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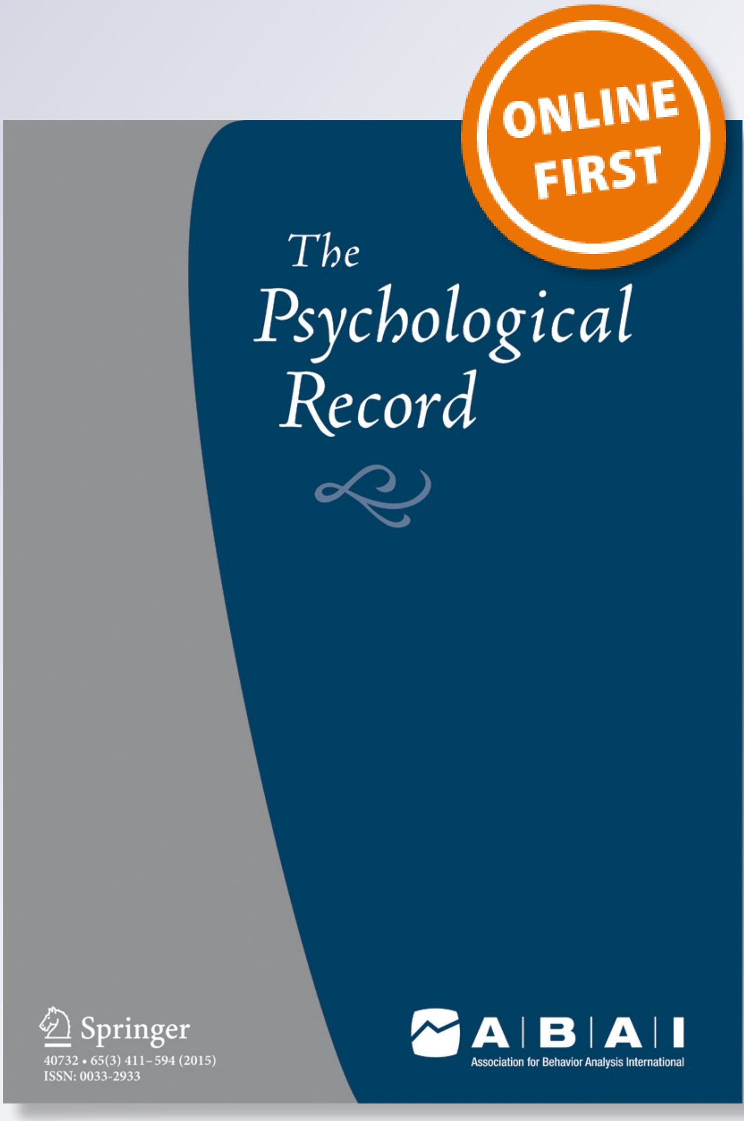

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ORIGINAL ARTICLE

Improving Portion-Size Estimation Using Equivalence-Based Instruction

Lisa M. Trucil[1] · Jason C. Vladescu[1,2] · Kenneth F. Reeve[1] · Ruth M. DeBar[1] · Lauren K. Schnell[1]

Abstract Obesity has become a major health concern in the United States. While a number of factors can contribute to obesity, including genetics, socioeconomic status, and sedentary lifestyle, its underlying cause tends to be overconsumption. Thus interventions are needed that will teach individuals the accurate estimation of portion sizes. The current study evaluated the use of equivalence-based instruction (EBI) to teach graduate students to accurately estimate different portion sizes. Participants were directed to estimate ¼-, ½-, and 1-cup portions of various foods. EBI was implemented to teach participants the portion sizes in a measuring cup and on a plate, as well as which aid represented each portion. The results demonstrated that EBI is an effective and efficient training procedure. These findings extend the current literature on teaching individuals to accurately estimate portion sizes.

Keywords Equivalence-based instruction · Portion-size estimation · Portion-size measurement aids

Obesity has become a major public health concern in the United States. National data from 2011–2012 suggest that the prevalence of obesity among adults 20 years and older is approximately 34 %, or 78 million adults (Ogden, Carroll, Kit, & Flegal, 2013; Ogden, Carroll, Kit, & Flegal, 2014). Obesity may decrease life expectancy by 5 to 20 years (Olshansky et al., 2005). There are numerous health-related risks associated with being obese, for example, type 2 diabetes, cardiovascular disease, high blood pressure, high cholesterol, and depression (Daggett & Rigdon, 2006; Flegal, Carroll, Ogden, & Curtin, 2010; Fleming, 2012; Levi, Segal, Thomas, Laurent, Lang, & Rayburn 2013; National Heart, Lung, and Blood Institute, 1998; Normand, 2008). In the United States, treating obesity and related problems results in annual healthcare costs that range from $147 billion to $210 billion (Finkelstein, Trogdon, Cohen, & Dietz, 2009; Levi et al., 2013; Thorpe, Florence, Howard, & Joski, 2004). Additionally, employers incur $73 billion a year in productivity loss related to obesity (Finkelstein, Fiebelkorn, & Wang, 2004).

