Four participants preferred healthier snacks, 14 preferred less-healthy snacks, and 3 had no preference. Seven participants preferred healthier grains, 12 preferred less-healthy grains, and 2 had no

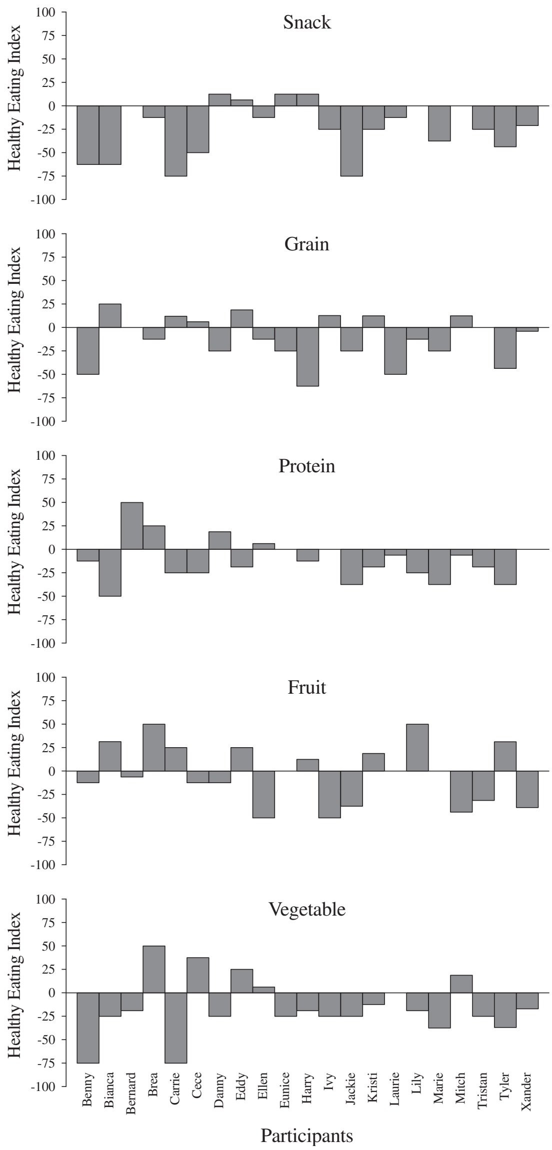

Figure 1. Healthy eating indices summarizing participants' preferences for healthier and less-healthy foods within each food group during the *within-food group preference assessments.* Bars above the x axis denote a preference for healthier foods and bars below the x axis denote a preference for less-healthy foods. The longer the bar, regardless of its direction, the greater the strength of preference.

preference. Four participants preferred healthier proteins, 14 preferred less-healthy proteins, and 3 had no preference. Eight participants preferred healthier fruits, 10 preferred less-healthy fruits, and 3 had no preference. Five participants preferred healthier vegetables, 15 preferred less-healthy vegetables, and 1 had no preference.

Figure 2 depicts participants' healthy eating index score collapsed across all foods in all food groups. We analyzed all trials that compared one healthier and one less-healthy food to yield an overall healthy eating index per participant. Most participants (i.e., 71%) preferred less-healthy relative to healthier foods. Four participants showed a preference for healthier foods, 15 showed a preference for less-healthy foods, and two showed no preference for healthier or less-healthy food. Across participants, the magnitude of preference for less-healthy foods was stronger than the magnitude of preference for healthier foods. The mean magnitude of preference for healthier foods was 12% (range, 5% to 20%) and for less-healthy foods was 19% (range, 4% to 43%).

Between-food group assessment. Fourteen participants ranked snack, two ranked grain, four ranked protein, two ranked fruit, and none ranked vegetables as most preferred. One participant ranked protein and fruit as most preferred. No participants ranked snacks, two ranked grains, two ranked proteins, 10 ranked fruit, and 10 ranked vegetable as least preferred. One participant ranked fruit and protein, and one ranked fruit and vegetables, as least preferred.

