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The placemat protocol: Measuring preschoolers' healthy-meal schemas with pretend meals

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ABSTRACT

Nutrition instruction can lead to more healthful food choices among children, but little is known about preschoolers' healthy-meal schemas because there are few developmentally appropriate measures. This study validated the Placemat Protocol, a novel measure of preschooler healthy-meal schemas using realistic food models to assemble pretend meals. Preschoolers ($N = 247$, mean age 4 years 8 months) created 2 meals (preferred and healthy), completed measures of verbal nutrition knowledge and vocabulary, and were weighed and measured for BMI. Parents reported healthy eating guidance, child dietary intake, and family demographics. Children used an average of 5.1 energy-dense (ED) and 3.4 nutrient-dense (ND) foods for their preferred meal, but reversed the ratio to 3.1 ED and 5.1 ND foods for their healthy meal. Healthy meals contained fewer estimated kcal, less fat, less sugar, and more fiber than preferred meals. Meal differences held for younger children, children with lower verbal nutrition knowledge and vocabulary, and child subgroups at higher risk for obesity. Placemat Protocol data correlated with parent healthy eating guidance and child obesogenic dietary intake as expected. The Placemat Protocol shows promise for assessing developing healthy-meal schemas before children can fully articulate their knowledge on verbal measures.

In 2011–2012, more than 20% of U.S. 2–5-year-olds were overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014), and overweight between ages 2 and 5 is a robust predictor of adult obesity (McCarthy et al., 2007). The age of adiposity rebound in children who later become obese is roughly 3, compared to 6 among normal-weight individuals (Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006). Thus the preschool years are a crucial developmental period for obesity prevention. Since obesity researchers (e.g., Kuhl et al., 2014) argue that prevention is the best approach to lowering the national obesity rate over time, young children's developing perceptions of healthy eating must be better understood.

Preschoolers' social contexts influence their food choices because parents (Wethington & Johnson-Askew, 2009) and childcare providers (Kim and Dev, 2011) exert primary control over young children's food intake. However, the preschool years mark the emergence of independent food preferences and personal control over eating and family food purchases, observable on the aggregate level by commercial data documenting the popularity of child-marketed food items. U.S. children spend $200 billion of their own money annually, mostly on food products (McGinnis, Gootman, & Kraak, 2006), and children ages 2–14 influence an additional $500 billion in family purchases each year (McGinnis, Gootman, & Kraak, 2006), again mostly for grocery items (McNeal, 1998).

Research on early childhood perceptions of food and health suggests that food sales are not driven by parents only. Children begin forming cognitive schemas about food and its functions prior to school age and share their perceptions with caregivers. Cognitive schemas are superordinate structures within which children organize knowledge, attitudes, and action tendencies relevant to the world and themselves, including health-relevant behaviors like eating and drinking (Dalton et al., 2005; Zucher, Kincaid, Fitzgerald, & Bingham, 1995). Decades ago, Paul Rozin and colleagues (e.g., Rozin & Fallon, 1980; Fallon, Rozin, & Pliner, 1984) applied this theoretical definition of cognitive schemas as psychological

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taxonomies to young children's classification of foods versus non-foods as a means of explaining child disgust and rejection of foods and the development of child food preferences with age, growth, and socialization.

With respect to preschoolers' perceptions of food and *health* specifically, children between the ages of 3 and 5 begin relating foods to health but do not typically grasp how food influences health in the body (Singleton, Achterberg, & Shannon, 1992). However, intervention work in Columbia aiming to improve cardiovascular health among preschoolers and their families showed that a developmentally appropriate nutrition and exercise curriculum produced significant increases in preschoolers' nutritional knowledge relative to a control group (Céspedes et al., 2013). By school age, children's beliefs about a food's healthiness guide their independent food choices and eating behaviors (Kandiah & Jones, 2002; Lakshman, Sharp, Ong, & Forouhi, 2010). Children as young as 5–6 who have completed nutrition education curricula display greater nutritional knowledge and more healthful food preferences (Kandiah & Jones, 2002) and independent, unsupervised food intake (Baskale & Bahar, 2011). Since children's independence over their food choices increases with entry into kindergarten, when they have more freedom to make their own selections or to reject or trade home-packed foods when assembling lunch, the ability to measure children's health-specific *meal* schemas prior to kindergarten will improve our understanding of the role played by these schemas in predicting later eating behavior.

Unfortunately, little is known about preschoolers' healthy-meal schemas due to a dearth of developmentally tailored measures. Pioneers in the study of preschool healthy-food schemas have attempted to map developing schemas by showing photographs of foods to children as young as 3 (Holub & Musher-Eizenman, 2010; Nguyen, 2007) and by restricting questionnaire items to basic vocabulary words (e.g., carrot, bacon, cake) with children as young as 4 (Nguyen, Gordon, & McCullough, 2011). Defining healthy food schemas as *evaluative categories* that include items sharing the same value-laden assessment (e.g., “healthy” foods versus “junky” foods), these investigators have revealed an emerging understanding among preschoolers regarding health-specific nutrition knowledge, operationalized as the classification of foods like apples as “healthy” and cookies as “junky.” These studies defined “healthier” foods as those with greater nutrient density and lower energy density. Nguyen (2007) reported that preschooler nutrition knowledge (favoring “healthy” foods) was just better than chance (59%) at age 3 and improved steadily to almost 80% by age 7. Extending the healthy-food concept to healthy meals, Holub and Musher-Eizenman (2010) asked 69 3–6-year-old children to assemble meals using photographs of 21 different foods. Children were asked to choose 4 foods and 1 drink to construct preferred, healthy, and unhealthy meals. Within these constraints, children's healthy meals featured less estimated fat and calories than their unhealthy meals, although few children were able to explain their choices in a nutritionally valid way.

