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Children's recalls from five dietary-reporting validation studies: Intrusions in correctly reported and misreported options in school breakfast reports

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Abstract

For school breakfast each day, many elementary schools offer a choice between a *cold option* that includes ready-to-eat (RTE) cereal and a *hot option* that includes a non-RTE-cereal entrée such as waffles. For breakfast reports, intrusions (reports of uneaten items) in correctly reported and misreported breakfast options were examined using data from five dietary-reporting validation studies. In each study, fourth-grade children were observed eating school breakfast and school lunch and then interviewed to obtain a dietary recall. A breakfast option was correctly reported in 240 breakfast reports for 203 intrusions total, and misreported in 97 breakfast reports for 189 intrusions total. Asymmetry was evident in misreported options; specifically, children observed eating a cold option almost never misreported a hot option, but children observed eating a hot option often misreported a cold option. Proportionately more breakfast reports were intrusion-free when a breakfast option was correctly reported than misreported. Linking of intrusions (i.e., multiple intrusions from the same option in a breakfast report) was especially evident with misreported breakfast options. Methodological aspects of dietary recalls such as target period (prior 24 hours; previous day), interview time (morning; afternoon; evening), and interview format (meal; open) had implications for intrusions and misreported breakfast options.

Keywords

Children; Dietary recalls; Intrusions; School breakfast; Ready-to-eat cereal; Validation; Meal observations; Accuracy

Introduction

Breakfast consumption plays an important role in children's health and is associated with improved nutritional adequacy; more healthful body weight; and benefits to cognitive function (particularly memory), academic performance, school attendance, psychosocial function, and mood (Rampersaud, Pereira, Girard, Adams, & Metzl, 2005). Consumption of ready-to-eat

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(RTE) cereal is common among American children, especially at breakfast (Albertson, Anderson, Crockett, & Goebel, 2003; Nicklas, Myers, & Berenson, 1994), and has been associated with improved nutrient intake (e.g., less fat; more fiber and minerals) and more healthful body weight (Albertson et al., 2003; Barton et al., 2005; Nicklas et al., 1994; Ruxton & Kirk, 1997). Millions of children in the United States eat breakfast at school (US Department of Agriculture & Economic Research Service, n. d.) where RTE cereal is commonly available (Gordon & McKinney, 1995). For breakfast each day, many elementary schools offer a choice between a *cold option* that includes RTE cereal and a *hot option* that includes a non-RTE-cereal entrée such as waffles (Baxter, Hardin, Smith, Royer, & Guinn, in press; Friedman & Hurd-Crixell, 1999).

Often, children's dietary recalls are used to estimate nutrient intake at school meals (Crepinsek, Singh, Bernstein, & McLaughlin, 2006; Gordon, Devaney, & Burghardt, 1995). A previous investigation that used data from two dietary-reporting validation studies concerning (a) children's reporting accuracy across multiple recalls and (b) the effect of reporting-order prompts, found that children were less accurate in reporting school breakfast than school lunch in 24-hour dietary recalls obtained in the morning on the day after those meals were observed eaten (Baxter, Royer, Hardin, Guinn, & Smith, 2007). Further investigation of data from the validation study concerning children's reporting accuracy across multiple recalls identified a profound asymmetry in misreports of school breakfast options; specifically, children observed eating a cold option almost always correctly reported a cold option, but children observed eating a hot option misreported a cold option in approximately 50% of interviews (Baxter, Hardin, Royer, Guinn, & Smith, in press). Furthermore, in misreported school breakfast options, there was a tendency for intrusions (reports of uneaten items) to be linked (i.e., multiple intrusions from the same option in a breakfast report).

The purpose of the current article is to examine intrusions in breakfast reports with data from a series of five dietary-reporting validation studies in which fourth-grade children were observed eating consecutive school meals (that included breakfast and lunch) and then interviewed to obtain a dietary recall. Each of the five studies was designed to evaluate a different aspect of children's dietary reporting accuracy — Study 1 evaluated reporting-order prompts (forward [morning-to-evening]; reverse [evening-to-morning]) (Baxter, Thompson, Smith et al., 2003); Study 2 evaluated interview modality (in person; by telephone) (Baxter, Thompson, Litaker et al., 2003); Study 3 evaluated interview format (meal; open) (Baxter, Smith et al., 2003); Study 4 evaluated target period (i.e., the period about which intake is to be reported [prior 24 hours; previous day]) and interview time (morning; afternoon; evening) (Baxter et al., 2004); and Study 5 evaluated body mass index (BMI), sex, and protocol (about intake for the prior 24 hours in an evening interview; about intake for the previous day in a morning interview) (Baxter et al., 2006). Key questions of interest concerning breakfast reports for the current article included whether (a) correctly reported and misreported breakfast options and (b) intrusions of specific meal components, varied according to study-specific manipulations and subject characteristics within studies and across all five studies; these questions were not examined previously.