Figure 3 depicts the healthy eating index summarizing participants' preference for healthier and less-healthy foods among their top three ranked foods in the between-food group preference assessments. Most participants (i.e., 76%) preferred less-healthy relative to healthier foods. Three participants showed a preference for healthier foods, 16 showed a preference for less-healthy foods, and two participants did not show a preference for healthier or less-healthy food. Across participants, the magnitude of preference for less-healthy foods was stronger

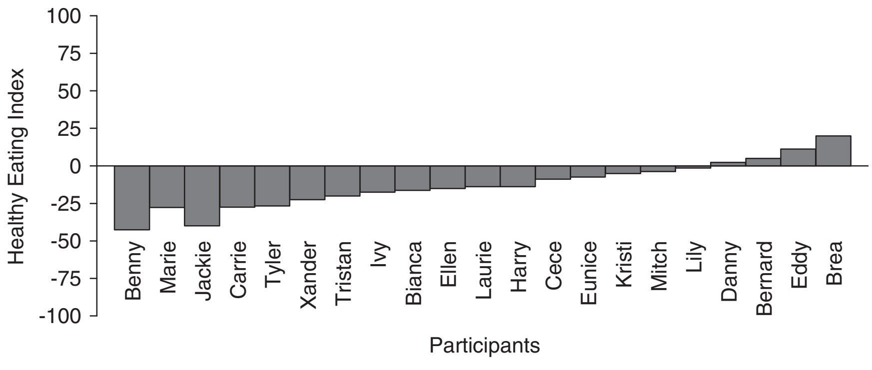

Figure 2. Healthy eating index summarizing participants' preferences for healthier and less-healthy foods across all foods in all food groups during the *within-food group preference assessments.* Bars above the x axis denote a preference for healthier foods and bars below the x axis denote a preference for less-healthy foods. The longer the bar, regardless of its direction, the stronger the preference.

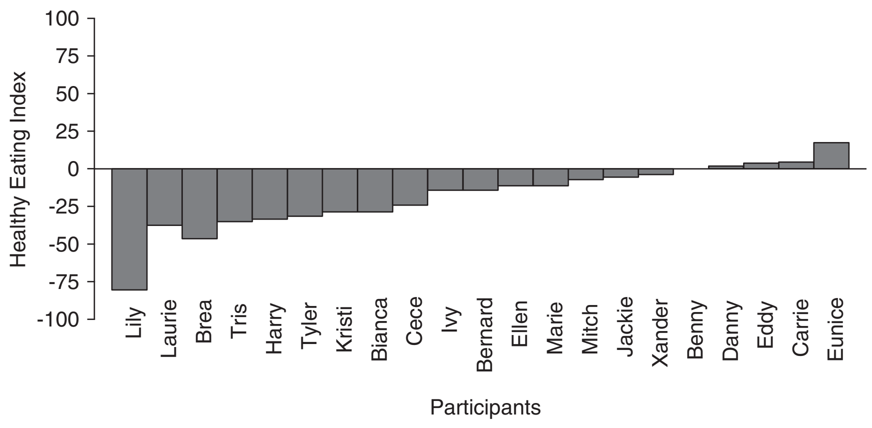

Figure 3. Healthy eating index summarizing participants' preferences for healthier and less-healthy foods among their top three ranked foods across all food groups during the *between-food group preference assessments.* The absence of a bar denotes no preference for healthier or less-healthy foods. Bars above the x axis denote a preference for healthier foods and bars below the x axis denote a preference for less-healthy foods. The longer the bar, regardless of its direction, the stronger the preference.

than the magnitude of preference for healthier food. The mean magnitude of preference for healthier foods was 9% (range, 5% to 18%) and was 26% (range, 4% to 80%) for less-healthy foods.

EXPERIMENT 2: COMPETING PARAMETERS ASSESSMENT

We assessed the relative influence of quality, magnitude, and immediacy on the food choices made by six participants from Experiment 1 who showed less-healthy preference profiles, and we evaluated whether dense and lean schedules of reinforcement differentially affected the efficacy of these reinforcer parameters.