1. The placemat protocol

Conceptions of “healthiness” vary widely and include categorical taxonomies like whole versus refined, organic versus conventional, carcinogenic versus noncarcinogenic, probiotic versus nonprobiotic, clean versus unclean, and so on. Since our target population was preschoolers and the contextual health issue is childhood obesity, we restricted our definition to the simple dichotomy of energy-dense versus nutrient-dense foods (corresponding to the “junky” versus “healthy” taxonomy of Nguyen, 2007 and Nguyen et al., 2011) on the grounds that (1) parents of preschoolers likely use simple categorizations like “junk food” and “healthy food” to broadly categorize foods that children should consume in small doses or on special occasions versus foods they are encouraged to eat at each meal, and that (2) months of pointing out such foods at mealtimes would allow children to recognize them visually. Of course this type of categorization is a false dichotomy. Energy-dense foods can be nutrient-dense, so our goal was to estimate the *overall* nutritional profile of a meal constructed of multiple foods to assess its *relative* energy density and nutrient density.

We also avoided defining “healthy” to research participants to assess how children's pre-existing schemas were reflected in the meals they assembled based on their understanding (or misunderstanding) of the term. The research summarized above indicates that the preschool years are a time of intense activity with respect to the development of evaluative schematic cognitions about “healthy” foods and meals, but since the measures used required children to process a series of verbal questions and provide verbal answers, it is unclear whether these studies provide a comprehensive map of preschoolers' healthy-meal schemas, especially for children whose verbal abilities lag behind the norm.

The present study builds on this formative body of work by taking the meal-construction task to the third dimension, asking children to assemble a “healthy” meal using highly realistic 3D food replicas rather than answering questions about food pairs. The Placemat Protocol was designed to maximize the ecological validity of the meal-construction task as much as possible short of using real foods. Although a meal-construction task using real foods (e.g., Amari et al., 2007) would be most realistic, real foods are impossible to standardize due to inconsistency in size and appearance. This makes real foods problematic schema-measurement tools because apparent differences in schemas across samples could reflect differences in a given food's appearance, freshness, color, or aroma across testing sessions. Real foods also present risks from perishability, allergens, and pathogens. In contrast, current research procedures using stylized, less realistic food models or color photos (Contento, 2011; Holub & Musher-Eizenman, 2010) are standardized, but can be difficult to connect schematically with real foods for young children who have not seen them in real life or for those who have not mastered symbolic relations between 2D and 3D objects (Uttal, Liu, & DeLoache, 2003). Likewise, verbal measures are effective for older children (Swanson, Shoenberg, Davis, Wright, & Dollarhide, 2013) but may be challenging for some preschoolers because their vocabularies are limited and because nutrition and health are abstract concepts. Since preschoolers rely heavily on visible and physical characteristics like texture, shape, and color to classify foods (Matheson, Spranger, & Saxe, 2002), the use of highly realistic toy foods to make pretend meals may be the most promising way to assess evaluative aspects of preschooler meal schemas without the risks and inconsistencies of real foods. Children play with toy foods realistically and grasp their connection to real foods (Lynch, 2012), and research on grocery-shopping role-play with toy products has proven valid for assessing various aspects of food, alcohol, and cigarette purchasing and consumption schemas among children ages 2–6 (Dalton et al., 2005; Zucher et al., 1995).

The Placemat Protocol, presented here, was designed to maximize concreteness and 3D visual and tactile interaction. It also offers the opportunity to select multiple portions of each food item, an important inclusion given the link between portion size and obesity (McConahy, Smiciklas-Wright, Mitchell, & Picciano, 2004). Using the measure, investigators can score the following dimensions of assembled meals: number of items on the plate; number of energy-dense versus nutrient-dense items; number of items in different food categories (vegetables, fruits, grains, milk and dairy, meat and beans, and beverages); portions of each item

(0, 1, or 2); and estimated macro- and micronutrients (e.g., grams of fat, sugar, salt, protein) in each item and assembled meal, calculated by multiplying volume and weight information stamped on the underside of each food model with data from the National Nutrient Database for Standard Reference (USDA, 2012a).

The goal of this study was to introduce and validate this measure by (a) estimating differences between preschoolers' baseline (preferred) meals and healthy meals, with the expectation that healthy meals would, on average, be more nutrient-dense and less energy-dense than preferred meals; and (b) evaluating the measure's construct validity by testing its correlation with child verbal nutrition knowledge, child vocabulary, parent healthy eating guidance, and child dietary intake as reported by parents. We also compared dimensions of meals for subgroups of children known to have different levels of obesity risk (e.g., Black children versus non-Black children, overweight children versus non-overweight children).

2. Method

2.1. Participants

This study was approved by the University of Michigan Health Sciences and Behavioral Sciences IRB prior to recruitment and data collection. Recruitment was based on a sample with unequal probability of selection (to maximize racial and economic diversity) among licensed preschools in a 3-county area in Michigan that 1) were registered with the state Bureau of Children and Adult Licensing, a condition for receiving federal food assistance; 2) were located within 50 miles of the study center in one of 9 urban or rural areas; and 3) enrolled a minimum of 10 children in the targeted age range. These criteria identified 25 eligible preschools, 18 of which agreed to participate (response rate = 72%). Parents of all 4–6-year-old children at each preschool were invited to complete a questionnaire for $50.00 and asked to provide permission for their children to be interviewed. Parents of more than 1 eligible child were asked to choose the oldest. Of 1058 parents contacted, 278 (93% female) agreed to participate, representing a 26% response rate; no reasons were offered for refusal. Interviews were conducted with 247 of their children (50% female). Data for the 247 complete parent–child pairs are reported here.

Child age ranged from 40 to 76 months ($M = 56.3$, $SD = 5.3$), with 97% (232) between 48 and 72 months. According to parent reports, 28% (68) of children were non-Hispanic Black, 59% (145) were non-Hispanic White, 7% (17) were Asian; 4% (11) were Hispanic; and 2% (6) were Native American Indian. Thirty-eight percent (89) of parents were unmarried; 37% (87) reported being enrolled in the Supplemental Food Program for Women, Infants, and Children (WIC); 46.5% (114) had obtained less than a 4-year college degree; and 26% (62) had enrolled their children in Head Start. Parents indicated monthly household income by checking 1 of 14 categories from 0 to >$6000; the median was $2501–$3000 ($30,012–$36,000 annually). Forty-two percent of the sample reported an annual income at or below the U.S. poverty threshold of $23,550 for a family of 4 in 2013 (U.S. Dept. of Health & Human Services, 2013).