Method

Sample and general design

For each study, approval was obtained from institutional review boards for research involving human subjects, and child assent and parental consent to participate were obtained in writing prior to data collection. Table 1 and this Method section summarize details of the studies relevant to analyses in this article; complete details for each study are found in the publication about that study (Baxter, Smith et al., 2003;Baxter et al., 2006;Baxter et al., 2004;Baxter, Thompson, Litaker et al., 2003;Baxter, Thompson, Smith et al., 2003).

As Table 1 shows, the five studies were conducted in non-overlapping order during three consecutive school years. An individual child was interviewed only once and for only one study, with two exceptions. First, in Study 1, each child was interviewed twice, separated by at least 29 days, with each interview concerning the previous day's intake. Second, in Study 5, the 40 children interviewed were a subset of 120 children who each were interviewed once about three to four months earlier that same school year for another study that included the 60 children in Study 4 and another 60 children interviewed without having been observed (Smith et al., 2007). Specifically, in Study 5, of the 40 children interviewed, 24 children had been observed and interviewed and the remaining 16 children had been interviewed without being observed. As Table 1 shows, for each study, children were recruited from fourth-grade classes in public elementary schools; the schools, which were in one school district in a southern state, were selected based on high participation in school meals. For each school year, the sex/race composition of children who provided written child assent and parental consent to participate was similar to that of fourth-grade children invited to participate.

Observations

In schools where data were collected, most foods were served to children because offer-versus-serve (for which children may refuse some meal items) had not been implemented by the school district (US Department of Agriculture & Food and Nutrition Service, n. d.). Children had to take milk, but could select the flavor and fat content. Children could select limited quantities of condiments (e.g., syrup; jelly) when available in single-serve packets. For school breakfast each day, children selected either a cold option or a hot option. A cold option consisted of RTE cereal, graham or animal crackers, milk, and juice (or rarely fruit). A hot option consisted of a non-RTE-cereal entrée (e.g., sausage biscuit; pizza; bagel; pancakes), milk, and fruit (or sometimes juice).

Because it can be difficult to unobtrusively identify contents of meals brought from home (Simons-Morton et al., 1992), only children who obtained meals at school were observed. Entire meal periods were observed to identify trading of food items (Baxter, Thompson, & Davis, 2001). An observer simultaneously observed one to three randomly selected children eating breakfast and recorded, for each child, items and amounts eaten in servings of standardized school portions. Dietitians conducted observations during usual school breakfast periods in school cafeterias with children seated according to their school's typical arrangement (i.e., as children arrived in the cafeteria at most schools; by grade level at a few schools). Although children could see that an observer was present at a meal, children did not know who, specifically, was being observed or would be interviewed. Practice observations were conducted prior to data collection each school year to familiarize children with an observer's presence (Simons-Morton & Baranowski, 1991). Modeling, practice, and assessment of inter-observer reliability (IOR) were used each school year to train observers. Throughout data collection for each study, IOR was assessed weekly and met established criteria (Baglio et al., 2004; Baranowski et al., 1986; Simons-Morton et al., 1992). Specifically, for Studies 1, 2, 3, 4, and 5, IOR was assessed on a total of 22, 10, 6, 14, and 6 children, respectively, and mean agreement across observers for food items in which amounts observed eaten were within one-quarter serving was 90%, 93%, 87%, 90%, and 98%, respectively.

