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Research report

Vegetable parenting practices scale. Item response modeling analyses ☆

Tzu-An Chen *, Teresia O'Connor, Sheryl Hughes, Alicia Beltran, Janice Baranowski, Cassandra Diep, Tom Baranowski

USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, 1100 Bates Street, Rm. 4012, Houston, TX 77030, USA

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ABSTRACT

Objective: To evaluate the psychometric properties of a vegetable parenting practices scale using multidimensional polytomous item response modeling which enables assessing item fit to latent variables and the distributional characteristics of the items in comparison to the respondents. We also tested for differences in the ways item function (called differential item functioning) across child's gender, ethnicity, age, and household income groups. *Method:* Parents of 3–5 year old children completed a self-reported vegetable parenting practices scale online. Vegetable parenting practices consisted of 14 effective vegetable parenting practices and 12 ineffective vegetable parenting practices items, each with three subscales (responsiveness, structure, and control). Multidimensional polytomous item response modeling was conducted separately on effective vegetable parenting practices and ineffective vegetable parenting practices. *Results:* One effective vegetable parenting practice item did not fit the model well in the full sample or across demographic groups, and another was a misfit in differential item functioning analyses across child's gender. Significant differential item functioning was detected across children's age and ethnicity groups, and more among effective vegetable parenting practices than ineffective vegetable parenting practices items. Wright maps showed items only covered parts of the latent trait distribution. The harder- and easier-to-respond ends of the construct were not covered by items for effective vegetable parenting practices and ineffective vegetable parenting practices, respectively. *Conclusions:* Several effective vegetable parenting practices and ineffective vegetable parenting practices scale items functioned differently on the basis of child's demographic characteristics; therefore, researchers should use these vegetable parenting practices scales with caution. Item response modeling should be incorporated in analyses of parenting practice questionnaires to better assess differences across demographic characteristics.

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Introduction

High dietary intake of fruit and vegetables has been associated with reduced risk of cardiovascular disease, stroke, diabetes, and some cancers (Boeing et al., 2012) and possibly obesity in adults (Ledoux, Hingle, & Baranowski, 2011). Diet behaviors are learned at young ages, continue throughout the childhood years (Kelder, Perry, Klepp, & Lytle, 1994) and carry into adulthood (Lien, Lytle, & Klepp, 2001; Lytle, Seifert, Greenstein, & McGovern, 2000; Savage, Fisher, & Birch, 2007). Parents can influence young children's food preferences (Birch, 2006; Faith, 2005; Faith, Scanlon, Birch, Francis, & Sherry, 2004; Spruijt-Metz, Lindquist, Birch, Fisher, & Goran, 2002). Parenting practices, i.e., parents' behaviors to influence their child's behaviors, were related to young children's vegetable consumption (O'Connor, Watson et al., 2010).

What parents do to influence their child's vegetable intake could be effective or ineffective at achieving the intended goal (O'Connor, Hughes et al., 2010). The effective vegetable parenting practices scale with three theoretically proposed subfactors was designed to identify parenting practices which are likely to contribute to a preschooler's long-term vegetable intake, and ineffective vegetable parenting practices also with three theory specified subfactors either not influencing, or adversely influencing, a preschool child's long-term vegetable intake. While scales measuring effective and ineffective vegetable parenting practices have been developed and evaluated via classical test theory approaches (Baranowski et al., 2013), no psychometric analyses have been reported using item response modeling. Compared to classical test theory which is sample-dependent, item response modeling provides model-based measurements, and has several advantages, including trait level and

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* Corresponding author.
E-mail address: anntzuac@bcm.edu (T.-A. Chen).

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item estimates as a function of participants' responses to administered items (Hambleton & Swaminathan, 1985; Hambleton, Swaminathan, & Rogers, 1991). For example, the participant's estimated trait level of vegetable parenting practices depends both on a person's response to these items and the items' parameters.

Since the introduction of Bock's nominal model (Bock, 1972), polytomous item response modeling (i.e., for items with multiple response categories) has been viewed as a means for improving psychological measurement. In comparison to dichotomous response (e.g., yes/no) models, polytomous models allow more information about trait level to be extracted from a fixed set of items (Bock, 1972; Drasgow, Levine, Williams, McLaughlin, & Candell, 1989; Lee, Moreno, & Sympson, 1986; Sympson, 1983; D. Thissen & Steinberg, 1984; D. M. Thissen, 1976); provide increased rates of detection of aberrant response patterns (Drasgow, Levine, & McLaughlin, 1987, 1991); and provide specific feedback to item writers about which response options are effective to measure respondents' latent trait.