Method

Participants and setting. Six participants (Cece, Ivy, Jackie, Kristi, Laurie, Mitch) from

Experiment 1 were selected for participation in Experiment 2 because (a) their within- and between-food group preference assessment data showed a preference for less-healthy food, and (b) they were available for participation. We conducted the study in a small therapy room equipped with a one-way observation mirror and materials relevant to each condition, as described in Experiment 1.

Stimuli. We identified two high-quality and two low-quality foods based on the results of the between-food group preference assessment in Experiment 1. High-quality foods were less-healthy foods the participant selected on at least 10 of the 14 trials in which the experimenter presented the foods. Low-quality foods were healthier foods the participant selected on 4 or fewer of the 14 trials in which the experimenter presented the foods. Only one food met criterion as low quality for Jackie and Kristi; therefore, these participants had one low-quality food in the competing parameters assessment. The experimenter gave each participant a choice between their two high-quality foods and a choice between their two low-quality foods before the start of session to mitigate potential abolishing operation effects (North & Iwata, 2005). The high-quality food he or she selected and the low-quality food he or she did *not* select was used in that session.

Response measurement, reliability, and procedural integrity. Trained observers collected data using ABC Data Pro™ software on Apple iPods™. The target response was stair stepping, to enhance the health benefits of participation in this experiment. Observers recorded the frequency of stair stepping for each response option, defined as stepping onto and off a 7.6-cm wood block with both feet. A second independent observer collected data during at least 44% (range, 44% to 67%) of sessions. We compared observers' records in each of the sixty 5-s intervals of the session. We calculated interobserver agreement by dividing the smaller by the larger number of responses in each interval, calculating the mean of the ratios for each interval, then converting the mean ratio to a percentage. Mean interobserver agreement across participants was 93% (range, 75% to 100%) for stair stepping and 94% (range, 76% to 100%) for reinforcement delivery.

Procedural integrity data were collected on correct reinforcement delivery, defined as the experimenter placing the correct food on the correct plate or into the correct plastic bag, according to the schedule of reinforcement in effect for that session. We collected these data during at least 66% (range, 66% to 100%) of all sessions by dividing the number of correct reinforcer deliveries by the total number of responses divided by the schedule requirement in effect for a given session. We then converted the ratio to a percentage. Mean procedural integrity for therapists' correct delivery of reinforcement was 99% (range, 0% to 100%).

Experimental arrangement. We used a concurrent-operants arrangement during all conditions. The experimenter placed two identical wood blocks in front of the participant. The experimenter placed pictures depicting the food associated with each response option on a plate or in a plastic sandwich bag behind each wood block. A plate signaled delivery of reinforcement immediately after the session. A sandwich bag signaled delivery of reinforcement 1 hr after the session. The length of the black bar on the strip of paper signaled the reinforcement schedule; the longer the bar, the leaner the reinforcement schedule. The black bar length–reinforcement schedule relation was as follows: a 2.5-cm bar signaled a fixed ratio (FR) 1 schedule, a 7.6 cm bar signaled an FR 4 schedule, a 15.2 cm bar signaled an FR 16 schedule, and a 22.9 cm black bar signaled an FR 32 schedule.

During baseline, we compared two values of quality, magnitude, and immediacy. During the reinforcer-parameter comparison phase, we compared different values of two of the three parameters in each condition (immediacy vs. quality, magnitude vs. quality, and immediacy vs. magnitude) under dense (FR 1) and lean (FR 4 or FR 16) schedules of reinforcement.

Experimental design. We evaluated the effects of dense and lean schedules of reinforcement on reinforcer parameters using a concurrent-operants arrangement within an ABAB reversal design. We compared dense (A) and lean (B) schedules of reinforcement with five of six participants. We exposed one participant (Ivy) to an ABABCDCD reversal design because we did not replicate the effect of the lean schedule of reinforcement on reinforcer-parameter efficacy during the initial ABAB reversal. Therefore, we conducted reversals in the immediacy versus quality condition, which was the only condition in which we observed an initial shift in responding from the dense to lean schedules. Specifically, we conducted the immediacy versus quality condition under a dense (C) and a leaner schedule requirement (D) to determine if a leaner schedule of reinforcement would influence the efficacy of quality and immediacy.