2.2. Procedure and measures

2.2.1. Parents

In addition to the demographics above, parents reported their height in feet and inches or cm and their weight in pounds or kg. Non-metric responses were converted and parent BMI was calculated as kg/cm^2. The median parent BMI was 25.6, with 32% of parents having BMIs $\geq$ 30 (the U.S. adult obesity threshold).

Child obesogenic dietary intake was estimated with parent reports of daily child intake of sugared beverages, French fries, fast food, candy/sweets, and salty snacks using items from the United States Department of Education's Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) interview protocol for 2-year-olds (U.S. Department of Education, 2008). Predictive validity of this measure is good; consumption of these foods was correlated with higher rates of obesity among children participating in the ECLS-B (Flores & Lin, 2013). The item read: "The next questions ask about food your child ate or drank during the past 7 days. Think about all the meals and snacks your child had from the time he/she got up until he/she went to bed. Be sure to include food your child ate at home, preschool, restaurants, play dates, anywhere else, and over the weekend." Response options included 0 (my child did not eat/drink any _____ during the past 7 days), 1 (once a day), 2 (twice a day), 3 (3 times a day), 4 (4 or more times a day), 5 (1–3 times during the past 7 days), 6 (4–6 times during the past 7 days), and 7 (don't know). Responses 5 and 6 were recoded as daily fractions (i.e., 1–3 times/week = .2857 times/day; 4–6 times/week = .7143 times/day). Responses of 7 were treated as missing. Each food item began "How many times did your child eat (drink)_____" and named the food in question. An index of child daily obesogenic dietary intake was created by adding scores for all 5 foods.

Parents also completed the Comprehensive Feeding Practices Questionnaire (CFPQ; Musher-Eizenman & Holub, 2007), a multifactor scale of child feeding attitudes and behaviors. The factor of interest was Healthy Eating Guidance, comprising 11 items reflecting parents' efforts to communicate with their preschoolers about healthy eating (e.g., "I discuss with my child why it's important to eat healthy foods," "I model healthy eating for my child by eating healthy foods myself"). Response options ranged from 1 (never) to 5 (always). In their sample of 1013 New Zealand parents, Haszard, Williams, Dawson, Skidmore, and Taylor (2013) reported internal consistency of $\alpha = .82$. In the present sample, $\alpha = .86$.

2.2.2. Children

Children were interviewed in person at their preschools. First they completed the Placemat Protocol. The Placemat (see Fig. 1) is a 4′ × 5′ laminated mat with 2 copies each of 36 food replicas arranged in 6 categories consistent with the MyPlate initiative (USDA, 2012b): vegetables, fruits, grains, milk and dairy, meat and beans, and beverages. Some foods spanned categories (e.g., a grilled cheese sandwich has both dairy and grain) and some did not contain any actual ingredients from their category (e.g., Jello is fruit-flavored but contains no fruit). The goal of categorization was not to definitively classify foods but to give children a wide variety of types of foods to choose from. Food models were purchased from Nasco (www.enasco.com), a supplier of highly realistic food replicas for nutrition education.

The primary criterion for choosing food models for the Placemat Protocol was their nationwide popularity within the 6 food categories. Based on research documenting the food consumption patterns of U.S. toddlers and preschoolers (Skinner et al., 1998), each food model was among, or a variant of, the most popular foods nationwide. Whenever possible, we used foods that were manufactured in child-sized portions. Tortilla chips, pumpkin pie, chocolate milk, and soda pop were only available in adult-sized portions.

Half of the items in each category were relatively nutrient-dense/energy-poor (i.e., "nutrient-dense" or ND) and half were relatively energy-dense/nutrient-poor (i.e., "energy-dense" or ED). As explained in the introduction, this dichotomy is a false one; some foods are both ED and ND (e.g., pumpkin pie), so our ED/ND dichotomy was not intended to be absolute, but rather a way to

Fig. 1. Six-year-old using the Placemat Protocol to complete preferred (top) and healthy (bottom) pretend meals. From the child's left, categories are vegetables, fruits, grains, milk and dairy, meat and beans, and beverages. Her preferred meal features two Jellos, two servings of cheddar cheese, two doughnuts, one brownie, one serving of grapes, one chocolate milk, and one soda pop, containing an estimated 1420 kcal. Her healthy meal features one fried egg, two servings of carrots, two servings of peas, one apple, one serving of grilled chicken, one serving of beans, and one water, containing an estimated 424 kcal.

discriminate between the kinds of foods children would choose *on average* for each meal. Thus the secondary criterion for food model selection was that foods designated as ED and ND would differ on average on estimated energy and nutritional density. Confirming the greater energy density on average of the foods we designated "ED," the total kcal of the ND foods was lower, at 1421 ($\bar{x} = 79$), than that of the ED foods, at 4821 ($\bar{x} = 272$). Table 1 lists the food models, their portion sizes, their energy density (kcal), and an estimate of their nutrient density, the naturally nutrient rich (NNR) score (see Drewnowski, (2005) for calculation).

The NNR is an average of recommended daily values of 14 nutrients supplied by 2000 kcal of a given food. Scores below 100 have little nutritional value for the energy they supply; scores exceeding 1000 have high nutritional value for the same amount of energy. Confirming the greater nutrient density on average of the foods we designated "ND," the total NNR of the ND foods was higher, at 188,539 ($\bar{x} = 24{,}541$), than that of the ED foods, at 13,861 ($\bar{x} = 770$). As some foods can have exceptionally high NNRs due to very low kcal combined with very high amounts of some nutrients (e.g., vitamin A in carrots), some nutrition researchers have recommended truncating the NNR to 2000 for any individual food (Drewnowski, 2005). Revising the values accordingly, the total estimated NNR of the ND foods, at 19,750 ($\bar{x} = 1097$), was still almost twice that of the ED foods, at 10,616 ($\bar{x} = 590$). We attempted to facilitate children's ability to distinguish between the designated ND and ED foods by naming the foods accordingly; for example, the chicken breast was called "grilled chicken" (ND) so it would not be mistaken for pan-fried (which would be more ED), and the chicken nuggets were called "fried chicken nuggets" (ED) so they would not be mistaken for baked nuggets (which would be less ED). This strategy used minimal language adjustments to maximize children's ability to identify and discriminate between ND and ED foods to the extent that such an evaluative distinction existed in their meal schemas.