Valid measures are critical to exploring how parents employ parenting practices to influence children's behavior and to evaluate factors moderating parenting practices' effects. Previous studies showed that parenting practices and the interpretation of a parenting practice questionnaire differed by demographics such as age, gender, ethnicity, and parental socioeconomic status (Bradley, Corwyn, McAdoo, & Coll, 2001; Chen et al., 2013). Differences in the interpretation or use of feeding parenting practices have also been reported (Anderson, Hughes, Fisher, & Nicklas, 2005; Loth, MacLehose, Fulkerson, Crow, & Neumark-Sztainer, 2013). For example, the Child Feeding Questionnaire (Birch et al., 2001) was found to have a different factor structure based on the ethnicity of the parent completing the questionnaire (Anderson et al., 2005). Children's psychological development is distinct by age (Gardner, 1978), thus parents may interact differently with children based on the child's age. It is therefore important to assess whether vegetable parenting practice items function differentially on the basis of a child's age, gender, ethnicity, or parental socioeconomic status as well. The analysis that examines differences in item performance among subgroups is called differential item functioning. For example, items in a TV parenting practices scale showed differential item functioning on the basis of parental education, parental language, and child age (Chen et al., 2013). Without assessing such differences, comparing the parameter estimates from different samples may be misleading. Multidimensional polytomous item response modeling incorporates differential item functioning analysis to assess possible different item performances among subgroups (Bolt & Stout, 1996). This study specifically assessed differences in subgroup performance at the item level, i.e., whenever participants from different subgroups have the same amount of the underlying trait measured by the scale but may perform unequally on an item. Since items deal with specific parenting practices (behaviors), there may be differences across demographic categories at the item level. The present study investigated the item and person characteristics of vegetable parenting practices scales using multidimensional polytomous item response modeling, and identified items that may function differentially across a child's gender, ethnic group, household income, and age.

Methods

General design

The study design and methods have been reported in detail elsewhere (Baranowski et al., 2013). All measures were collected using a web-based survey from October 2010 to February 2011 (Survey Monkey, 2010). Briefly, parents reported vegetable parenting practices and demographic information including children's gender, age, ethnicity, and income. The Institutional Review Board of the Baylor College of Medicine approved the study protocol, and participants provided informed consent.

Participants

Parents with a preschool-aged child were recruited through the Children's Nutrition Research Center newsletter; fliers throughout the Texas Medical Center, public libraries, and YMCAs in Houston; personal emails to previous Children's Nutrition Research Center volunteers; and a posting on the Baylor College of Medicine volunteer website. The eligibility criteria included (1) being a parent of a preschooler (3–5 years old), (2) being able to read and write in English, and (3) having the child spend most of their time with a caregiver. In addition, the authors assumed that (1) if a respondent had more than one child, he/she chose one child and answered questions accordingly and (2) multiple respondents did not answer separate surveys for the same child. IP, email, and home addresses were examined for duplicates; if there were duplicates, the first set of responses was kept and subsequent entries removed. Of 406 parents who initiated the questionnaire, 307 parents were included in the study after deleting participants with incomplete or duplicated data, participants who did not have a 3 to 5 year old child, or whose child did not spend most days with that parent or guardian.

Instrument

The survey scale contained 28 items, with 14 items each for effective vegetable parenting practices and ineffective vegetable parenting practices. All items featured three response options: *Always*, *Sometimes*, and *Never*. The items were conceptualized across three hypothesized dimensions (responsiveness, structure, and control) of food parenting (S. O. Hughes, O'Connor, & Power, 2008). Therefore, there are six subscales in total with three subscales for each effective and ineffective practice. Responsiveness is "the extent to which parents foster individuality and self-assertion by being attuned, supportive, and acquiescent to children's requests; it includes warmth, autonomy support, and reasoned communication" (Baumrind, 2005) (e.g., "I tell my child that vegetables taste good"). Structure, within a parenting context, is creating an environment for children that supports the desired behavior and highlighting associations between actions and consequences through availability, accessibility, expectations, and rules provided by parents (Grolnick, Deci, & Ryan, 1997) (e.g., "I give my child vegetables for their snacks"). Control is parents' attempt to direct children's behavior by punitive and restrictive methods, with an emphasis on psychological control and demeaning remarks (Grolnick & Pomerantz, 2009) (e.g., "I make my child feel guilty when they don't eat their vegetables").

Effective vegetable parenting practices should boost children's enjoyment of and actual vegetable consumption beyond the short term (O'Connor, Watson et al., 2010). While ineffective vegetable parenting practices might obtain a child's immediate compliance with eating more vegetables, the result would not become part of a child's long term eating habits (O'Connor, Hughes et al., 2010). Professional judgments were used to provide guidance for dividing the items into categories identified as effective and ineffective (O'Connor, Hughes et al., 2010). All scales were re-coded so that higher scores reflected higher levels of a given construct.

Values of Cronbach's alpha ranged between 0.46 and 0.63, and each of the six subscales contained roughly equal numbers of items (Table 2). Multiple approaches were used to determine the factor structure of 31 effective and ineffective vegetable parenting practices used by parents of preschool children. In addition to Cronbach's alpha, corrected item-total correlation (for scales with few items) and confirmatory factor analyses were also used to assess the structure of the vegetable parenting practices. The corrected item-subscale total correlations were all above 0.20, and the data fit the

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hypothesized second-order factor models well. Details of the development of the items and instrument have been reported elsewhere (Baranowski et al., 2013).

Analyses

Classical test theory

Classical test theory procedures were conducted to determine item difficulty (mean) and item discrimination (corrected item-total correlations). Paired t-test was used to examine whether the frequency of using effective and ineffective vegetable parenting practices was different from one another. The measure of internal consistency reliability, Cronbach's alpha, is deemed acceptable when greater than 0.70 (Nunnally, 1978). A lower value possibly indicated a need for additional items, deleting low corrected item-total correlation items, or the presence of multiple latent trait constructs. The criterion for acceptable corrected item-total correlation was defined as a value greater than 0.20 (Streiner & Norman, 2008). An average inter-item correlation between 0.15 and 0.50 is considered an indication of acceptable internal consistency when the number of items is small (Clark & Watson, 1995; Voss, Stem, & Fotopoulos, 2000). Classical test theory analyses were conducted using Statistical Analysis Systems (SAS Institute Inc, 2011).