General Procedure

Before each session, the experimenter described the contingencies associated with both response options (e.g., "If you step on this block [while pointing to one of the blocks], this much [while pointing to the bar on the strip of paper], you will get X pieces of X food. If you step on this block [while pointing to the other block], this much [while pointing to the bar on the strip of paper], you will get X pieces of X food"). The experimenter then prompted the participant to complete the response requirement twice for both response options. The experimenter placed the specified amount of food associated with that response option on the plate and delivered it immediately or in the bag and did not deliver it. The experimenter then told the participant that he or she could do whatever he or she wanted during the session. The experimenter did not provide additional prompts after the session began.

Sessions were 5 min in length. We conducted at least two sessions per condition with each participant. We conducted additional sessions if participant responding was inconsistent across sessions until the participant allocated responding toward the same response option for two consecutive sessions. We cut the food into dime-size pieces and did not conduct more than three sessions per day to limit each participants' caloric intake. To mitigate satiation effects, we conducted sessions at least 1 hr after the participant's last meal, session, or delivery of the food associated with the delayed response option earned in a previous session (e.g., if a participant allocated responding to the delayed response option during the first session of the day, we delivered the food earned during the first session 1 hr after the session ended, then waited 1 hr before conducting a second session with that participant). We conducted conditions in a random order within and across participants to control for order effects.

Baseline. The purpose was to determine whether participants' responding was sensitive to the value of the assessed reinforcer parameters in isolation. We held the values of the quality and immediacy at a favorable value. We held magnitude at a modest value of one piece of food, rather than a favorable value of five pieces of food, to limit participants' caloric intake.

Quality. Responding toward the favorable response option resulted in one piece of the high-quality food immediately after the session. Responding toward the less-favorable response option resulted in one piece of the low-quality food immediately after the session.

Magnitude. Responding toward the favorable response option resulted in five pieces of the high-quality food immediately after the session. Responding toward the less-favorable response option resulted in one piece of the high-quality food immediately after the session.

Immediacy. Responding toward the favorable response option resulted in one piece of high-quality food immediately after the session. Responding toward the less-favorable response option resulted in one piece of food 1 hr after session.

Reinforcer-parameter comparison. When we compared different values of two of the three parameters in each condition, we held the value of the other parameter constant at the favorable value (quality and immediacy) or the modest value (magnitude). We arranged separate but identical FR schedules for both response options.

Immediacy versus quality. Responding to one response option resulted in one piece of the high-quality food 1 hr after the session. Responding toward the other response option resulted in one low-quality food immediately after the session. This condition was designed to resemble a situation in which parents make healthier foods freely available (e.g., precut and placed on the counter), but make their children wait for less-healthy foods (e.g., cookies take approximately 1 hr to prepare and bake).

Magnitude versus quality. Responding to one response option resulted in one piece of the high-quality food immediately after the session. Responding toward the other response option resulted in five pieces of the low-quality food immediately after the session. This condition was designed to resemble a situation in which parents offer a small quantity of less-healthy food (e.g., cookie) or a larger quantity of healthier foods (e.g., small bowl of fruit or vegetables).

Immediacy versus magnitude. Responding to one response option resulted in one piece of the high-quality food immediately after the session. Responding toward the other response option resulted in five pieces of the high-quality food 1 hr after the session. This condition was designed to resemble a situation in which parents offer a small amount of food immediately versus a larger quantity later.

Schedules of reinforcement. We selected schedules of reinforcement that may approximate the amount of effort a child may be required to exert in the natural environment. For example, we designed the FR 1 schedule to approximate a situation in which food is available readily in the kitchen (e.g., precut fruit on the kitchen counter). Given that it is unlikely that young children between the ages of 2 to 5 years would be required to exert a great deal of effort to obtain food, we selected a moderate value (FR 16) to approximate a situation in which a young child may be required to obtain food from an area outside of the kitchen (e.g., bag of chips from the basement or garage).

FR 1. We used an FR 1 schedule for the dense schedule of reinforcement for all participants.

FR 16. We used an FR 16 schedule of reinforcement for the lean schedule of reinforcement for five of six participants.

