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Tests of the accuracy and speed of categorizing foods into child vs. professional categories using two methods of browsing with children

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Abstract

This research tested whether children could categorize foods more accurately and speedily when presented with child-generated than professionally-generated food categories; and whether a graphically appealing browse procedure similar to the Apple, Inc, "cover flow" graphical user interface accomplished this better than the more common tree view structure. In fall 2008, one hundred and four multi-ethnic children ages eight to 13 were recruited at the Baylor College of Medicine, Houston, and randomly assigned to two browse procedures: cover flow (with collages of foods in a category) or tree view (food categories in a list). Within each browse condition children categorized the same randomly ordered 26 diverse foods to both child and professionally organized categories (with method randomly sequenced per child). Acceptance of categorization was determined by dietitians. Speed of categorization was recorded by the computer. Differences between methods were determined by repeated measures analysis of variance. Younger children (eight to nine years old) tended to have lower acceptance and longer speeds of categorization. The quickest categorization was obtained with child categories in a tree structure. Computerized dietary reporting by children can use child generated food categories and tree structures to organize foods for browsing in a hierarchically organized structure to enhance speed of categorization, but not accuracy. A computerized recall may not be appropriate for children nine years or younger.

Keywords

twenty four hour diet recall; children; food categories; food search strategy

Introduction

Twenty-four hour dietary recalls (24DR) are the preferred method of diet assessment among children (1), but many problems exist, including cost (2). The youngest age at which children

can provide a reliable 24DR is eight years (3), while at approximately 13 or 14 years of age children are as accurate as adults (4). A child self-administered 24DR located on the web requires a browse procedure to help users find foods in hierarchically organized food groups. Children have experienced difficulty in finding specific foods in hierarchically-organized food categorization systems (5) which ordinarily reflect dietitians' in-depth understanding of foods and nutrients. Children reported food categories different from those specified by nutrition professionals (6–9). Child-generated categories and labels may enable children to more accurately and speedily find categories of foods during computerized diet assessment.

Computer interface issues may also be important. A “tree view” is a graphical user interface wherein each first level category (called a branch or “node”) has second level or sub-category nodes. When a first level category is clicked, all the sub-category nodes in that category appear as a list, slightly indented, under the first category term. Children, however, are exposed to more visually appealing ways of presenting a hierarchical (two level) structure. For example, in the Apple, Inc., iTunes® digital media player, customers can select from pictures that look like the jacket covers of albums they peruse by dragging their cursor across the album covers (called “cover flow”). When the child clicks on the cover, the album flips over, and the songs are displayed on the reverse side. Similar procedures can be employed with pictures of foods in categories.

This paper reports the use of a computer-based system for testing of child-versus professionally-generated food categories on the accuracy and speed of categorization of 26 commonly consumed foods in children aged eight to 13 years. Concurrently, tree view versus cover flow interfaces were similarly assessed for accuracy and speed of categorization. Finally, the performance of younger compared to older children was assessed in all tasks.

Methods

Design

In an experiment, children ($n=104$, both genders, from the Houston, TX area) were randomly assigned to either the tree view or cover flow interfaces for displaying the two types of food categories (between groups factor). All children categorized 26 commonly consumed foods (as determined from NHANES data for children this age) twice, once into child- and again into professionally-generated categories with the sequence randomly assigned (within groups factor).

Sample

The inclusionary criteria were being a child from ages 8 to 13 who were literate in English, and had no known cognitive limitations. A sample of 100 children provided >75% power to detect moderate or larger main effect differences between factors in the design, or large interaction effects. The Institutional Review Board of the Baylor College of Medicine approved the study protocol in 2008. Written parental consent and child assessment were obtained.

Recruitment

Participants enrolled represented a convenience sample recruited from the participant data base maintained by the Children's Nutrition Research Center.

Procedures

The participant was randomly presented with the first categorization task (child or professional categories), where the 26 images of foods were randomly ordered by the computer. The participant viewed the first level categories and clicked on the one in which they believed each food should be placed, which opened the second level categories. The participant then clicked

and dragged the picture of the food to the second level category that they felt was the best fit. This process was repeated for the remaining foods. Then, the participant performed the second categorization task following the same procedure.