Item response modeling

Exploratory factor analysis was used to assess whether the data satisfied the unidimensionality assumption of item response modeling, and was conducted for each subscale using SPSS (IBM Corp, 2012). The criteria for unidimensionality were met if there was only one eigenvalue greater than one (Kaiser–Guttman rule); the first factor explained at least 20% of the variance; and the factor loadings were greater than 0.30 (Reeve & Mâsse, 2004).

Item response modeling (IRM) characterizes the relationship between respondents' latent traits and their item endorsements using a nonlinear monotonic function. Item difficulty in IRM refers to the level of a latent trait necessary to have a probability of 0.5 of a participant agreeing with a statement associated with the trait in a consistent direction. Different kinds of item response modeling could be differentiated by the functional forms specifying the association between underlying traits and item endorsement probability and by the number of estimated parameters (Embretson & Reise, 2000; Hambleton et al., 1991; van der Linden & Hambleton, 1997). Polytomous item response models are used when items include more than two ordered responses by categories (e.g., always, sometimes, never) (Chernyshenko, Stark, Chan, Drasgow, & Williams, 2001; Hays, Morales, & Reise, 2000). In polytomous item response modeling, the probability of a participant responding to a given item category is a function of the participant's latent trait level and the location parameter of the category boundary. The difference between two adjacent response categories can be viewed as *category thresholds* or *step difficulty*, yielding $m-1$ category boundaries for m response categories. For three response options (e.g., *never*, *sometimes*, and *always*), two thresholds separate the response categories: (1) *never* to *sometimes* and (2) *sometimes* to *always*.

The locations of the respondents' latent traits and items' difficulties are presented in item-person maps (also called Wright maps). A Wright map aligns person performances and item performances on the same interval scale, in units referred to as *log odds*. A Wright map determines whether the items in a questionnaire cover the range of person abilities in the sample. Persons are mapped on the left of the map, with lower vegetable parenting practices values located at the bottom of the map. In the present study, the notation *x* represented the vegetable parenting practices trait estimates, and each *x* denoted 2.7 and 2.6 persons in effective vegetable parenting practices and ineffective vegetable parenting practices, respectively. Vegetable parenting practices items and thresholds were located at the right of the map. Vegetable parenting practices items and thresholds at the top of the scale were more difficult to agree with, becoming easier to endorse further down the scale.

Given the three subscales for both the effective vegetable parenting practices and ineffective vegetable parenting practices instruments, two multidimensional polytomous item response models were considered to assess participants' latent traits: the partial credit model (Wright & Masters, 1982) and the rating scale model (Andrich, 1978a, 1978b). Rating scale model is a simplified version of the partial credit model that assumes the response threshold parameters are identical across items. For the present study, the choice between the two nested models was determined by comparing the deviance of the two competing multidimensional polytomous item response models using a chi-square test with *df* equal to the difference in the number of estimated parameters (Bentler & Bonett, 1980).

The infit mean square (information-weighted) and the outfit mean square (outlier-sensitive) fit statistics were used to assess item fit. Both the infit and outfit mean squares were derived from the squared standardized residuals (Bond & Fox, 2001), which provide non-negative numbers. An infit or outfit mean square value of one indicates that the observed variance is similar to the expected variance, while a value close to zero or much greater than one is evidence against the fit of an item. Infit or outfit mean square values greater than 1.3 (with significant t-values) indicate poor item fit when sample size is smaller than 500 (Osteen, 2010; Smith, Schumacker, & Bush, 1998). For thresholds, outfit mean square values greater than 2.0 indicate misfit, identifying candidates for collapsing with a neighboring category (Bond & Fox, 2001; Linacre, 1999).

Differential item functioning

Differential item functioning is tested by a significant interaction term (e.g., item × gender) (Baranowski, Allen, Masse, & Wilson, 2006; Chen et al., 2013; Watson, Baranowski, & Thompson, 2006) and indicated that participants from different groups (e.g., gender, ethnicity, or geography) with the same latent trait have a different probability of endorsing an item (Holland & Wainer, 1993). If item performance is simply compared between unmatched reference and focal group members where the latent trait level was ignored, then the result is impact instead of differential item functioning (Wainer & Braun, 1988). Differential item functioning can be attributed to the presence of nuisance dimensions intruding on the underlying trait that researchers intend to measure (Ackerman, 1992). When differential item functioning is detected, items can be rewritten (Berberoglu, 1995; Gierl, Bisanz, Bisanz, & Boughton, 2003).

Analyses assessed differential item functioning by child's gender (boy vs. girl), ethnicity (white vs. non-white), household income (<$60,000 vs. ≥ $60,000), and age (3 yo, 4 yo, and 5 yo) groups. While we appreciate the sample size limitation for a three group DIF in these data, each age group is distinct from a developmental psychology perspective (Gardner, 1978), and collapsing the age groups would lead to severely unbalanced groups. A significant chi-square for the item-by-group interaction term, with the ratio of the item-by-group parameter estimates to the corresponding standard error exceeding 1.96, indicated the presence of differential item functioning. The differences of the item-by-group interaction parameter estimates were calculated to determine the magnitude of differential item functioning. The parameters were constrained to be zero, so the item-by-group interaction parameter estimates were summed to zero across subgroups. Therefore, the magnitude of differential item functioning difference was twice the estimate of the focal group if only two subgroups were analyzed. Statistically significant differential item functioning was classified into one of the three categories: small (difference < 0.426), intermediate (0.426 < difference < 0.638), and large (difference > 0.638) (Paek, 2002; Wilson, 2005). Multidimensional polytomous item response modeling

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analyses were conducted using ACER ConQuest software (Wu, Adams, Wilson, & Haldane, 2003).