According to the National Institutes of Health's National Heart, Lung, and Blood Institute (1998), the most common cause of obesity is overeating, although other variables (e.g., genetics, socioeconomic status, sedentary lifestyle) play a significant role (Chandon & Wansink, 2007; Fleming, 2012; Hausman, Borrero, Fisher, & Kahng, 2014; Kopelman, 2000; Rolls, Roe, & Meengs, 2007; Wansink, Ittersum, & Painter 2006). In fact, caloric intake has been reported to have increased by 18 % since 1983 in both men and women (Chandon & Wansink, 2007).

Recent research suggests that portions are 2–5 times as large as they were 20 years ago (Young & Nestle, 2003). Larger portions are problematic in that they may result in the consumption of 18–25 % more food (Marchiori, Corneille, & Klein, 2012). This is not surprising, as 54 % of American adults have reported that they attempt to eat until they "clean their plates" (Wansink et al., 2005). Accurate estimation of portion size is an important skill that may help prevent

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individuals from consuming more calories than recommended, thereby helping to prevent or reduce obesity.

One potentially effective method for teaching individuals to consume appropriate portions is the use of portion size measurement aids (PSMAs). PSMAs are objects that can be used to directly measure (e.g., measuring cups, spoons), or arranged to visually represent (e.g., sports balls, dice, deck of cards, common household items), different food portions. Although the use of direct measures may lead to more accurate measurement of portion sizes than the use of visual representations, individuals may be less likely to use them in public, as they require transportation and may be stigmatizing (Hausman et al., 2014). It may be more practical to teach individuals to use common items to estimate portion sizes, as these are less stigmatizing and more transferrable (Hausman et al., 2014).

One potentially effective approach for teaching individuals to estimate portion sizes is through the use of equivalence-based instruction (EBI). The purpose of EBI is to teach individuals to respond to physically dissimilar stimuli as if they were the same (Fields & Reeve, 2001). In doing so, an individual has developed an equivalence class. An equivalence class is a set of stimuli in which the members do not share the same physical characteristics, yet all stimuli in the class occasion a common response (Fields & Reeve, 2001; Sidman, 2009). The benefit of EBI is that after certain conditional discriminations are trained, other conditional discriminations may emerge without training or reinforcement (Green, 2001; Sidman, 2009).

Hausman et al. (2014) evaluated the usefulness of EBI for increasing the accuracy of portion size estimations for nine college-age participants. During baseline, the participants were asked to estimate a ½-cup portion of a specific food (Cheerios). During EBI, the participants were directly taught the AB, BC, BC, and CB relations, in which the A stimulus represented the food on a plate, the B stimulus represented the food in a measuring cup, and the C stimulus represented the PSMA. Next, the AC and CA relations were tested. Following EBI, the participants were again asked to measure a ½-cup portion of a specific food (Cheerios). For all nine participants, the results indicated that portion estimation accuracy increased, and these outcomes were maintained for 1 week. Furthermore, the experimenters evaluated the extent to which the participants could accurately estimate ½-cup portions of up to two foods not associated with training (crackers and egg noodles), and found that participants estimated at least one of these foods accurately.

The results of Hausman et al. (2014) are encouraging, as they suggest that EBI is a useful tool for increasing the accuracy of portion size estimation. However, several limitations are worth noting. Hausman et al. only evaluated improvement in accuracy of estimating ½ cup of a single food during training (Cheerios). It seems important to demonstrate that EBI would successfully lead to increased accuracy of multiple portion size estimations (e.g., ¼ cup, ½ cup, 1 cup) across multiple foods. In addition, participants were presented with the food item not in its original packaging. This may be problematic, as it may not represent the condition under which participants will have to make portion size estimations (i.e., food in its original package). Third, no baseline data were collected for the novel foods. Without such data, limited inferences can be drawn regarding the degree to which responding generalized to foods not associated with training. Lastly, Hausman et al. directly trained two symmetrical relations (the BA and CB symmetrical relations). During EBI, symmetrical relations are not typically trained, as they often emerge without such training (Green & Saunders, 1998). Because the training of the symmetrical relations may reduce the efficiency of the procedure, it seems worthwhile to determine whether direct training of these relations is necessary.

The purpose of the current evaluation was to replicate Hausman et al. (2014) by evaluating the effects of EBI on increasing participants' estimation of portion size, and extend Hausman et al. by (a) training multiple portion sizes (i.e., ¼ cup, ½ cup, and 1 cup) across multiple foods, (b) evaluating the extent to which responding was generalized across multiple foods by conducting pre- and post-training generalization probes, (c) presenting foods in their original packaging when requiring participants to make portion size estimations, (d) conducting a water displacement test to determine which PSMAs to use, and (e) collecting treatment integrity and social validity data.

Method

Participants

Participants were three white female students attending a private suburban university and enrolled in a non-related master's degree program. Reese, Paige, and Kira were 22, 22, and 23 years of age, respectively. Informed consent was obtained prior to participation in the study. Participants were paid an hourly stipend of $10 based on session attendance, not performance. Potential participants were excluded if they estimated portion sizes within 20 % deviation during baseline or if they scored 60 % or higher for any of the relations during the pre-test.

Setting and Materials

Sessions were conducted in a room at the private suburban university. An observation room was connected to the room via a one-way mirror. The room contained a table, chairs, and materials necessary to conduct each session (described below). The participant, the experimenter, and an assistant (to assist with materials) were the only individuals present in the room during all sessions.