At the start of the procedure each child was asked, "Are you hungry right now?" Response options included no, a little, or a lot. The researcher then seated the child on the mat in front of a 10″ white plate, named the foods on the mat using the exact terminology in Table 1, and helped the child assemble the first (preferred) meal. Children were told, "We're going to make a pretend meal together, using the foods and drinks here. You can put a little food on the plate, or a lot, but don't put any more than you think you could eat at one time. Let's start by making a meal of your FAVORITE foods. If you could pick any of these foods and drinks—the ones you like best—which would you pick?" When the child was finished, the plate was cleared and the procedure repeated for the healthy meal: "Now we're going to make a HEALTHY meal. I want you to pick foods and drinks you think are healthy. You can use the same or different foods." We chose not to define "healthy" a priori to avoid priming specific schematic content. The 42 children who spontaneously asked what "healthy" means were told "good for your body." Feasibility pretesting with 12 children (not in the present sample) showed that when they began the procedure by constructing the "healthy" meal first, they chose more ED foods because the first foods they wanted to touch were favorites like brownies and doughnuts. Thus all children in the present sample constructed the preferred meal first, consistent with the order used by Holub and Musher-Eizenman (2010). The preferred meal served as a baseline against which the healthy meal could be compared.

The Placemat procedure required approximately 20 min, after which children completed a verbal nutrition knowledge measure validated with U.S. children across locations and time periods (Harrison, 2005; Signorielli & Staples, 1997). This forced-choice evaluative measure asked respondents to choose the "healthier" food in each of 6 pairs comparing analogous ND and ED foods in the same categories as the Placemat: baked sweet potato vs. French fries (vegetable); apple vs. fruit roll-ups (fruit); whole-wheat bagel vs. chocolate-chip cookie (grains); cottage cheese vs. ice cream (dairy); chicken breast vs. fried chicken nuggets (meat and beans); and 2% milk vs. regular Coke (beverages). Internal consistency for the preschool sample was $\alpha = .80$.

Within 2 weeks of completing the Placemat Protocol, children completed the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 2007), a widely used assessment of receptive language that yields scores in national percentiles. The median PPVT percentile for the preschool sample was 75, with 72% scoring at or above the national 50th percentile (Dunn & Dunn, 2007). At the same visit, child height and weight were measured twice, to the nearest 0.1 cm and 0.1 kg, by 2 judges following CDC protocol (CDC, 2010). The measurements were then averaged. BMI percentile was tabulated using the CDC's BMI Tool for Schools program (National Center for Health Statistics, 2010a, 2010b). Three percent of the sample were in the underweight range (<5th percentile), 73% were in the normal range (5th to 85th percentile), 23% were in the overweight range (≥85th percentile), and 9% were in the obese range (≥95th percentile).

Approximately 1 week after completing the PPVT, 53 children

Table 1
Food items in the placemat protocol and estimated energy and nutrient densities.

Category	ND/ED	Food item	Size (×2 servings on placemat)	Energy density (kcal)	Nutrient density (NNR)
Vegetables	ND	Peas	¼ cup	15	2482
	ND	Carrots	½ cup	18	163,710
	ND	Green beans	½ cup	19	6315
	ED	French fries	½ cup	355	444
	ED	Potato salad	½ cup	163	922
	ED	Pumpkin pie	5.5 oz.	379	5246
Fruits	ND	Banana half	3 oz.	45	1272
	ND	Apple	4 oz.	95	894
	ND	Grapes	3 oz.	59	1039
	ED	Jello	½ cup	84	8
	ED	Gummy fruit snacks	26 g	89	12
	ED	Chocolate-covered raisins	¼ cup	191	523
Grains	ND	Oatmeal	½ cup	80	3607
	ND	Whole-grain bread	1 oz.	247	302
	ND	Whole-grain spaghetti	½ cup	87	110
	ED	Brownie	60 g	243	114
	ED	Doughnut	1.5 oz.	192	85
	ED	Tortilla chips	¾ oz.	99	240
Dairy	ND	String cheese (2)	2 oz.	172	1018
	ND	Cheddar cheese	1 oz.	113	1116
	ND	Cottage cheese	¼ cup	49	647
	ED	Cheesecake	4 ½ oz.	233	539
	ED	Ice cream	4 oz.	143	1023
	ED	Grilled cheese on white bread	½ sandwich	241	572
Meat/beans	ND	Sliced turkey	2 oz.	92	497
	ND	Grilled chicken	3 oz.	83	753
	ND	Kidney beans	½ cup	112	855
	ED	Fried chicken nuggets	3 oz.	284	184
	ED	Hot dog (bun and dog)	1 bun/40 g dog	264	165
	ED	Fried egg	1 medium	68	1657
Beverages	ND	Milk	4 oz.	74	2675
	ND	Orange juice	4 oz.	61	1247
	ND	Water	8 oz.	0	0
	ED	Fruit punch	6 fl. oz.	103	155
	ED	Chocolate milk	8 fl. oz.	158	1954
	ED	Soda pop	12 fl. oz.	182	19

Note. ND = nutrient-dense; ED = energy-dense. Energy density = kcal for one serving. NNR = the naturally nutrient rich score (Drewnowski, 2005), an estimate of a food's concentration of 14 essential nutrients in a 2000 kcal portion.

were randomly selected from the initial sample to complete the Placemat Protocol a second time so we could estimate test–retest reliability. All data collection procedures from the initial administration of the measure were repeated the second time.