Results

Descriptive statistics

The online questionnaire was completed by 307 parents, whose demographic characteristics are shown in Table 1. The sample was mostly female (90%), white (37.1%), well educated (69.3% bachelor's degree or higher) and higher income (54.1% annual household income of $60,000 or higher).

Classical test theory

For all subscales, the first factor explained at least 30% of the variance, and all the factor loadings were greater than 0.3. For the ineffective responsiveness subscale, the second factor had an eigenvalue slightly greater than 1 (1.024); all the other subscales had only one factor with an eigenvalue greater than one. Therefore, a single common factor was accepted for all the subscales.

On average, parents reported performing effective vegetable parenting practices significantly more frequently ($t = 39.57$, $p < .001$) than ineffective vegetable parenting practices (item means ranged from 1.73 (SD = 0.63) to 2.83 (SD = 0.40) for effective vegetable parenting practices and 1.24 (SD = 0.53) to 2.07 (SD = 0.72) for ineffective vegetable parenting practices). The internal consistency of each subscale was generally low, but the corrected item-total correlations were acceptable (Table 2). Average inter-item correlations were acceptable (>0.15) for all subscales. Thus, all items were accepted to continue with the analyses.

Table 1
Demographic characteristics of participants.

Demographic characteristics	n	%
Child gender		
Boy	163	53.1
Girl	144	46.9
Child age		
3 years old	113	36.8
4 years old	106	34.5
5 years old	88	28.7
Parent gender		
Male	33	10.8
Female	274	89.3
Marital status		
Married or Living with a significant other	255	83.1
Single, never married	21	6.8
Divorced, separated, or widowed	31	10.1
Primary feeding responsibility		
Me	236	76.9
My spouse/significant other	28	9.1
A relative	2	0.7
Child(ren)	2	0.7
Shared among multiple people	39	12.7
Highest education level		
Attended some high school	2	0.7
High school graduate or GED	26	8.5
Technical school	7	2.3
Some college	59	19.2
College graduate	118	38.4
Post graduate study	95	30.9
Race/ethnicity		
White	114	37.1
Hispanic	31	10.1
African-American	60	19.5
Asian	43	14.0
Other	54	17.6
Missing	5	1.6
Income		
Less than $10,000	11	3.6
$10,000–$19,999	16	5.2
$20,000–$39,999	56	18.2
$40,000–$59,999	58	18.9
$60,000 or more	166	54.1

Item response modeling model fit

A chi-square test revealed a significant difference (effective vegetable parenting practices: Δ deviance = 75.06, $\Delta df = 13$, $p < 0.001$; ineffective vegetable parenting practices: Δ deviance = 77.10, $\Delta df = 13$, $p < 0.001$), indicating that the rating scale model exhibited a significant decrement in chi-square fit over the partial credit model. Thus, the partial credit model was more appropriate for both effective vegetable parenting practices and ineffective vegetable parenting practices, and was employed in ensuing analyses.

Item fit

A summary of item difficulties and misfit indicators is shown in Table 2. Only one item (number 3) did not meet the recommended criterion value of 1.3 (Smith et al., 1998). Item 3 was also a misfit in the differential item functioning analyses when the subgroups were child's gender (infit mean square = 1.31) or age (infit mean square = 1.45). Item 5 was also flagged as a misfit item when the difference in child's gender was considered (infit mean square = 1.36).

Item-person fit Wright map

The Wright maps are presented in Fig. 1 (effective vegetable parenting practices) and Fig. 2 (ineffective vegetable parenting practices). Parents with the lowest vegetable parenting practices (at the bottom of the scale) had difficulty with even the easiest vegetable parenting practices items; parents with greater vegetable parenting practices (at the top of the scale) had no difficulty performing any of the vegetable parenting practices. Items became easier to endorse and persons became less able further down the scale. For example, the statement (item 8) "I give my child vegetables for their snacks" (1.89 logits) was more difficult to agree with than the statement (item 12) "I ask my child to help with vegetable preparation" (0.98 logits).

The distributions did not fully overlap between item locations and person measures. Items were clustered toward the bottom for effective vegetable parenting practices and toward the upper regions for ineffective vegetable parenting practices. In each subscale category, thus, most parents found it relatively easy to endorse the effective vegetable parenting practices items (Fig. 1), but relatively difficult to endorse the ineffective vegetable parenting practices items (Fig. 2). Item difficulties ranged from –1.46 to 2.55 logits and from –1.75 to 1.40 logits for effective vegetable parenting practices and ineffective vegetable parenting practices, respectively.

Differential item functioning

Child's gender

Results of the differential item functioning analyses are presented in Table 3. Parents with girls found it easier to tell their child that vegetables taste good, and ask their child to help with vegetable preparation.

Ethnicity

White parents were more likely to agree that they tell their child that vegetables taste good, that they reward their child with sweets if they eat their vegetables, and that they keep their child from having sweets if they don't finish their vegetables. However, white parents were less likely to tell their child that their favorite cartoon characters eat vegetables, to give their child something to eat or drink

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Table 2
Item description, item difficulty, and misfit item(s).