FR 4. We used an FR 4 schedule of reinforcement for the lean schedule of reinforcement for one of six participants (Cece). We exposed Cece to an FR 4 rather than an FR 16 because she revoked assent (e.g., "It's too much" or "It's too hard") during presession exposure to both FR 16 and FR 8 schedule requirements.

FR 32. We used an FR 32 schedule of reinforcement for an even *leaner* schedule of reinforcement for one of six participants (Ivy).

Data Analysis

We analyzed data in three ways. First, we analyzed data by comparing the relative proportion of responding toward both response options within a given condition. Second, we analyzed data within a given phase to identify the most influential parameter of food that governed children's food choices. Within each phase, we determined the most influential reinforcer parameter by comparing the relative proportion of responding toward both response options across conditions. Finally, we determined the differential effects of dense and lean schedules on reinforcer efficacy by comparing assessment results across phases of dense and leans schedules.

We analyzed data from the second session of each condition because these data show response allocation after a history of exposure to the contingencies arranged in the first session of each condition. Because participants did not contact the full reinforcement contingency arranged in each session until the session ended, it is unlikely that first-session data represented responding under the control of the programmed contingencies. That is, we would not observe any change in behavior as a function of the session contingencies until the second session.

Results and Implications

Figure 4 depicts the results of the competing parameters assessment. The behavior of two (Kristi and Jackie) of six participants was not sensitive to the favorable values of each reinforcer parameter during baseline (data not depicted; available from the first author). Specifically, during baseline, Kristi responded exclusively toward the favorable value of quality and more toward the favorable value of immediacy. However, responding was allocated toward the unfavorable (i.e., smaller) value of magnitude. Jackie allocated more responding toward the favorable magnitude value, but more toward the unfavorable quality (i.e., low quality) and immediacy (i.e., delayed) values during baseline. Because these participants demonstrated a lack of sensitivity to the favorable values of all three reinforcer parameters, it was likely that factors other than the assessed reinforcer parameters influenced their responding during baseline. Therefore, we excluded Kristi and Jackie from the subsequent assessment. We found it interesting that these participants were the only two for whom we identified only one low-quality food in the competing parameters assessment. We compared these participants' preference profiles from Experiment 2 with those of the other participants and did not find any patterns that might have predicted their unlawful responding in the baseline of Experiment 2.

The behavior of the remaining four participants (Cece, Ivy, Laurie, and Mitch) was sensitive to the favorable value of each reinforcer parameter during baseline (see Figure 4); therefore, these four participants participated in the reinforcer-parameter comparison phase. For Cece and Laurie, the assessment results under dense and lean schedules of reinforcement were identical, suggesting that effort did not influence their food choices. Under dense (FR 1) and lean (FR 4) schedules of reinforcement, Cece allocated exclusive responding toward the immediately (after session) available food, even when doing so produced a (a) smaller magnitude of food during the immediacy versus magnitude condition and (b) lower quality of food during the immediacy versus quality condition. When we compared magnitude and quality, Cece allocated exclusive responding toward the high-quality option, indicating that quality of food was the second most influential parameter of food governing her responding. Under both dense (FR 1) and lean (FR 16) schedules of reinforcement, quality of food was found to most influence Laurie's food choices. That is, Laurie allocated all or most of her responding toward the quality option, even when doing so produced (a) a1-hr delay to food access during the immediacy versus quality condition and (b) smaller magnitude of food during the magnitude versus quality condition. When we compared immediacy and magnitude, Laurie responded exclusively toward the immediacy option, indicating that immediacy of food access was the second most influential parameter of food governing her food choices.