3. Results

3.1. Descriptive statistics

The food models on the Placemat appeared to be popular, as none of them went unselected. For the preferred meal, the least selected food was cottage cheese (chosen by 3.2%) and the most selected was ice cream (40.8%). For the healthy meal, the least selected food was chocolate-covered raisins (6.0%) and the most selected was apples (44.1%). Placemat data were used to generate 4 key nutritional indicators for preferred and healthy meals: (1) total number of food items overall and in each category; (2) number of ED and ND items; (3) estimated energy (kcal) using the USDA National Nutrient Database for Standard Reference (USDA, 2012a) with the weight/volume information stamped on the bottom of each food model; and (4) estimated protein, fat, carbohydrates, fiber, and sugar using the same database.

Table 2 shows that on average, children chose just over 8 items for each meal. Although the total number of items did not differ, children chose significantly more ND and fewer ED foods for the healthy meal than the preferred meal. The healthy meal also had significantly fewer estimated kcal, less fat, more fiber, and less carbohydrate content due primarily to less sugar. There was no difference in estimated protein. Overall estimated nutrition differences were not driven by children's reliance on particular categories of foods (e.g., the replacement of meat in the preferred meal with vegetables in the healthy meal), but by an overall tendency to choose fewer ED and more ND items across all 6 food categories.

Additional analyses compared preferred and healthy nutrition indicators for demographic subsamples. Greater obesity rates have been recorded for African Americans (Siceloff, Coulon, & Wilson, 2014), children who are already overweight (Kitzmann et al., 2010), children in Head Start (Maher, Li, Carter, & Johnson, 2008), and children enrolled in WIC (Obeidat, Shriver, & Roman-Shriver, 2010). In addition, children who scored at or below the sample's 50th percentile (chance) on the verbal nutrition knowledge measure were compared with those who scored higher, and children who scored below the national 50th percentile on vocabulary were compared with those who scored higher. We also compared children by gender, age, parent healthy eating guidance, and child obesogenic dietary intake by splitting the latter 3 variables at the median.

Table 3 summarizes the results of paired *t*-tests comparing meal characteristics for preferred and healthy meals within subsamples, and independent-samples *t*-tests comparing individual characteristics between subsamples. Healthy meals featured significantly fewer ED foods than preferred meals for all subsamples. Healthy meals also featured more ND foods than preferred meals for all subsamples except Black children and children in Head Start, and fewer kcal than preferred meals for all subsamples except children in Head Start and children enrolled in WIC. In addition, the healthy

Table 2
Average number of food items and estimated nutrients in preferred (P) and healthy (H) meals, by category (N = 247).

	Overall		Vegetables		Fruits		Grains		Dairy		Meat/Beans		Beverages	
	P	H	P	H	P	H	P	H	P	H	P	H	P	H
Items (#)	8.2	8.5	1.2*	1.7*	2.0	2.0	1.3	1.2	1.1	.9	1.3	1.2	1.4	1.5
ED (#)	5.1*	3.4*	.6	.5	.7*	.4*	1.0*	.6*	.8*	.5*	1.0*	.8*	1.0*	.6*
ND (#)	3.1*	5.1*	.7*	1.3*	1.3*	1.5*	.3*	.5*	.3*	.4*	.2*	.5*	.3*	.9*
Protein (g)	31.2	30.1	3.1	3.1	1.5	1.3	3.7	3.3	6.3	6.0	12.2	12.9	4.4*	3.5*
Fats (g)	42.8*	34.0*	7.7	6.0	.9	1.0	8.6*	5.2*	11.1	9.5	12.9*	10.2*	1.6*	2.1*
Carb. (g)	166.3*	133.3*	25.1	21.2	42.0	38.8	31.1*	22.0*	16.1*	10.8*	16.3	15.0	35.7*	25.6*
Fiber (g)	9.9*	11.1*	2.5*	3.1*	3.1*	3.8*	1.9	2.0	.6*	.4*	1.3	1.6	.6*	.3*
Sugar (g)	103.1*	76.2*	10.0	7.7	31.9	29.0	13.8*	6.7*	12.6*	7.9*	1.4	1.2	33.4*	23.8*
kcal	1153*	938*	181	150	173	157	210*	144*	186	150	232	205	171*	132*

Note. # = number. ED = energy-dense. ND = nutrient-dense. kcal = kilocalories. Carb. = carbohydrates. kcal are entered in whole numbers and nutrition data rounded to tenths to facilitate readability. Significant (p < .05) differences by within-samples t-test between analogous P and H indicators (paired in rows) overall and within each category are noted by asterisks (*).

Table 3
Number of energy-dense (ED) and nutrient-dense (ND) food items and estimated kcal in children's preferred and healthy meals, by sample subgroups.