The materials included portion-size measurement aids (PSMAs; described below), food (described below), Betty Crocker® plastic measuring cups with a 2-cup-capacity (model number 14157), white 9″ plastic dinner plates (SKU# 922526), an Ozeri Pronto© digital multifunction kitchen and food scale (model number B004164SRA), a digital timer, data sheets, and pencils. An iPad was used to video-record all sessions.

We used seven foods during the current evaluation: Goya® dried Black Beans, ShopRite® Naturally Sweetened Fiber Twigs, Soy Protein Grahams and Honey Puff Cereal, Sun-Maid® dried Mixed Fruit, ShopRite® Ziti Rigati, Ronzoni® Mini-Shells, Goya® dried Lima Beans, and UTZ® Pub Mix. These foods were selected because they are nonperishable, thought to be commonly consumed, and of various shapes (circular, irregular) and sizes (small and large). The four training foods were the black beans, cereal, ziti rigati, and mixed fruit. The training foods selected were a small and large food item of a consistent shape and color (the black beans and ziti rigati) and a small and large food item of different shapes and colors (the cereal and mixed fruit). The three generalization foods were mini-shells, lima beans, and pub mix. The generalization foods selected were a small (mini-shells) and large (lima beans) food item of a consistent shape and color and a food item of mixed shapes, sizes, and colors (pub mix).

We selected a white Tommy Armour® golf ball, a white Wilson® tennis ball, and a white Rawlings Little League® baseball to serve as PSMAs for the ¼-cup, ½-cup, and 1-cup portion sizes, respectively.

Dependent Variables and Measurement

The participants' estimation of portion sizes served as the dependent variable during the baseline, post-training, generalization, and maintenance phases. The accuracy of portion-size estimations was determined by the degree to which participant's estimation of portion size differed from the training and generalization food measurements. The process for identifying the training and generalization food measurements was based on procedures described by Hausman et al. (2014) and were as follows for each portion size (¼ cup, ½ cup, and 1 cup) of each training and generalization food item: (a) the experimenter measured a portion of the food item using a measuring cup, (b) the experimenter weighed (in grams) the portion using a digital kitchen scale, (c) this process was repeated ten times for each portion, and (d) the average weight (in grams) of these ten measurements was calculated for each portion. The average weight was rounded to the nearest whole number. Accurate portion estimations were defined as those that fell within 20 % of the target measurements for each food.

The average percentage deviation was calculated as follows: (a) the experimenter subtracted the target measurement from a participant's estimation, (b) the difference was divided by the target measurement, (c) the absolute value of the quotient was determined, (d) the number was multiplied by 100 to obtain the percentage, and (e) the average of each portion size was calculated. All ¼-cup, ½-cup, and 1-cup portion sizes were summarized separately. For example, to determine the percentage deviation of ½ cup of ziti rigati, the experimenter subtracted the target measurement (38 g) from the participant's estimation (84 g) and calculated the difference (−46 g). The difference (−46 g) was divided by the target measurement (38 g), and the quotient was calculated (−1.2105). The absolute value of the quotient (1.2105) was multiplied by 100 % to determine the percentage deviation (121.05 %). Finally, the average percentage deviation of each portion size was calculated: the percentage deviations among black beans, cereal, ziti rigati, and mixed fruit were averaged for each of the ¼-cup, ½-cup, and 1-cup portion sizes. The same procedure was used for generalization foods.

The experimenter scored unprompted correct and incorrect responses during the pre-test, training, post-test, and full post-test phases. Additionally, the experimenter scored prompted correct and incorrect responses during the training phase. Unprompted and prompted correct responses were defined as the participant engaging in a correct response prior to or following the delivery of a prompt, respectively. Unprompted and prompted incorrect responses were defined as errors of commission or omission following the antecedent stimulus or prompt, respectively. Only unprompted correct responses were summarized in the figures for each participant.

Interobserver Agreement

A calibration test was conducted to determine the accuracy of the digital scale. A naïve observer was asked to record the weight (in grams) of a portion size of a food item. The experimenter poured an amount of a food item onto a plate and then placed the plate onto the digital scale. The naïve observer was asked to record the weight (in grams) displayed on the digital scale. This process was continued until 100 % consistency was achieved.

A second observer independently scored data by viewing a video for interobserver agreement (IOA) purposes. During baseline, post-training, generalization, and maintenance phases, IOA data on the participant's accuracy of portion-size estimations were collected. The primary and secondary observers were asked to independently record the participant's estimation (in grams) displayed on the digital scale and then calculate the participant's accuracy of portion-size estimation. Interobserver agreement was calculated by dividing the smaller weight by the larger weight, and multiplying by 100 to obtain the percentage. For each participant, IOA was collected for 54 % of sessions. The mean IOA scores were 99 % for Reese (range, 99–100 %), 99 % for Paige (range, 98–100 %), and 99 % for Kira (range, 96–100 %).