Item question	All	Boy	White	Low income	3 yo	4 yo	5 yo
Effective: Responsiveness (Cronbach's alpha = 0.55)							
BEH05 – I tell my child that their favorite cartoon characters eat vegetables.	2.549	–0.087[b]	0.385	–0.183	–0.276	–0.097	0.373
BEH04 – I praise my child when I see them eat vegetables.	–0.023	–0.135	0.080	0.088	–0.178	0.026	0.152
BEH02 – I tell my child that vegetables taste good.	–0.664	0.313	–0.402	–0.124	–0.205	–0.180	0.385
BEH03 – I encourage my child to try a couple of bites of a vegetable.	–0.73[a]	–0.088[c]	–0.207	0.248	0.376[d]	–0.054[d]	–0.322[d]
BEH01 – I tell my child eating vegetables will make them strong and healthy.	–1.131	–0.003	0.144	–0.029	0.283	0.305	–0.588
Effective: Structure (Cronbach's alpha = 0.46)							
BEH08 – I give my child vegetables for their snacks.	1.891	–0.023	–0.190	0.059	0.218	–0.141	–0.077
BEH06 – I serve meals for my family to eat together.	–0.581	0.009	0.182	–0.183	–0.216	0.222	–0.005
BEH09 – I make vegetables easy to eat, such as cleaning, peeling or cutting them.	–0.599	0.096	–0.086	–0.076	0.067	–0.246	0.180
BEH07 – I show my child that I enjoy eating vegetables.	–0.711	–0.083	0.094	0.200	–0.068	0.166	–0.098
Effective: Non-directive control (Cronbach's alpha = 0.63)							
BEH12 – I ask my child to help with vegetable preparation.	0.983	0.294	–0.190	–0.125	–0.095	–0.008	0.103
BEH15 – I allow my child to serve themselves vegetables.	0.197	–0.063	0.146	–0.020	0.279	–0.173	–0.107
BEH14 – I ask my child to choose their vegetables for meals and snacks.	0.169	–0.103	0.108	–0.003	0.214	–0.138	–0.076
BEH11 – I ask my child to help select vegetables at the grocery store.	0.112	0.062	–0.115	0.008	0.080	0.023	–0.103
BEH10 – I offer vegetables without forcing my child to eat them.	–1.46	–0.190	0.050	0.139	–0.479	0.296	0.183
Ineffective: Responsiveness (Cronbach's alpha = 0.55)							
BEH21 – I feel like not responding when my child asks about the food.	0.411	–0.103	–0.262	–0.083	–0.055	–0.273	0.328
BEH20 – I get too busy to notice when my child talks about the food.	0.231	0.008	–0.129	0.116	0.161	0.034	–0.196
BEH19 – I give my child something to eat or drink if they are upset.	–0.313	0.144	0.071	–0.054	–0.151	0.328	–0.176
BEH18 – I give my child something to eat or drink if they are bored.	–0.329	–0.049	0.320	0.022	0.045	–0.089	0.044
Ineffective: Structure (Cronbach's alpha = 0.50)							
BEH17 – I let my child wander around during a meal.	1.054	–0.145	–0.055	0.029	–0.128	0.235	–0.107
BEH22 – I let my child watch TV at meals.	0.121	0.055	–0.111	0.099	–0.210	0.240	–0.030
BEH30 – I allow my child to drink sweet drinks.	–0.523	–0.070	0.235	–0.257	0.004	–0.226	0.222
BEH25 – I keep a lot of snack foods (such as chips, cheese puffs, crackers) in our house.	–0.652	0.159	–0.069	0.129	0.334	–0.249	–0.085
Ineffective: Control (Cronbach's alpha = 0.63)							
BEH26 – I yell at my child for not eating their vegetables.	1.400	0.199	0.236	–0.043	0.102	0.296	–0.399
BEH31 – I make my child feel guilty when they don't eat their vegetables.	0.685	–0.071	0.000	0.178	0.090	–0.082	–0.007
BEH13 – I keep my child from going to play if they don't eat their vegetables.	0.095	–0.073	0.157	–0.273	–0.118	0.035	0.082
BEH29 – I reward my child with sweets if they eat their vegetables.	–0.052	–0.119	–0.310	0.254	–0.024	–0.027	0.051
BEH28 – I promise my child something other than food if they finish their vegetables.	–0.375	0.053	0.153	–0.130	0.047	–0.150	0.103
BEH27 – I keep my child from having sweets if they don't finish their vegetables.	–1.753	0.010	–0.236	0.014	–0.098	–0.072	0.170

[a] Misfit item (Item 3) outfit mean square = 2.18.
[b] Misfit item (Item 5) outfit mean square = 1.36.
[c] Misfit item (Item 3) outfit mean square = 1.31.
[d] Misfit item (Item 5) outfit mean square = 1.45.
*Item difficulties for Girl, High income, and Nonwhite were not shown here since the estimates were constrained to be zero; the item difficulty will have opposite sign if only two groups were considered. For example, item difficulty of item 1 for Girl is 0.003.

if they were bored, or to admonish their child for not eating their vegetables.

Socioeconomic status

Parents from high income families tended to encourage their child to try a couple of bites of a vegetable, and to reward their child with sweets if they eat their vegetables. However, such parents were less likely to keep their child from going to play if they don't eat their vegetables.