The assessment results under a dense and lean schedule of reinforcement were different

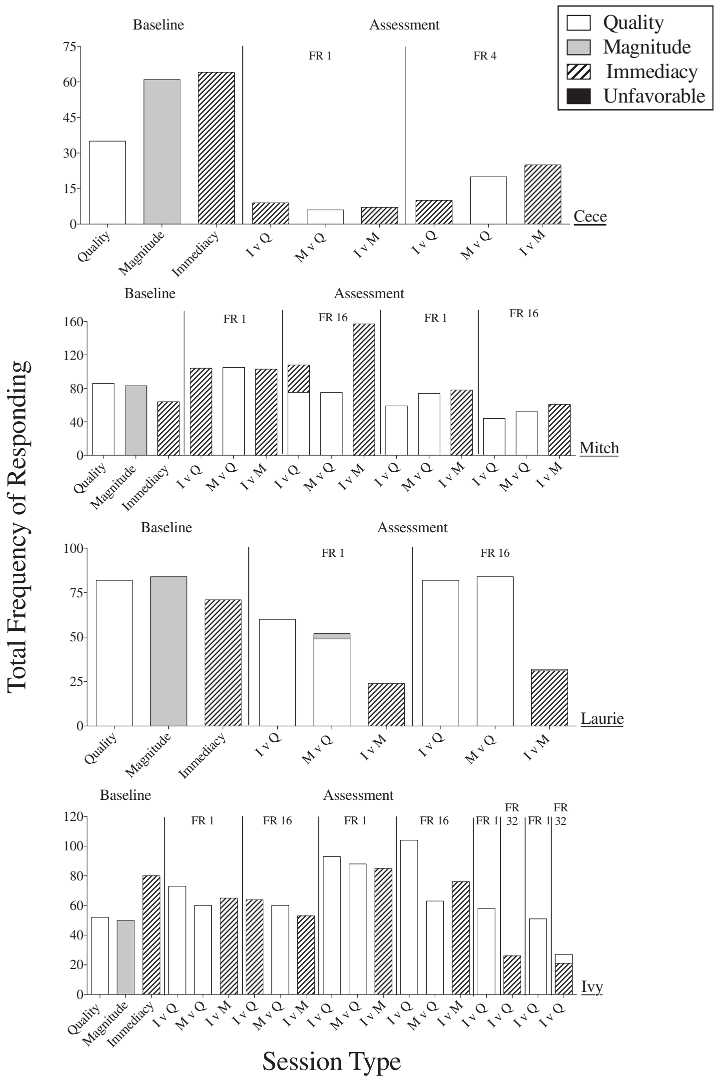

Figure 4. The total frequency of responses allocated to each parameter during the final session of each assessment condition during Experiment 2. The total height of a bar denotes the total frequency of responses to both parameters. Stacked bars indicate that the participant responded to both parameters and the bar fills denote the proportion of responses allocated to each parameter.

for Mitch and Ivy. Under a dense (FR 1) schedule of reinforcement, Mitch responded exclusively toward the response option that produced food immediately after the session in both conditions in which we assessed immediacy (immediacy vs. quality and immediacy vs. magnitude conditions), indicating that immediacy of food access was the most influential parameter governing his food choices under a dense schedule of reinforcement. Mitch responded exclusively toward the quality option in the magnitude versus quality condition, indicating that quality of food was the second most influential parameter governing his food choices under a dense schedule. Under a lean (FR 16) schedule, Mitch responded exclusively toward the response option associated with quality during both conditions in which we assessed quality, indicating that quality of food was the most influential parameter of food governing his choices. However, we were unable to replicate this effect when we reintroduced the FR 1 and FR 16 schedules of reinforcement. When we reintroduced the FR 1 and FR 16 schedules, Mitch responded exclusively toward the quality option during both conditions in which we assessed quality.

Although we were unable to identify the precise conditions that controlled Mitch's responding, two possible explanations for his pattern of responding exist. First, it is possible that the initial FR 1 schedule phase may have inaccurately identified immediacy of food access as the most influential parameter governing Mitch's food choices. Second, it is possible that increasing the response requirement may have (a) decreased the value of food immediacy and (b) increased the value of food quality; when the response requirement subsequently decreased, the value of food quality may have maintained and overrode the value of food immediacy.