During the pre-test, training, post-test and full post-test phases, IOA data were collected on the participant's responses. A response was defined as the participant moving the sample stimulus in front of the specific comparison stimulus. The primary and secondary data collectors recorded the participant's responses independently. An agreement was recorded when both observers recorded the same response. Interobserver agreement was calculated on a trial-by-trial basis, dividing the number of agreements by the total number of trials, and multiplying by 100. During the above-referenced phases, IOA was collected for 50 % of sessions for Reese, 50 % of sessions for Paige, and 56 % of sessions for Kira. The mean IOA scores were 99 % for Reese (range, 96–100 %), 99 % for Paige (range, 96–100 %), and 100 % for Kira.

Treatment Integrity

An independent observer collected treatment integrity data from a video for 52 %, 53 %, and 50 % of sessions for Reese, Paige, and Kira, respectively, across all conditions. The observer scored each video using a checklist of steps implemented. A "+" was scored if a step was completed correctly, a "−" if a step was completed incorrectly, and "N/A" if the step was not applicable. Treatment integrity was calculated by dividing the number of steps implemented correctly by the sum of the number of steps implemented correctly and incorrectly and multiplying by 100 %. Treatment integrity scores were 99 % (range, 96–100 %) for Reese, 99 % (range, 94–100 %) for Paige, and 100 % for Kira.

A second independent observer collected treatment integrity data from the same video for 54 %, 50 %, and 50 % of the sessions for Reece, Paige, and Kira, respectively, for IOA purposes. The second observer scored each video using the same checklist of steps implemented. An agreement was recorded when both observers scored a step on the checklist the same (i.e., "+", "−", or "N/A"). A disagreement was recorded when both observers scored a step on the checklist differently (i.e., one observer recorded a "+" and the other observer recorded a "−"). Interobserver agreement was calculated by dividing the number of agreements by agreements plus disagreements and multiplying by 100. Treatment integrity IOA was 100 % for all participants. The treatment integrity results show that the experimenter implemented the procedures as intended.

Design and General Procedure

A non-concurrent multiple-baseline-across-participants design (Watson & Workman, 1981) was used to evaluate the effects of equivalence-based instruction (EBI) on participants' portion-size estimation. The experimenter directed the participants to estimate portions of each food item during the baseline, post-training, generalization, and maintenance phases. Each food was presented in its original packaging. Once the participant made an estimation of the portion size of a particular food item, the experimenter weighed the food portion on a digital scale and recorded the weight. The weighing process was performed in the presence of the participants, but they could nether view nor were shown the results.

Baseline During baseline, the participants were directed to estimate three portion sizes (¼ cup, ½ cup, and 1 cup) of each training food. A plate and the specific food in its original package were provided. No PSMAs or measuring cups were available or within view. The participants also had access to a clear bin to use for excess food that they wished to remove from their estimation. The experimenter gave the instruction, "Please give me (portion size) of (food item). I cannot answer any questions or provide you with assistance. If you have any extra food that you would like to remove from your estimation, you can place it in the bin." Vocal feedback was not provided for correct or incorrect responses. The experimenter weighed the food and recorded the weight on a data sheet. Sessions involving training foods included 12 trials (three portion sizes multiplied by four training foods).

Equivalence-Based Instruction Equivalence-based instruction (EBI) was arranged to establish three classes (i.e., ¼-cup, ½-cup, and 1-cup portion sizes) of three learning stimuli (i.e., the A stimulus was the portion size of the food item in a 2-cup-capacity measuring cup, the B stimulus was the portion size of the food item on a plate, and the C stimulus was the PSMA). A one-to-many training structure was employed to teach the AB and AC relations (Fields & Verhave, 1987; Fields, Hobbie-Reeve, Adams, & Reeve 1999). Previous studies have found that this training structure is the most efficient for developing an understanding of equivalence (Fields & Verhave, 1987; Green & Saunders, 1998; Lian & Arntzen, 2013). A simple-to-complex training protocol was implemented (Green & Saunders, 1998). Following training of each individual relation, the corresponding symmetrical relation (i.e., BA or CA) was tested. Post-tests involved the testing of the BC and CB relations.

Pre-Test Pre-tests were conducted to test the AB, BA, AC, CA, BC, and CB relations. During a trial, the experimenter presented an array of three stimuli (i.e., various portion sizes of a food in measuring cups, different portion sizes of a food on a plate, or the various PSMAs), one sample stimulus (i.e., a measuring cup of a portion size of a food, a plate with a portion size of a food, or the PSMA), and instructed the participant to "match." Vocal feedback was not provided for unprompted correct or incorrect responses. For example, to test the BA relation, the experimenter presented the participant with a plate containing ¼ cup of black beans (the sample stimulus) and an array of three measuring cups containing ¼ cup, ½ cup, and 1 cup of mixed fruit (the comparison stimuli), and gave the instruction, "Match." Forty-eight trials were conducted for AB and BA relations and 12 trials were conducted for AC, CA, BC, and CB relations (the number of sample–comparison stimuli combinations required for the AB and BA relations resulted in more trials). The results were recorded on a data sheet.