	Preferred meal			Healthy meal		
	ED	ND	kcal	ED	ND	kcal
Child racial group						
Black (n = 68)	5.2^{a}	3.7^{1}	1213^{c}	4.2^{a,1}	4.4^{1}	1082^{c,1}
Not (n = 172)	5.1^{a}	2.9^{b,1}	1137^{c}	3.1^{a,1}	5.3^{b,1}	882^{c,1}
Child overweight						
Yes (n = 55)	5.3^{a}	2.9^{b}	1199^{c}	3.9^{a}	4.5^{b,1}	1002^{c}
No (n = 185)	5.1^{a}	3.2^{b}	1146^{c}	3.3^{a}	5.3^{b,1}	928^{c}
Child in Head Start						
Yes (n = 62)	4.8^{a}	3.5	1112	3.8^{a}	4.3^{1}	992
No (n = 178)	5.3^{a}	3.0^{b}	1178^{c}	3.3^{a}	5.4^{b,1}	923^{c}
Family receiving WIC						
Yes (n = 87)	5.2^{a}	3.6^{b,1}	1190	4.3^{a,1}	4.5^{b,1}	1122^{1}
No (n = 142)	5.2^{a}	2.9^{b,1}	1155^{c}	2.9^{a,1}	5.5^{b,1}	833^{c,1}
Child verbal nutrition knowledge						
≤50% (n = 111)	5.6^{a,1}	3.3^{b}	1245^{c,1}	4.3^{a,1}	4.5^{b,1}	1092^{c,1}
>50% (n = 136)	4.7^{a,1}	3.0^{b}	1077^{c,1}	2.6^{a,1}	5.6^{b,1}	812^{c,1}
Child vocabulary						
<50% (n = 66)	5.6^{a}	3.3^{b}	1263^{c}	4.3^{a,1}	4.4^{b,1}	1087^{c,1}
≥50% (n = 170)	5.0^{a}	3.1^{b}	1133^{c}	3.1^{a,1}	5.4^{b,1}	902^{c,1}
Child age						
40–55 months (n = 112)	5.0^{a}	3.3^{b}	1146^{c}	3.7^{a}	4.4^{b,1}	963^{c}
56–76 months (n = 125)	5.3^{a}	3.1^{b}	1183^{c}	3.2^{a}	5.8^{b,1}	942^{c}
Child gender						
Female (n = 124)	4.7^{a,1}	2.9^{b}	1078^{c,1}	3.2^{a}	5.0^{b}	893^{c}
Male (n = 118)	5.5^{a,1}	3.4^{b}	1245^{c,1}	3.6^{a}	5.2^{b}	994^{c}
Parent healthy eating guidance						
Lower (n = 113)	5.3^{a}	3.4^{b}	1193^{c}	3.9^{a,1}	4.8^{b}	1037^{c,1}
Higher (n = 129)	5.0^{a}	3.0^{b}	1130^{c}	3.0^{a,1}	5.4^{b}	859^{c,1}
Child obesogenic dietary intake						
Lower (n = 124)	5.1^{a}	3.1^{b}	1162^{c}	3.3^{a}	5.0^{b}	915^{c}
Higher (n = 109)	5.1^{a}	3.4^{b}	1138^{c}	3.6^{a}	5.2^{b}	994^{c}

Note. Horizontal pairs of means that share a letter superscript (a, b, or c) differ significantly by within-samples t-test (p < .05). Vertical pairs of means that share a number superscript (1) differ significantly by independent-samples t-test (p < .05). T-tests were not adjusted for multiple comparisons. Child age, parent healthy eating guidance, and child obesogenic dietary intake were split at the median.

meals of Black children, children in WIC, lower-nutrition-knowledge children, and lower-vocabulary children featured significantly more ED foods, fewer ND foods, and more estimated kcal than their comparison groups' healthy meals. In addition, overweight children, children in Head Start, and younger children used significantly fewer ND foods in their healthy meals than did their comparison groups. Lastly, children from families with lower healthy eating guidance used more ED foods and had more estimated kcal in their healthy meals than did children from families with higher healthy eating guidance.

The 175 children who reported being hungry at the start of the procedure used significantly more ED foods in their preferred meal than did nonhungry children (5.33 vs. 4.54, $p < .05$), but there were no differences in estimated kcal in preferred or healthy meals for hungry versus nonhungry children. Analyses on the 42 children who asked what "healthy" means and were told "good for your body" revealed that they assembled healthy meals with significantly more ND foods (4.61 vs. 2.99, $p < .01$), fewer ED foods (3.64 vs. 5.24, $p < .01$), and fewer kcal (944 vs. 1183, $p < .01$) than their preferred meals, similar to the sample as a whole.

3.2. Test–retest reliability and construct validity

Validation of the Placemat Protocol was provided via 2 sets of analyses. First, the stability of the attributes of the healthy meals was estimated by calculating test–retest reliability coefficients for the 53 children who completed the Placemat Protocol twice. Table 4 reports significant positive correlations for the total number of foods, the number of ED and ND foods, and estimated kcal, fat, carbohydrates, and sugars. Estimated protein and fiber in the first healthy meal were not correlated with the same nutrients in the second healthy meal. Children who chose fruits the first time were likely to choose fruits the second time; otherwise, correlations were driven primarily by consistency in the nutritional attributes of foods, especially vegetables, dairy, and fruits. Analyses on individual food items indicated significant ($p < .05$) coefficients for pumpkin pie ($r = .51$), bananas ($r = .29$), grapes ($r = .28$), cottage cheese ($r = .56$), cheesecake ($r = .41$), beans ($r = .30$), orange juice ($r = .58$), and water ($r = .33$). Otherwise, choosing a particular food the first time did not increase the chance of choosing it the second time. The moderate consistency in ED and ND portions, estimated kcal, fat, carbohydrates, and sugar despite inconsistency in specific food selections across the 2 sessions suggests that preschoolers took a somewhat holistic approach to the construction of healthy pretend meals. Since the preferred meal was assessed only as a baseline and the task asked, "If you could pick any of these foods and drinks—the ones you like best—which would you pick," test-retest reliability coefficients were not expected to be high for the preferred meal due to day-to-day fluctuations in appetite and the allure of particular foods; thus test–retest correlations are not reported for the preferred meal.

Construct validation was estimated by assessing the relationship between key Placemat Protocol indicators, verbal nutrition knowledge, and child and family variables expected to predict both Placemat Protocol data and verbal nutrition knowledge in specific directions. To begin, verbal nutrition knowledge was used to predict key Placemat Protocol data indicators using hierarchical multiple regression analyses. Controlling parent BMI, household income, parent education, child BMI percentile, and the ED-to-total-foods ratio in children's preferred meals, their verbal

Table 4
Test–retest correlations between healthy-meal nutrition indicators at time 1 and corresponding indicators at time 2 (n = 53).