Finally, under the dense (FR 1) schedule of reinforcement, Ivy responded exclusively toward the high-quality response option during both conditions in which we assessed quality (immediacy vs. quality and magnitude vs. quality conditions), indicating that quality was the most influential parameter determining her food choices under a dense schedule of reinforcement. However, during the first lean (FR 16) schedule of reinforcement phase, Ivy responded exclusively toward the immediate option during both conditions in which we assessed immediacy, which initially suggested that immediacy of food access was the most influential parameter governing her food choices under lean schedules of reinforcement. When we reintroduced the FR 1 and lean FR 16 schedule of reinforcement phases, Ivy responded exclusively toward the high-quality response option during both conditions in which we assessed quality (i.e., we did not observe replication of the effects under the initial FR 16 schedule of reinforcement). Therefore, we increased the schedule requirement to FR 32 to determine if a leaner schedule of reinforcement would influence the efficacy of the quality and immediacy. Ivy either allocated more or all responding toward the more immediate response option under both FR 32 phases, suggesting that immediacy was the most influential parameter governing her food choices under those conditions. It may be possible that Ivy habituated to the effort required by the schedule after repeated exposure to the FR 16 reinforcement schedule. Because we replicated the effects of the FR 32 schedule across both FR 32 phases, it appears that (a) Ivy did not habituate to the more effortful FR 32 schedule requirements, and (b) the influence of immediacy of food access was durable when we doubled the schedule requirement. Further, these findings demonstrate that disparate amounts of effort influenced the efficacy of immediacy and quality for Ivy in a predictable manner.

General Implications and Suggestions for Future Research

The series of food preference assessments we conducted in Experiment 1 established empirical evidence of food-preference patterns in children under age 5 and confirmed previous research suggesting that most children prefer less-healthy foods relative to healthier foods (Skinner et al., 2002; Skinner et al., 1998). When we assessed the preference for foods from the snack, grain, protein, fruit, and vegetable food groups, 76% of participants showed a preference for less-healthy foods relative to healthier foods. Further, when we assessed preference for food groups, we found snacks were the most preferred food group for 14 of 21 participants, whereas vegetables and fruits were ranked as the least preferred food group for 10 of 21 participants, confirming published reports based on indirect assessments (Domel et al., 1993; Kirby, Baranowski, Reynolds, Taylor, & Binkley, 1995; Skinner et al., 1998; Wardle et al., 2005).

In Experiment 2, we demonstrated the utility of the competing parameters assessment to identify parameters of food that influenced young children's food choices using an analogue arrangement that was designed to approximate choices among concurrently available healthier and less-healthy foods children may encounter in the natural environment. Our competing parameters assessments also extended previous research in three important ways. First, we used the competing parameters assessments to evaluate the relative influence of various reinforcer parameters with young, typically developing children. Second, the competing parameters assessment extended the series of studies conducted by Neef and colleagues (Neef, Bicard, & Endo, 2001; Neef, Bicard, Endo, Coury, & Aman, 2005; Neef & Lutz, 2001; Neef et al., 1993; Neef et al., 2005; Neef et al., 1994) by evaluating the relative influence of various reinforcer parameters on food choices. Third, we evaluated the interactive effects of effort by comparing the relative influence of reinforcer parameters under dense and lean schedules of reinforcement (e.g., DeLeon et al., 1997; Roane, Lerman, & Vorndran, 2001; Tustin, 1994).

The competing parameters assessments conducted in Experiment 2 (a) never identified magnitude of reinforcement as one of the top two most influential parameters for any participant, and (b) identified quality and immediacy as the top two most influential reinforcer parameters for all four participants who participated in the reinforcer-parameter comparison phase of the assessment. These results seem problematic considering how many less-healthy foods are packaged and marketed. That is, several types of less-healthy snacks (e.g., Twinkies™, Wagon Wheels™, Fruit Gushers™) are packaged to be immediately available. Fast food restaurants, many of which sell less-healthy food, are specifically designed to deliver food as quickly as possible. This essentially targets both parameters found to influence young children's food choices.