Training Participants were taught the AB and then the AC relations separately. Forty-eight trials were conducted per session. Training for each relation continued until a participant engaged in an unprompted correct response during 90 % of trials for one session. After a relation was trained, a post-test of the relevant symmetrical relation (BA or CA) was conducted. For example, the AB relation was taught using all training foods, and the BA relation was then tested using the training foods. If the participant did not meet the mastery criterion on the symmetrical relation, the prior relation was retrained until the mastery criterion was met, and the symmetrical relation was then retested. If the participant did not meet the mastery criterion after a second training, the symmetrical relation was trained directly (this was never required).

Training of the AB relation consisted of teaching the participants to match the portion size of a training food in a 2-cup-capacity measuring cup to the portion size of a food on a plate. The sample stimulus was the portion size of a training food in a 2-cup-capacity measuring cup (e.g., ½ cup of ziti rigati in a measuring cup), and the comparison stimuli were ¼ cup, ½ cup, and 1 cup of a food item in a pile in the center of a plate (e.g., ¼ cup, ½ cup, and 1 cup of ziti rigati on three different plates). During each trial, the experimenter presented the sample and comparison stimuli to the participant and said, "Match." Vocal feedback was provided after each trial, contingent on correct and incorrect responses (e.g., "Good" for correct responses, or "Try again" and then prompting for correct response with a gesture prompt for incorrect responses). The experimenter recorded the data on a data sheet.

After the AB relation was trained, a post-test was conducted on the BA symmetry relation with the training foods. The participants were instructed to match the portion size of a training food on a plate to the portion size in a 2-cup-capacity measuring cup. The sample stimulus was the portion size of a training food on a plate (e.g., ½ cup of cereal on a plate), and the comparison stimuli were ¼ cup, ½ cup, and 1 cup of a food item in a 2-cup-capacity measuring cup (e.g., ¼ cup, ½, cup, and 1 cup of black beans in three different measuring cups). During each trial, the experimenter presented the sample and comparison stimuli to the participant and said, "Match." Vocal feedback was not provided for correct or incorrect responses. The experimenter recorded the data on a data sheet.

Training of the AC relation consisted of teaching the participants to match the portion size of a training food in a 2-cup-capacity measuring cup to the appropriate PSMA. The sample stimulus was the portion size of a training food in a 2-cup-capacity measuring cup (e.g., ½ cup of dried fruit in a measuring cup), and the comparison stimuli were the PSMAs (e.g., golf ball, tennis ball, and baseball). During each trial, the experimenter presented the sample and comparison stimuli to the participant and said, "Match." Vocal feedback was provided after each trial, contingent on correct and incorrect responses (e.g., "Good" for correct responses, or "Try again," and then prompting for the correct response, with a gesture prompt for incorrect responses). The experimenter recorded the data on a data sheet.

After the AC relation was trained, a post-test was conducted on the CA symmetry relation with the training foods. The participants were instructed to match a PSMA to a portion size of a food item in a 2-cup-capacity measuring cup. The sample stimulus was a PSMA (e.g., golf ball), and the comparison stimuli were ¼ cup, ½ cup, and 1 cup of a food item in 2-cup-capacity measuring cups (e.g., ¼ cup, ½ cup, and 1 cup of dried fruit in three different measuring cups). During each trial, the experimenter presented the sample and comparison stimuli to the participant and said, "Match." Vocal feedback was not provided for correct or incorrect responses. The experimenter recorded the data on a data sheet.

Post-Test Following training of the AB and AC relations and testing of the BA and CA relations, the experimenter tested the BC and CB equivalence relations. The procedure was identical to the pre-test sessions. Twelve trials were conducted for the BC and CB relations for each training food. The results were recorded on a data sheet. Mastery criterion was 90 % across all trials for each relation.

Full Post-Test A full post-test was conducted to test the AB, BA, AC, CA, BC, and CB relations. Procedures were identical to the pre-test sessions. Forty-eight trials were conducted for AB and BA relations, and 12 total trials were conducted for AC, CA, BC, and CB relations. Mastery criterion was 90 % across all trials for each relation.

Post-Training During the post-training phase, the participants were directed to estimate the three portion sizes of each training food using procedures identical to baseline sessions.

Pre- and Post-Training Generalization During the generalization pre- and post-training probes, the participants were directed to estimate the three portion sizes of each generalization food using procedures identical to baseline sessions.

These sessions included nine trials (three portion sizes multiplied by three generalization foods).

Maintenance Participants were asked to estimate the three portion sizes for the training foods 1 and 2 weeks after the generalization post-training sessions and 2 weeks after generalization post-training sessions for the generalization foods, using procedures identical to baseline sessions.

Content and Social Validity

Prior to the start of the study, two registered dietitians and licensed dietitian/nutritionists anonymously completed a survey that pertained to the selection of the specific portion sizes. The nutritionists were asked to rank six portion sizes by their level of importance, with 1 being the most important and 6 being the least important. They were then asked to rank the top three portion sizes that they deemed to be important to teach. The survey aimed to validate the portion sizes selected as ones that nutritionists find valuable to teach to individuals. The nutritionists' rankings of the six portion sizes in order of importance were as follows: 1 cup, ½ cup, ¼ cup, 2 cups, ¾ cup, and 1/8 cup. The top three portion sizes were 1 cup, ½ cup, and ¼ cup. This information provides support for the portion sizes selected for training in the current study.