	Overall	Vegetables	Fruits	Grains	Dairy	Meat/Protein	Beverages
Total items	.37*	.00	.35*	.18	.24	.07	.09
ED items	.35*	.33*	.23	.19	.45*	.02	.02
ND items	.30*	−.07	.46*	.09	.16	.14	.28*
Protein	.26	.31*	.42*	.09	.27	.04	.11
Fats	.49*	.37*	.12	.16	.40*	−.06	.07
Carbohydrate	.38*	.39*	.18	.11	.47*	.09	.04
Fiber	.25	.06	.24	.12	.39*	.25	.21
Sugars	.35*	.50*	.20	.01	.42*	−.11	.01
kcal	.46*	.38*	.17	.13	.42*	−.01	.04

Note. ED = energy-dense. ND = nutrient-dense. Correlations represent the association between the same variable measured at two separate sessions for the test-retest subsample of 53 children (e.g., dairy fat at time 1 was correlated at r = .40 with dairy fat at time 2). *p < .05.

nutrition knowledge independently predicted the ED-to-total-foods ratio in children's healthy meals, $R^2\Delta = .12$, $\beta = -.36$, $F(1, 198) = 29.17$, $p < .001$; healthy meal total kcal, $R^2\Delta = .05$, $\beta = -.24$, $F(1, 198) = 11.73$, $p < .01$; healthy meal total fat, $R^2\Delta = .04$, $\beta = -.21$, $F(1, 198) = 9.26$, $p < .01$; and healthy meal total sugar, $R^2\Delta = .04$, $\beta = -.21$, $F(1, 198) = 8.76$, $p < .01$. Repeating these analyses with vocabulary added to the controls, the coefficients dropped to $\beta = -.28$ ($p < .001$), $\beta = -.19$ ($p < .05$), $\beta = -.17$ ($p < .05$), and $\beta = -.16$ ($p < .05$) respectively, smaller but still meaningful. This suggests that verbal nutrition knowledge correlated with key Placemat healthy-meal indicators as expected, and that this correlation was not entirely driven by vocabulary. Thus both measures appear to reflect some degree of genuine nutritional knowledge, signaled either verbally (verbal nutritional knowledge) or nonverbally (via the food choices on the Placemat).

Further construct validation was provided by entering parent healthy eating guidance, child obesogenic dietary intake, and vocabulary simultaneously on the second step of hierarchical linear regression analyses with controls from the previous analysis on the first step. Criterion variables were verbal nutrition knowledge, the ED-to-total-foods ratio in the healthy meal, and estimated healthy-meal kcal, fat, and sugar. Table 5 summarizes these analyses. Vocabulary positively predicted verbal nutrition knowledge as expected. However, healthy eating guidance and obesogenic dietary intake were unrelated to verbal nutrition knowledge. In contrast, healthy eating guidance predicted significant reductions in ED-to-total foods, calories, fat, and sugar in the Placemat healthy meal. These relationships were modest but statistically meaningful and in the direction expected for children receiving healthy eating guidance at home. In contrast, obesogenic dietary intake predicted significant increases in estimated kcal and fat in the Placemat healthy meal. Vocabulary predicted some Placemat indicators in the direction one would expect from a richer conceptualization of the meaning of “healthy,” with higher scorers assembling healthy meals with fewer ED-to-total foods, fewer estimated kcal, and less sugar. We would therefore be remiss in suggesting that the Placemat Protocol is not dependent to some degree on vocabulary. However, the Placemat indicators were predicted by family variables in ways the verbal nutrition knowledge measure was not, and the Placemat appeared to be less dependent on vocabulary for successful completion. In summary, the Placemat Protocol appeared to capture emerging healthy-meal schematic information that some children were not able to translate into expressions of valid nutrition knowledge on the verbal nutrition knowledge measure.

4. Discussion

Using the Placemat Protocol, most preschoolers in this study assembled healthy pretend meals with more ND foods, fewer ED foods, more estimated fiber, and less estimated fat, carbohydrates, sugar, and kcal than their preferred meals. It is highly unlikely that children's selections reflected knowledge of the nutrient and energy content of the food items provided; rather, their healthy-meal selections more likely reflected an emerging schematic distinction between “healthy” and other foods based on observable attributes like apparent sweetness or richness. The average nutritional profile of each meal (Tables 2 and 3) captured children's ability to distinguish ED and ND foods across all food categories, even if the concepts of “energy density” and “nutrient density” were not salient to children when assembling their meals.

Healthy eating guidance predicted a small but significant decrease in the energy density of preschoolers' healthy meals. Thus preschoolers' emerging healthy-meal schemas likely reflect

Table 5
Hierarchical multiple regression analyses predicting verbal nutrition knowledge and key healthy-meal nutrition indicators (n = 200).

Predictor	Verbal NK		ED to total		Calories		Fat		Sugar	
	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1:	.09**		.08**		.09**		.10***		.04	
Parent BMI		−.11		.08		−.03		−.01		−.04
Household income		.15		.01		−.23*		−.20*		−.13
Parent education		−.04		−.13		.03		−.03		.06
Child BMI percentile		.02		−.06		−.05		−.09		.03
ED to total, preferred		−.01		−.04		.06		.00		.08
Step 2:	.09***		.12***		.06**		.08***		.04*	
Healthy eating guidance		.08		−.21**		−.14*		−.15*		−.16*
Obesogenic dietary intake		.04		−.04		.15*		.17*		.06
Vocabulary		.31***		−.19*		−.17*		−.14		−.16*
Total R^2	.18***		.20***		.15***		.18***		.08**	

Note. Betas for all variables are from the final step of the model. For Step 1, the baseline model, ΔR^2 = baseline R^2. Verbal NK = verbal nutrition knowledge. “ED to Total” refers to the proportion of total foods in the healthy meal that were energy-dense. “ED to total, preferred” refers to the same proportion in the preferred meal. *p < .05. **p < .01. ***p < .001.

parental instruction about healthy meals containing fewer sweet- or rich-looking foods across multiple food categories, from fruits to meats to beverages. Indeed, some of the foods on the Placemat may have been discussed at home. It is possible that some of the preschoolers in our sample had been introduced to nutritional rules like "baked, not fried," but unlikely that such rules drove the choices of the majority. Importantly, the Placemat Protocol data suggest that preschoolers can identify relatively healthful food choices before they can articulate the reasoning behind those choices. When they are allowed to see, touch, and place realistic food facsimiles on a plate and assemble pretend meals in a holistic fashion, they can indicate their developing schematic knowledge through the sum of their choices. Even though some children had ND foods on the preferred meal plate and ED foods on the healthy meal plate (see example in Fig. 1), the nutritional estimates at the meal level revealed an early understanding that "healthy" meals are, overall, relatively limited in energy density.