Child vs. Professional Categories

The two-level child categories and category labels were based on child card sorts (6–9). The professional two-level categories were obtained directly from a dietary assessment website (10). Substantial redundancy of food items in multiple food categories was allowed in the child categories to account for differences in the way children think about foods with somewhat less redundancy in the adult categories.

Tree view vs. Cover Flow Interface

The tree view interface was modeled directly after an automated dietary assessment website (10). The cover flow interface was modeled after the iTunes© digital media player (©www.iTunes.com).

Variables

For each food, the acceptable categories were identified by a group of dietitians for both the professional and child structures. A list of acceptable categorizations was generated before the study began. Two dietitians independently determined if the food category placement was acceptable. Comments written by the on-site observer were considered in these determinations. Disagreements between dietitians were resolved by the group of investigators.

Demographics

A demographic questionnaire was sent home for parent completion with the consent/assent forms.

Height and Weight

Height and weight were measured according to a standardized protocol (11).

Scoring

Acceptable food placement scores—A total acceptable food placement score was generated by summing the acceptably placed food items within each categorization method and dividing by the number of food items. The child-generated method had a higher probability of acceptable placement due to chance; therefore, the professional category method was weighted by the ratio of probabilities to obtain a chance-corrected score. The following values were assigned to create a composite food item score: both unacceptable (0), child acceptable only (1), professional acceptable only (2), and both acceptable (3).

Total minutes—The computer was programmed to record the time in seconds from the appearance of a new food on the screen to when it was dropped into a second level category. The total time was a summed score of the time used for each food item.

Quantitative Analyses

A repeated measures analysis of variance was used to investigate differences in the acceptable placement of all foods within categorization methods (child derived, professional) and between browse strategies (cover flow, tree view). The unadjusted model contained browse strategy (between) and categorization method (within) as factors. The adjusted model included: gender, race/ethnicity, age group, household income, highest household level of education, and body

mass index (BMI). Analyses were repeated for chance-corrected acceptable placement scores. The same models were used to investigate differences in the time spent categorizing all foods.

Results and Discussion

The sample (n=104) was evenly split by gender. Nearly one-fourth of the sample was Black (23%) or Hispanic (29%) and less than one-half (43%) was White. The remaining 5% self-identified as “Other” race/ethnicity. Nearly one-half (49%) of the participants came from homes with an annual household income greater than or equal to \$70,000 and most participants (70%) were from homes in which a parent/guardian had a college degree. Age groups were reasonably evenly divided with 39%, 30%, and 31% ages eight and nine years, 10–11 years, and 12–13 years, respectively. Nearly one third of the sample (35%) was overweight or obese. One child did not complete the professional categorization due a computer malfunction, and was deleted from those analyses.

Accurate Categorization

Results from the unadjusted model yielded a significant method main effect [$F(1,101)=21.28$, $p<0.001$], with the child category mean accurate or acceptable rate (0.73 ± 0.22) significantly higher than the professional category mean acceptable rate (0.68 ± 0.22). The adjusted model (see Table 1) yielded significant gender ($p=0.007$) and age group ($p<0.001$) main effects and significant browse by education ($p=0.030$) and browse by BMI ($p=0.013$) interactions. Overall, girls had a higher mean acceptable rate (0.77 ± 0.14) than the boys (0.65 ± 0.28). Younger (eight and nine year old) children had a lower rate (0.59 ± 0.27) compared to the 10–11 (0.75 ± 0.16), and 12–13 (0.82 ± 0.11) year olds. Among participants from non-degreed homes, the mean tree view strategy acceptable score (0.66 ± 0.16) was higher than the mean cover flow score of (0.62 ± 0.26); but among those from degreed homes, the mean tree view strategy acceptable score (0.71 ± 0.22) was significantly lower than the cover flow score of (0.78 ± 0.19). Among normal weight participants, the mean tree view acceptable rate ($0.73, \pm 0.15$) was higher than the cover flow rate ($0.67, \pm 0.28$); but, among overweight/obese participants, the mean tree view rate (0.62 ± 0.27) was less than the cover flow rate (0.78 ± 0.14). Similar results were observed when using chance-corrected acceptable food placement scores. This complex pattern of results provided no clear guidance for use of browse or food category method in dietary assessment software. Selecting from among the great diversity in child-generated names for the categories (6–9) may have limited understanding of the child categories.