Following the last post-training session, the participants were asked to anonymously complete a questionnaire adapted from the Treatment Acceptability Rating Form-Revised (TARF-R; Reimers, Wacker, & Cooper, 1991). The questionnaire consisted of five questions pertaining to the acceptability of the training procedures used. The participants' responses were based on a Likert scale ranging from 1 to 5 (i.e., 1=not at all; 5=very much).

Results

Figure 1 displays the mean percentage deviation across the three portion sizes for all participants. During baseline, the mean percentage deviation was greater than 20 % for all training and generalization foods for all participants. Following EBI, all participants showed clear improvement in all portion size estimations for the training and generalization foods. Reese and Paige continued to demonstrate accurate portion size estimation for the training foods during the 1- and 2-week maintenance probes. With the exception of the 1-cup portion size during the 1-week probe and the ½- and 1-cup portion sizes during the 2-week probe, Kira's estimations of the portion sizes were improved relative to baseline responding for the training foods during maintenance sessions. During the 2-week maintenance probe for the generalization foods, participants generally demonstrated responding that was

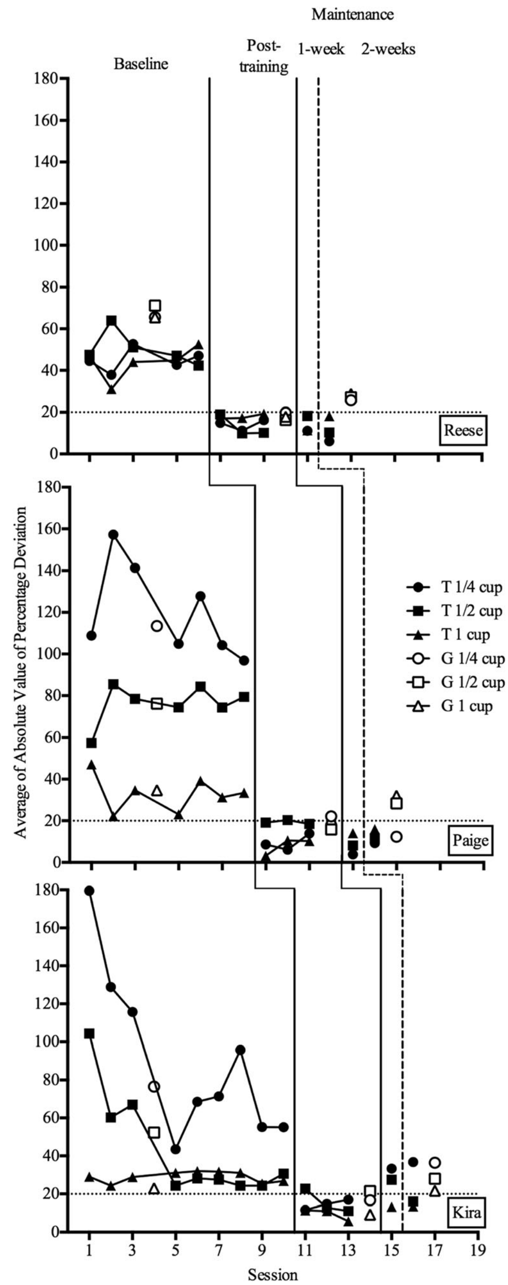

Fig. 1 Absolute value percentage deviation from the target measurement across portion sizes. The closed data points represent the training (*T*) foods, and the open data points represent the generalization (*G*) foods

more accurate than baseline responding. Table 1 displays an overall summary of mean percentage deviation for participants across baseline, post-training, and maintenance.

Figure 2 provides a summary of EBI training data for Reese, Paige, and Kira. Two to four training sessions were required to demonstrate mastery of the AB relation. Following mastery of the AB relation, Paige and Kira demonstrated emergence of the BA relation. Because Reese did not demonstrate full emergence, another AB training session was conducted. Following this session, Reese demonstrated

Table 1 Overall Summary of Mean Absolute Value Percentage Deviation across Each Portion Size

Participant name	Portion size	Baseline training foods	Baseline generalization foods	Post-training training foods	Post-training generalization foods	Maintenance training foods	Maintenance generalization foods
Reese	¼	44.98	65.56	14.12	19.75	8.62	25.71
	½	50.40	71.11	13.05	16.34	14.28	27.15
	1	43.90	65.45	17.87	17.80	14.80	28.64
Paige	¼	120.15	113.49	9.55	22.15	6.56	12.35
	½	76.25	76.16	19.33	15.78	9.87	28.32
	1	32.98	34.67	8.01	20.75	14.98	32.00
Kira	¼	90.40	75.53	14.45	16.74	35.03	36.40
	½	43.48	52.26	15.54	21.55	21.76	27.97
	1	28.94	22.89	9.40	9.22	13.33	21.68

Note. Data represent an overall summary of the mean absolute value of percentage deviation for each participant across each portion size for training and generalization foods in baseline, post-training, and maintenance sessions.

emergence of the BA relation. All participants demonstrated mastery of the AC relation in one training session. During subsequent probes, all participants demonstrated emergence of the CA relation as well as the BC and CB relations without further training.