Test-retest reliability data (Table 4) reveal moderate consistency between the healthy meals assembled by the same children at two points in time. It would be unrealistic to expect children to remember and duplicate their exact food choices a week later, so variation in selection was expected. Given the great variation in children's selection of specific foods, it is noteworthy that moderate correlations were observed between the first and second healthy meals for the total number of food items, the number of ED and ND items, and the estimated kcal, fat, carbohydrate, and sugar content. The possibility that children take a holistic view of healthy meals early in life and assemble them accordingly, relying less on decision rules about specific foods and food categories and more, perhaps, on rules about apparent sweetness or richness across all food categories, is a prime research topic for future investigations, both quantitative and qualitative. As our data do not supply the reasons behind children's choices, studies gathering this information would supply valuable details about children's healthy-meal schemas and even their broader mental models of healthy eating and obesity (Ogden et al., 2001).

Despite its promise as a tool for capturing evaluative aspects of early healthy-meal schema development, there are some important limitations to the Placemat Protocol. First, the food models' ecological fidelity to real-world meals is not 100%; they do not smell like real food and may not look like similar foods consumed by children in real life. Second, the practice of having children assemble a preferred-foods meal before their healthy-foods meal introduced potential order effects. In feasibility testing prior to this study, we observed children being attracted to highly desirable foods like brownies and doughnuts at the start of the activity, whether they were completing the preferred meal or the healthy meal first. Thus we chose to administer the preferred meal before the healthy meal for all children rather than counterbalancing the meal order. In subsequent investigations, alternative strategies will be tested (e.g., giving all children a 5-min period to play with the food models before completing the meal tasks in random order).

Third, the meals do not necessarily represent what children actually eat. The average "healthy" meal in this study contained more than eight food items and almost 1000 kcal. Research on children's food plating preferences points to an average of seven items and six colors compared to three items and three colors for adults (Zampollo, Kniffin, Wansink, & Shimuzu, 2011), so although children emphasize variety when plating foods, they may not aim for variety when eating. Still, increased variety and larger portion sizes of real foods predict greater intake among children and adults (Wansink, 2006), so more ED foods on the plate would likely predict consumption of more ED foods in real life. A test of the Placemat Protocol's predictive validity for actual food selection and consumption will be essential before claims can be made about its utility for predicting dietary intake. In addition, future research will need to substitute food items to confirm that the findings reported here were not specific to the foods we used. The Placemat Protocol was designed around the evaluative distinction between ED and ND foods so researchers could adapt it to different groups and regions by replacing some food items with other items that are regularly eaten by the population under consideration. As long as the distinction between ED and ND foods is maintained, the measure should continue to work. We encourage researchers interested in using the measure to devote some of their efforts to validation whenever they replace food items.

Fourth, the baseline against which the healthy meal was validated was a preferred meal, not a "typical" meal. Therefore, although the healthy meal was lower in fat, sugar, and energy than the preferred meal, it was impossible to determine which of these meals is more like the meal a child might construct if asked what he or she ordinarily eats at mealtime. Were the healthy meals more healthful than children's typical meals? Were the preferred meals *less* healthful? There is so much variation in family eating patterns that asking about typical meals was not feasible given the need to constrain the number of foods on the Placemat to a manageable quantity. Relatedly, we had no data on children's exposure to nutritional curricula in their preschools, so we were unable to test differences between children with more and less established nutritional knowledge. Further research is needed to understand how preschoolers' healthy-meal schemas compare with their typical-meal schemas (along with schematic differences between breakfast, lunch, and dinner), to determine whether they perceive a difference between what they usually eat and what they consider healthy.

Finally, the differences and relationships observed in this study were modest. However, minor substitutions in dietary intake can result in significant change (e.g., 100 kcal/day equaling about 10 lbs./year, see Harris, Bargh, & Brownell, 2009), so complete dietary overhaul is not needed to reduce a child's obesity risk. Do minor differences in preschooler healthy-meal schemas translate to differences in dietary intake in elementary school when children have more control over their food intake? This too is a question for future research focused on predictive validity assessment.

4.1. Implications for research and practice

The need for targeted intervention has been demonstrated in research on racial and socioeconomic disparities in nutrition knowledge and dietary intake (Fahlman, McCaughtry, Martin, & Shen, 2010). The Placemat Protocol may be useful for assessing evaluative aspects of emerging healthy-meal schemas of children in vulnerable groups because it can be adapted to different racial/ethnic populations by administering a preliminary audit of community food intake for the targeted sample and choosing food models accordingly. The food-model supplier for this study produces a wide array of food replicas including many foods consumed primarily by ethnic subpopulations; for example, the company website features a "Native American Food Set" with fry bread and squash. Adaptability to regional food preferences is a useful feature of the measure given elevated child obesity rates among groups with different dietary traditions such as African Americans (Campo & Mastin, 2007) and Latino/as (Davis et al., 2007). Our decision to use nationwide data on preschooler food preferences (Skinner et al., 1998) to choose our food models for the initial validation was successful, as each food on the Placemat was chosen by at least four children in the sample. However, as long as a distinction is maintained between ED and ND foods in each category, food items may be substituted without the measure losing its power to capture emerging evaluative perceptions of the ED/ND distinction.

The Placemat Protocol's utility for meeting practical goals such as child or family nutrition education and intervention is unknown. Its promise at this point lies in its capacity to reveal preschoolers' schematic distinctions between preferred and healthy meals before they are old enough to articulate their nutrition knowledge verbally. Since the children most vulnerable to obesity in the U.S. are often those with the most limited verbal skills (Maher et al., 2008), measures that capture healthy-meal perceptions without relying exclusively on language as the medium for knowledge transmission are optimal for accessing mental models of healthy meals as early in life as possible. Given increased emphasis on early-childhood prevention (Kuhl et al., 2014) for lowering the rate of child obesity nationwide, the Placemat Protocol's capacity to yield information about children's earliest perceptions of what healthy meals look like could, pending further evaluation, make it a promising tool for devising strategies to teach children and their families plating strategies using the types of foods they already eat.

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