It should be noted that we only evaluated two different values of each parameter with all participants. That is, we only evaluated two values of quality (high- and low-preference foods), magnitude (one piece of food and five pieces of food), immediacy (delivery of food immediately after session and 1 hr after session), and effort (FR 1 and FR 4 or FR 16). We exposed one participant, Ivy, to an FR 32 schedule of reinforcement; however, we exposed all other participants to two different schedules of reinforcement only. It is possible that evaluating a wider variety of values of each parameter may have yielded different outcomes. For example, we did not find that magnitude of reinforcement governed any of the participants' food choices. It is possible that the favorable value of magnitude, five pieces of food, we arranged was insufficient to exert control over any of the participants' food choices. Similarly, the differential efficacy of reinforcer parameters under dense and lean schedules was only partially observed with two participants. Therefore, it is possible that the lean schedule requirement we arranged was not sufficiently effortful to influence responding under the current experimental conditions. Conversely, it is also possible that effort simply does not influence the efficacy of reinforcer parameters for some children. Researchers may consider evaluating more than two values of reinforcer and response parameters when conducting future competing-parameters assessments of food choices. Alternatively, future research may use a progressive-ratio schedule of reinforcement as an efficient means to identify the effect of effort on response allocation. The relative influences of other factors that may govern children's food preferences also can be evaluated, such as texture (e.g., Patel, Piazza, Layer, Coleman, & Swartzwelder, 2005), taste (e.g., Tiger & Hanley, 2006), food color (Cornish, 1998), brand (Cornish, 1998; Rogers, Magill-Evans, & Rempel, 2012; Whiteley, Rodgers, & Shattock, 2000), or even food packaging (Whiteley et al., 2000).

Although the purpose of this translational study was to evaluate the utility of the competing parameters assessment to identify the most influential parameter governing young children's food choices, a discussion of the practical implications of this assessment is warranted. That is, the results of this assessment could be used to design individualized interventions to promote healthier food choices among children. Specifically, once a child's most influential parameter of food is identified, it can be systematically manipulated to shift responding toward healthier food choices. For example, for children whose behavior is most influenced by the quality of food, treatment options to increase the consumption of healthier foods may consist of (a) enhancing the quality of healthier food (e.g., add gelato to a bowl of mixed fruit), (b) sequential presentation (e.g., Piazza et al., 2002), in which less-healthy food is delivered contingent upon consumption of healthier food, and (c) the high-probability request sequence (e.g., Meier, Fryling, & Wallace, 2012), in which a bite of less-healthy food could be offered following three bites of healthier food. For those children whose behavior is primarily influenced by the immediacy of food access (i.e., they make impulsive food choices), one possible treatment option might be to increase their self-control behavior by (a) using a delay fading procedure (e.g., Dixon & Falcomata, 2004; Dixon & Holcomb, 2000), in which the amount of time the child is required to wait for food is gradually increased, (b) teaching children to recite a rule to themselves during the wait period (e.g., "when I wait, I can have a snack"; Hanley, Heal, Tiger, & Ingvarsson, 2007), or (c) introducing a mediating activity during the delay (e.g., Newquist, Dozier, & Neidert, 2012). Finally, for those children whose behavior is also influenced by the effort involved in acquiring food, one possible treatment option might be to simply decrease the amount of effort required to obtain healthier foods. For example, parents can place precut fruits and veggies in the fridge or on the kitchen counter.

Our preference assessments included food that was regularly served at the center in which the study took place and we did not collect data on the consumption of these foods outside of the experimental context. Therefore, we do not know whether the results of these preference assessments corresponded to food choices made in other settings (e.g., home, restaurant). Therefore, researchers may consider evaluating the relation between preference patterns and eating habits to validate our outcomes. In addition, it may be interesting to evaluate this relation over multiple points in time to establish empirical evidence for the suggestion that food preferences learned early in life are likely to influence eating habits later in life (Birch, 1999). In addition, researchers may opt to use a preference assessment methodology (e.g., multiple stimulus without replacement) that more closely approximates the conditions under which children make choices among several concurrently available options in the natural environment.

Finally, without an evaluation of an intervention based on the results of the competing parameters assessments, it is unclear if the competing parameters assessments accurately identified the most influential reinforcer parameter for each child. However, this limitation should be tempered with the fact that Neef et al. (2001) developed effective intervention strategies based on the results of competing parameters assessments, thereby establishing the utility of competing parameters assessments to identify the reinforcer parameter that most influences an individual's choices. Nonetheless, future research should develop and evaluate food-based interventions based on the results of the competing parameters assessments.

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