Child's age

Parents with 5-year-olds, more than parents with younger children, tended to tell their child eating vegetables will make them strong and healthy and to admonish their child for not eating their vegetables. Compared with parents with 3-year-olds, parents with an older child showed a higher degree of agreement in encouraging their child to try a couple of bites of a vegetable and in keeping many snack foods in their houses. Parents with a younger child tended to tell their child that vegetables taste good to a greater extent than did parents with 5-year-olds.

Parents with 3-year-olds were more likely to offer vegetables without forcing them to eat them than were parents with 4- or 5-year-olds. Parents with 3-year-olds were more likely to agree with serving meals for the family to eat together and with ineffective vegetable parenting practices items concerning giving their child something to eat or drink if they are upset, and letting their child watch TV at meals. Compared with parents of the other two age groups, parents with 4-year-olds showed a lower degree of agreement on giving their child something to eat or drink if they are upset.

Discussion

The present study investigated both item difficulty based on multidimensional polytomous item response modeling using the partial credit model which identified misfit items, and examined items exhibiting differential item functioning on the basis of demographic subgroups for a vegetable parenting practices instrument.

One misfit item was identified in the effective vegetable parenting practices scale, and neither effective vegetable parenting practices nor ineffective vegetable parenting practices items covered the full range of the latent trait distribution. Output from the multidimensional partial credit model differential item functioning analyses indicated that some items functioned differently across certain subgroups, even when participants were at the same latent trait level. Small differential item functioning effects could be ignored, leaving 7 effective vegetable parenting practices and 8 ineffective vegetable parenting practices items with moderate or large differential item functioning. These findings suggest parents' approaches to parenting practices were different across various demographic groups, consistent with findings in previous studies (C. Hughes, Deater-Deckard, & Cutting, 1999; Russell et al., 1998; Vereecken, Keukelier, & Maes, 2004). Differential item functioning could be due

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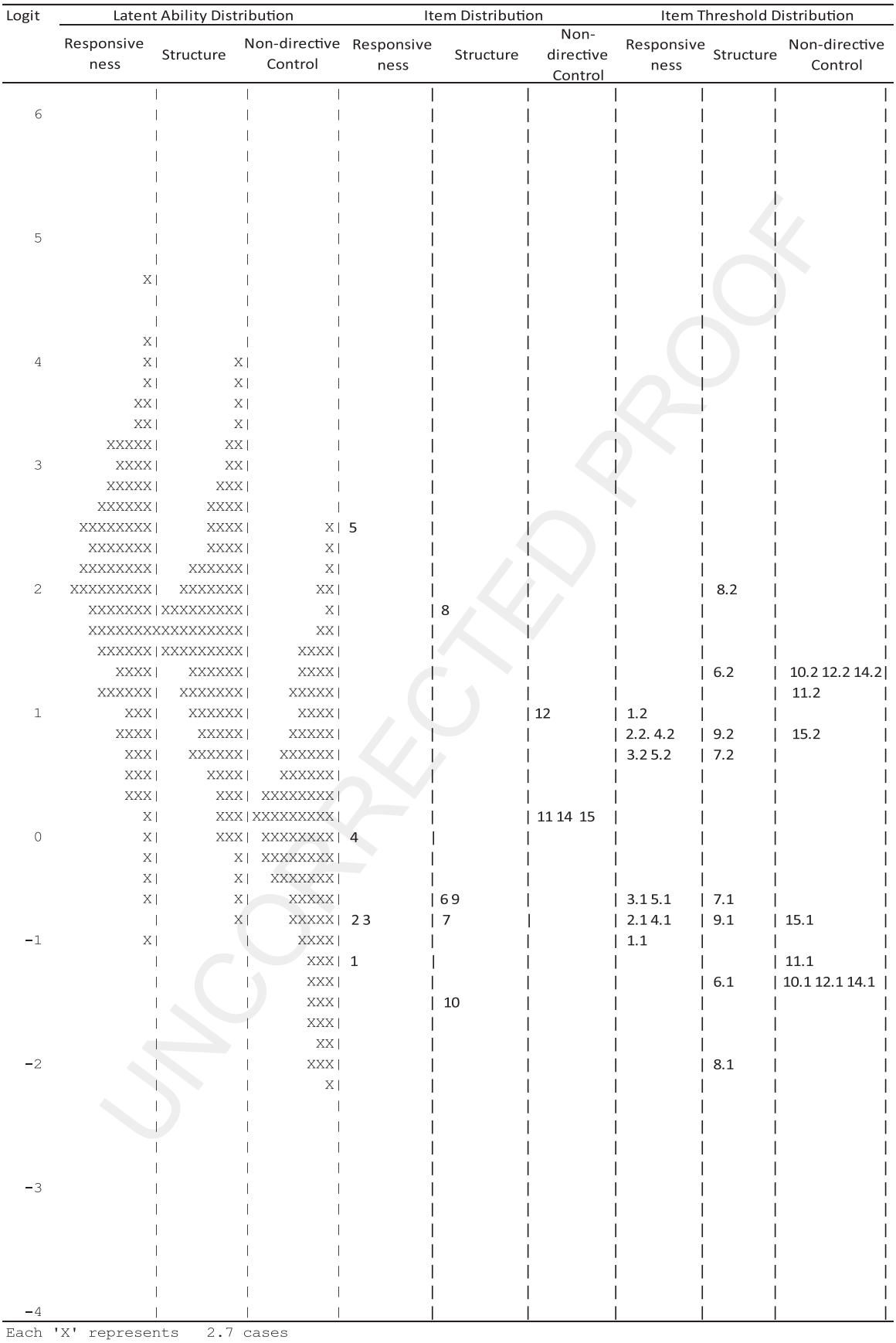

Fig. 1. Wright map of effective vegetable parenting practices scale. Note. The notation x represented the vegetable parenting practices trait estimates, and vegetable parenting practices items (denoted by numbers) and thresholds (denoted by number after decimal, for example, 19.2 is the 2nd threshold for Item 19) were located at the right of the map.