All participants completed a questionnaire modified from the TARF-R (Reimers et al., 1991). Overall, participants indicated that they practiced the newly acquired skill at home (M= 4, range 3–5), found the training to be acceptable (M=5), were willing to implement the procedures they were trained in (M= 5), thought the procedures were affordable (M=5), and thought the procedures were effective in their daily lives (M=5).

Discussion

In the current evaluation, three participants more accurately estimated three portion sizes of various foods following EBI. In addition, participants demonstrated generalized responding by increasing the accuracy with which they estimated the portion sizes of foods not associated with training. This was not surprising, as we attempted to program for generalized responding by arranging training foods to include items that were of different sizes, colors, and shapes. Generally, maintenance was demonstrated across all participants during 1- and 2- week follow-up sessions. Additionally, the high ratings reported from the social validity measures indicate that our goals, procedures, and outcomes are socially important and acceptable.

This study extends Hausman et al. (2014) in several ways. Similar to Hausman et al., the results demonstrate that EBI was effective in increasing the accuracy of portion size estimation. In addition to teaching participants to estimate ½-cup portion sizes, this study evaluated accuracy across various foods and incorporated additional portion sizes (i.e., ¼ cup, 1 cup) into the training procedure. Baseline and post-training generalization probes were conducted to better evaluate the extent to which participants demonstrated generalized responding. This is in contrast to Hausman et al., in which only post-training probes were conducted. During all baseline sessions, the foods were presented to participants in their original packaging rather than in a generic plastic container. We hypothesized that presenting foods in original packaging would be more representative of the conditions under which participants would estimate and consume the items (e.g., while eating at home). However, future studies could further evaluate whether portion size estimation with food in original packaging would generalize to the estimation of portion sizes of the same foods out of original packaging.

Unlike Hausman et al. (2014), we found it unnecessary to train the symmetrical BA and CA relations, as participants demonstrated emergent responding when these relations were tested. It is important to note that our EBI protocol differed from Hausman et al. in two ways. First, we arranged the stimuli such that the A stimulus was the portion size of the food item in a 2-cup-capacity measuring cup, the B stimulus was the portion size of the food item on a plate, and the C stimulus was a PSMA. In Hausman et al., however, the A and B stimuli were reversed. We made this change to the A and B stimuli because we hypothesized that it would be beneficial for participants to view the three portion sizes of a food on plates concurrently, as they did during the AB training when the foods on the plates were arranged as comparison stimuli. Second, our training structure and protocol were different from that in Hausman et al. We implemented a one-to-many training structure to teach the AB and AC relations, whereas Hausman et al. used a