Duration

Results for the number of minutes to categorize the foods yielded significant method [$F(1,102)=23.70$, $p<0.001$], and browse [$F(1,102)=6.63$, $p=0.011$] main effects, and a method by browse [$F(1,102)=5.84$, $p=0.017$] interaction in the unadjusted model. In the adjusted model (Table 1), there was a significant Method*Browse*Age interaction term, graphed in Figure 1. In general, speed increased with age; children with the tree view were faster than those with cover flow; and children using the child categories were quicker than those with the professional categories. The quickest performance in all age groups clearly was children using the tree view and child categories.

Younger children (eight or nine year olds) tended to have less acceptable or accurate food categorizations and took more time. This suggests that computerized dietary assessment programs should be used with children 10 years or older. Research on how to further enhance accuracy would be valuable in all these groups. Dietitians acting as observers reported that many participants tended to rely on the collages of pictures, rather than the category labels, to

identify categories into which to insert foods. Perhaps the accuracy of the tree view procedure could be enhanced by adding pictures of foods at each level in the hierarchy.

Girls tended to provide more acceptable categorization, but did not take more time than boys. Reasons for gender differences in category accuracy are not clear. Further research is needed to enhance accuracy of categorization in computerized diet assessment programs among children of all ages.

The strengths of this research were the reasonably large ethnically diverse sample able to detect moderate effects; the random assignment of children to condition; the sophisticated graphic browse strategies (cover flow and tree view); and the high frequency of consumption of the foods for the categorization task. The limitations were the convenience sample, high socio-economic status of the sample, and the somewhat larger number of acceptable child response categories.

Conclusion

Accuracy of children's food categorization into hierarchically organized groups was not clearly aided by using child derived categories nor a graphically appealing browse procedure (cover flow). Alternatively, speed of categorization was substantially facilitated by child categories and tree view browse structure. Tree view with child categories appears to be the preferred method of browsing for this computerized diet assessment program. Children younger than 10 may have more difficulty with food categorization tasks, and thereby may not be ideal candidates for using browse strategies in computerized dietary assessment programs.

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Figure 1.
The method by browse by age group interaction for total minutes.

Table 1

Time differences per food categorization methods

Variables	Acceptable category	Total Time
	F stat p value	F stat p value
Between-Subjects		
BROWSE (tree view, cover flow)	0.305	0.018
Gender	0.007	0.337
Race/Ethnicity	0.504	0.049
Income	0.375	0.017
Household education	0.409	0.987
Age group	0.000	0.001
BMI group	0.783	0.855
BROWSE * Gender	0.259	0.962
BROWSE * Race/Ethnicity	0.475	0.891
BROWSE * Income	0.115	0.547
BROWSE * Household education	0.030	0.523
BROWSE * Age group	0.482	0.657
BROWSE * BMI group	0.013	0.692
Within-Subjects		
METHOD (child, professional)	0.060	0.011
METHOD * BROWSE	0.587	0.178
METHOD * Gender	0.178	0.747
METHOD * Race/Ethnicity	0.507	0.883
METHOD * Income	0.267	0.988
METHOD * Household education	0.859	0.687
METHOD * Age group	0.371	0.230
METHOD * BMI group	0.659	0.201
METHOD * BROWSE * Gender	0.717	0.139
METHOD * BROWSE * Race/Ethnicity	0.618	0.597
METHOD * BROWSE * Income	0.059	0.437
METHOD * BROWSE * Household education	0.738	0.447
METHOD * BROWSE * Age group	0.117	0.025
METHOD * BROWSE * BMI group	0.496	0.851

BMI (Body Mass Index) = wt/ht^2 ;

* placed between variables in an interaction effect; "F stat p value" means the probability associated with the F statistic.