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Logit	Latent Ability Distribution			Item Distribution			Item Threshold Distribution		
	Responsiveness	Structure	Non-directive Control	Responsiveness	Structure	Non-directive Control	Responsiveness	Structure	Non-directive Control
								30.2	
2							19.2 20.2		
									29.2
						26		22.2 25.2	28.2
							21.2	17.2	26.2
1		X			17		18.2		31.2
		XX							27.2
		X	X			31			13.2
		XX	X						
		XXX	XX	21					
		XXXX	XX	20					
0		XXX	XX		22	13			
		XXXXX	XXX			29			
	X	XXXXXXXX	XXXX	18 19					
	X	XXXXXXX	XXXX		30	28			
	X	XXXXXXX	XXXXX		25				
	X	XXXXXXXX	XXXXX						13.1
-1	XXXXXXXXXXX	XXXXXXXX							27.1
	XXX	XXXXXXX	XXXXXXX				18.1	17.1	31.1
	XXXX	XXXXXXX	XXXXXXXX				21.1	22.1 25.1	26.1
	XXXX	XXXXXX	XXXXXXXXX						28.1
	XXXX	XXXXXXX	XXXXXXX						29.1
	XXXXXXX	XXXXX	XXXXX			27	19.1 20.1		
-2	XXXXXXX	XXXX	XXXXXXX						
	XXXXXXX	XXXX	XXXXXX					30.1	
	XXXXXXX	XXX	XXXXXX						
	XXXXXX	XXX	XXXXX						
	XXXXXXXX	XX	XXXX						
	XXXXXXXXXX	XX	XXXX						
-3	XXXXXX	X	XXX						
	XXXXX		XX						
	XXXXXX	X	XX						
	XXXXX		XX						
	XXXX		X						
	XXXX	X	X						
-4	XXX		X						
	XXX		X						
	X								
	X								
	X								
-5	X								
	X								
-6									
-7									

Each 'X' represents 2.6 cases

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Fig. 2. Wright map of ineffective parenting practices scale. Note. The notation x represented the vegetable parenting practices trait estimates, and vegetable parenting practices items (denoted by numbers) and thresholds (denoted by number after decimal, for example, 19.2 is the 2nd threshold for Item 19) were located at the right of the map.

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Table 3
Item description and estimates of differential item functioning where significant.

Item question	CITC	Boy–Girl[a]	White–nonwhite[b]	Low income–high income[c]	3 yo–4 yo[d]	3 yo–5 yo[e]	4 yo–5 yo[f]
Effective: Responsiveness (Cronbach's alpha = 0.55)							
BEH05 – I tell my child that their favorite cartoon characters eat vegetables.	0.25		0.77***				
BEH04 – I praise my child when I see them eat vegetables.	0.38					–0.33*	
BEH02 – I tell my child that vegetables taste good.	0.35	0.63**	–0.80***			–0.59**	–0.57**
BEH03 – I encourage my child to try a couple of bites of a vegetable.	0.31		–0.41*	0.50**	0.43**	0.70***	
BEH01 – I tell my child eating vegetables will make them strong and healthy.	0.34					0.87***	0.89***
Effective: Structure (Cronbach's alpha = 0.46)							
BEH08 – I give my child vegetables for their snacks.	0.20		–0.38*		0.36*		
BEH06 – I serve meals for my family to eat together.	0.26		0.36*	–0.37*	–0.44**		
BEH09 – I make vegetables easy to eat, such as cleaning, peeling or cutting them.	0.28						
BEH07 – I show my child that I enjoy eating vegetables.	0.32			0.4*			
Effective: Non-directive control (Cronbach's alpha = 0.63)							
BEH12 – I ask my child to help with vegetable preparation.	0.43	0.59**	–0.38*				
BEH15 – I allow my child to serve themselves vegetables.	0.30						
BEH14 – I ask my child to choose their vegetables for meals and snacks.	0.50				0.35*		
BEH11 – I ask my child to help select vegetables at the grocery store.	0.47						
BEH10 – I offer vegetables without forcing my child to eat them.	0.21	–0.38*			–0.78***	–0.66***	
Ineffective: Responsiveness (Cronbach's alpha = 0.55)							
BEH21 – I feel like not responding when my child asks about the food.	0.21						
BEH20 – I get too busy to notice when my child talks about the food.	0.36						
BEH19 – I give my child something to eat or drink if they are upset.	0.37				–0.48**		0.50**
BEH18 – I give my child something to eat or drink if they are bored.	0.42		0.64***				
Ineffective: Structure (Cronbach's alpha = 0.50)							
BEH17 – I let my child wander around during a meal.	0.25				–0.36*		
BEH22 – I let my child watch TV at meals.	0.33				–0.45**		
BEH30 – I allow my child to drink sweet drinks.	0.33						
BEH25 – I keep a lot of snack foods (such as chips, cheese puffs, crackers) in our house.	0.27	0.32*			0.58**	0.42*	
Ineffective: Control (Cronbach's alpha = 0.63)							
BEH26 – I yell at my child for not eating their vegetables.	0.32	0.40*	0.47**			0.50**	0.70***
BEH31 – I make my child feel guilty when they don't eat their vegetables.	0.41						
BEH13 – I keep my child from going to play if they don't eat their vegetables.	0.37			–0.55**			
BEH29 – I reward my child with sweets if they eat their vegetables.	0.37		–0.62**	0.51**			
BEH28 – I promise my child something other than food if they finish their vegetables.	0.38						
BEH27 – I keep my child from having sweets if they don't finish their vegetables.	0.34		–0.47**				