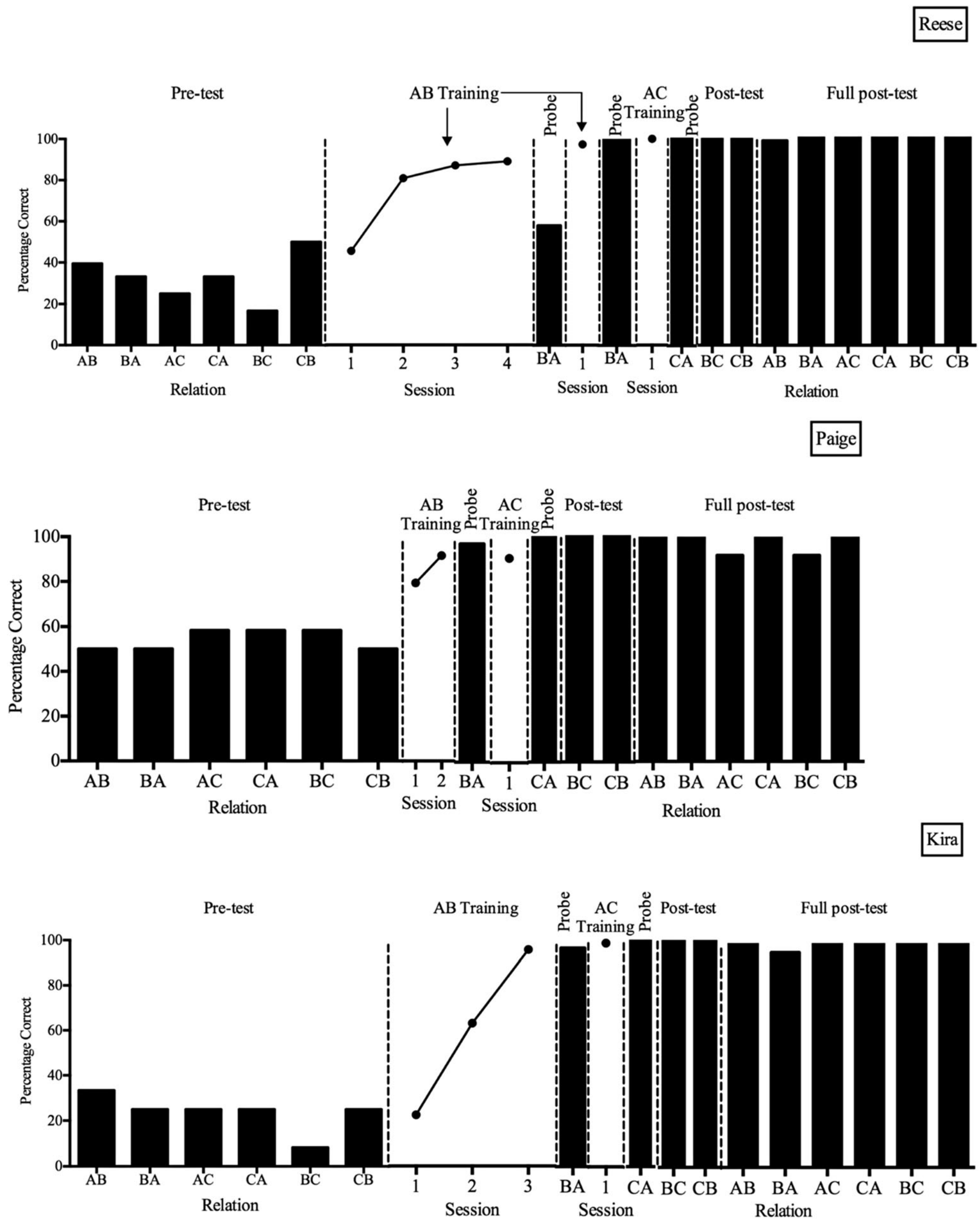

Fig. 2 Percentage correct for the relations during the training phase for Reese, Paige, and Kira

linear training structure to teach the AB and BC relations. We selected a one-to-many training structure because past studies have reported that a one-to-many training structure is typically more effective in equivalence class formation (Lian & Arntzen, 2013). Additionally, we employed a simple-to-complex training procedure in which each relation was trained sequentially, followed by symmetry tests, and then further tests for emergent relations (i.e., BC and CB). It is unclear what, if any, effect these differences had on necessitating training of the symmetrical relations by Hausman et al.

Lastly, we included measures of social validity from nutritionists and the participants. The nutritionists' results validated the specific portion sizes targeted in the current evaluation. Ratings from all participants indicated high acceptability of the procedures and suggest that participants were practicing the newly acquired skill at home.

The significant increase in caloric consumption in adults and children suggest the need for additional studies to evaluate the use of EBI in teaching children how to accurately estimate portion sizes. The same procedures could be assessed for individuals with disabilities, as past research has found EBI to be effective in teaching a wide variety of skills to individuals diagnosed with Down syndrome, autism, fragile X syndrome, and brain injury (Guercio, Podolska-Schroeder, & Rehfeldt, 2004; Hall, DeBernardis, & Reiss, 2006; Keintz, Miguel, Kao, & Finn, 2011; Lane & Critchfield, 1998; LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003; Mackay, 1995).

Additionally, the current study had only one participant who was considered overweight. Future studies could investigate whether the use of EBI actually leads to a change in eating habits among overweight or obese individuals.

Several aspects of the current study merit future research. First, we did not assess whether the participants accurately estimated portion sizes outside the context of the current study. Although all participants reported that they had used the skills acquired in the current evaluation, future studies are needed to provide more objective measures of the extent to which participants demonstrate portion size estimation skills within the context of preparing meals and eating outside the experimental context.

Second, the training and generalization foods selected for use may not have been regularly consumed by the participants. We selected these foods because they were thought to be commonly consumed, were nonperishable, and were of various shapes (circular, irregular) and sizes (small and large). We chose to use multiple exemplars in our training as well as to vary irrelevant characteristics of the food items (i.e., color, size, shape, etc.) in order to program for generalization. Even though the food items selected may not have been regularly consumed by the study participants, we attempted to program for generalized responding and did observe evidence of generalization for all participants. It is possible that further evidence of generalization would have been observed had additional foods been tested. If this is the case, it may not be necessary to conduct training with foods that are regularly consumed by participants, if responding readily generalizes from training foods to foods not associated with training. Future studies are needed to further evaluate this possibility.

Third, although we collected data 1 and 2 weeks after post-training, the extent to which accurate portion size estimation would be maintained over longer periods is unknown. Although the current study is one of only a few to have collected maintenance data of emergent skills (Rehfeldt, 2011), accurately estimating portion size is a skill that is important over very long periods of time. Thus, future studies are needed to evaluate long-term maintenance.

Fourth, in the current study, all food items were served on the same plastic plates in order to control for dish size; however, in the natural environment, some of the food items may not be served on a plate. For example, the participants were taught to estimate cereal on a plate rather than in a bowl. Future studies could evaluate the current teaching procedures with more appropriate tableware. A specific portion size of a food item in a bowl may look different from the same item presented on a plate. Additionally, future studies could investigate training using plates of different sizes and shapes. Teaching portion sizes in appropriate vessels could be more functional and aid in more accurate estimations.

Lastly, researchers should evaluate whether procedures other than EBI would lead to similar outcomes. A traditional discrimination training procedure could lead to similar results, as could an automated computer-based procedure. Future studies are needed to evaluate the effectiveness and efficiency of these alternative training approaches.

Despite these limiting factors, the results of this study demonstrate the effectiveness of EBI for increasing the accuracy with which individuals estimate portion sizes. To our knowledge, the current study is only the second such work investigating the use of EBI in teaching individuals to accurately estimate various portion sizes (Hausman et al., 2014).

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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