[a] If positive values, easier for girl; if negative values, easier for boy.
[b] If positive values, easier for nonwhite, if negative values, easier for white.
[c] If positive values, easier for high income, if negative values, easier for low income.
[d] If positive values, easier for 4 years old, if negative values, easier for 3 years old.
[e] If positive values, easier for 5 years old, if negative values, easier for 3 years old.
[f] If positive values, easier for 5 years old, if negative values, easier for 4 years old.
*small effect (difference < 0.426); **moderate effect (0.426 < difference < 0.638); ***large effect (difference > 0.638).

to differences in the understanding or meaning of the item across groups (which could require rewording to minimize these differences), or in the actual use of these vegetable parenting practices, e.g., treating children of varied ages differently. It will be important to modify and re-examine items showing medium and large differential item functioning (Angoff, 1993; Shepard, 1982). Revising items should produce non-differential item functioning or considerably lower-differential item functioning items (Allalouf, 2003). To provide more detailed guidance on use of these scales and subscales, further research must be conducted that revises, and/or adds items, or conducts testing within narrower participating groups (e.g. narrower age range of children). Formative research with samples representative of the target populations may be beneficial to simplify and clarify items. To the extent that differential item functioning reflects true differences in practices, it will be difficult to compare vegetable parenting practices across groups varying in these demographic characteristics using the same scale. Future research using parent–child interaction observational methods will be needed to clarify the nature of the differential item functioning.

Several limitations were identified. These vegetable parenting practices scales with three theoretically derived subfactors each for effective and for ineffective vegetable parenting practices employed items from previous research (O'Connor, Hughes et al., 2010; O'Connor, Watson et al., 2010) and were separately validated (Baranowski et al., 2013). No other implementations were identified, and test–retest reliability and inter-rater reliability are not available. Classical test theory analyses revealed that the scales generally had low internal reliability, even though the adequate level of reliability depends on the decision that is made with the scale (Cortina, 1993) and high internal consistency would not be expected with heterogeneous behavioral domains (Berscheid, Snyder, & Omoto, 1989). The limited overlap between items or item thresholds and individuals on the Wright map indicated that the instruments were not optimally targeted. Effective vegetable parenting practices items did not cover the more difficult to endorse end of each of the three latent subscale distributions, whereas ineffective vegetable parenting practices items did not cover the easier to endorse end of the distributions. The limited internal consistency reliability and the asymmetric nature of the item and person distributions indicate a need to further develop items.

Due to the model complexity of multidimensional polytomous item response modeling, no clear standards for minimum sample

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size are available. However, diverse minimum sample sizes have been recommended to conduct item response modeling (e.g., 500 (Embretson & Reise, 2000); 350 (Reeve & Fayers, 2005); 200 per group (Scott et al., 2009)). Five hundred participants per group in polytomous item response modeling with non-uniform differential item functioning procedures showed well estimated results (Chang, Mazzeo, & Roussos, 1996). We acknowledged that the relatively small sample size in the present study was a huge limitation. Further research should seek to recruit larger samples and retest these findings. Future research could detect whether the probability of endorsing an item is greater for one group than for the other group over all latent trait levels (uniform differential item functioning, e.g., no matter the vegetable parenting practices latent trait level, parents with girls find it easier to ask their child with vegetable preparation), or the difference in probabilities changes depends on the latent trait levels (non-uniform differential item functioning, e.g., the probability of endorsing "I ask my child to help with vegetable preparation" is greater for the parents with girls at the high end of the vegetable parenting practices latent trait scale, but is higher for the parents with boys at the low end of the vegetable parenting practices ability scale). Additionally, non-uniform differential item functioning -detection procedures (e.g., Mantel-Haenszel Procedure (Mantel, 1963); or Shealy-Stout multidimensional model for differential item functioning (R. Shealy & Stout, 1993; R. T. Shealy & Stout, 1993)) could be undertaken to investigate whether similar results would be found. Psychometric analyses are informative, especially early in instrument development.

Conclusion

Limitations of an existing vegetable parenting practices scales were identified. Parts of the extreme ends of the effective vegetable parenting practices and ineffective vegetable parenting practices construct distributions were not adequately covered by the items. Missing were items that were more difficult and easier to endorse for effective vegetable parenting practices and ineffective vegetable parenting practices, respectively. Some effective vegetable parenting practices and ineffective vegetable parenting practices items were not equivalent in meaning or use to parents from groups that differed with respect to children's age, gender, ethnicity, and household income. More items showing differential item functioning were identified on the basis of children's age and ethnicity, and more effective vegetable parenting practices items exhibited differential item functioning than ineffective vegetable parenting practices items. Additional psychometric work needs to be done; thus, the scales should be used in diverse groups with due caution.

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