Interviews

As Table 1 shows, children were interviewed in the morning, afternoon, or evening about intake for the previous day, the same day, or the prior 24 hours. Dietitians interviewed individual children in person at school, in person in a research van parked outside the child's home, or by telephone. Validation results from Study 2 indicated no significant effect of interview modality (in person; by telephone) on children's reporting accuracy (Baxter, Thompson, Litaker et al., 2003). Except for five children in Study 5 for whom breakfast was observed by the interviewer, a child's interviewer had not observed that child's breakfast. Each interview was audio recorded and later transcribed. Interviewers followed multiple-pass protocols that were modeled after that of the Nutrition Data System for Research (NDSR, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA) with the following exceptions. First, Study 1 utilized the NDSR protocol with forward-order prompts (Regents of the University of Minnesota, n. d.) as well as a protocol that we created that was based on NDSR, but was modified to contain reverse-order prompts (Baxter, Thompson, Smith et al., 2003). Second, Study 3 utilized a protocol with a meal format that we created (Baxter, Smith et al., 2003) and a protocol with an open format patterned after the automated multiple-pass method (AMPM) of the United States Department of Agriculture [USDA] (US Department of Agriculture, n. d.). Third, for Studies 4 and 5, children interviewed about the prior 24 hours were asked to report intake for the interview day first, followed by intake for the previous day to complete the 24 hours. Fourth, during all interviews, instead of using computerized software, interviewers wrote information reported by children onto paper forms. Table 1 shows the initial instructions and prompts used for interviews in each study. Modeling, practice, and assessment of quality control for interviews (QCI) were used for each study to train interviewers. Throughout data collection for each study, QCI was assessed regularly and indicated that interviewers adequately adhered to the protocols (Shaffer et al., 2004). Specifically, for the 242, 69, 23, 60, and 40 interviews in Studies 1, 2, 3, 4, and 5, respectively, QCI was assessed on a total of 51, 22, 11, 17, and 12 randomly selected interviews, respectively.

Weight and height measurements and age/sex BMI percentiles

On days when no observations or interviews were conducted at a particular school, dietitians measured children without shoes at school (see Table 1) using digital scales and portable stadiometers according to established procedures (Lohman, Roche, & Martorell, 1988;Maternal and Child Health Bureau, n. d.). Weight and height were measured twice (back-to-back) per child; if the two weight or height measurements were not within a tenth of a pound, or a quarter of an inch, respectively, then a third weight or height was measured. If three weight and/or height measurements were obtained, then the average of the closest two was used for the child's weight and/or height, respectively. Inter-rater reliability was assessed daily across pairs of dietitians on a random 10% of children; for all five studies, the intraclass correlation reliability was >0.99 for weight and for height. Each child's age, sex, height, and weight were used to determine his or her age/sex BMI percentile (Centers for Disease Control and Prevention & US Department of Health and Human Services, n. d.). For Studies 1, 2, 3, and 4, children were observed and interviewed irrespective of age/sex BMI percentile. For Study 5, according to the study's design, only children with an age/sex BMI percentile that was $\geq 5^{th}$ and $< 50^{th}$ percentiles (*low BMI*) or $\geq 85^{th}$ percentile (*high BMI*) were observed and interviewed (Baxter et al., 2006).

Classification of reported food items

For each study, children were asked to report all eating occasions for the specified target period, but assessment of reporting accuracy was restricted to information about school breakfast and school lunch because only these meals were observed. Furthermore, for this article, analysis of reported intake was restricted to information about school breakfast obtained in dietary recalls (of an entire day's intake). Reported items from dietary recalls were considered as reported eaten for school breakfast only if the specific criteria explained in footnote c of Table 2 were met; if all of these criteria were met, then a recall contained a *breakfast report*.

Each item that a child reported as eaten at school breakfast was classified as a *match* if the child had been observed eating that item at that school breakfast; otherwise, the reported item was classified as an *intrusion*. Reported items were classified as matches unless it was clear that the child's reports did not describe items observed eaten. Footnote d of Table 2 provides examples.

Reported items were categorized by meal component as indicated in Table 3. Footnote b of Table 3 provides examples of food items in each meal component.

Classification of breakfast options

Observed information for a child on a school morning was used to classify a breakfast option *observed* eaten as *cold*, *hot*, *mixed*, *beverage only*, or *nothing* as defined in footnote e of Table 2. Information from a breakfast report was used to classify an option *reported* eaten as *cold*, *hot*, *mixed*, *beverage only*, or *no meal reported met criteria to be considered school breakfast* as defined in footnote f of Table 2. A breakfast option reported eaten was further classified as *correctly reported* if it was the same as an option observed eaten for the respective dietary recall (regardless of whether items reported eaten were intrusions); otherwise, it was classified as *misreported*. Footnote g of Table 2 provides examples. For 429 observed breakfasts, 10 were *mixed*, 22 were *beverage only*, and 3 were *nothing*; these differed from what was selected, so what was observed, rather than what was selected, was used as the standard when further classifying breakfast options reported eaten as correctly reported or misreported.

Analyses

As Table 1 shows, five children who had each been observed and interviewed were excluded from analyses for the current article because they moved to schools not in the study before weight and height measurements were obtained.

Analyses were conducted for the five studies both separately, because several covariates of interest were specific to individual studies (due to different aspects in study design), and combined, because other covariates (i.e., race, sex, age/sex BMI percentile) were available for all studies.

For the five studies separately and combined, the proportions of intrusion-free breakfast reports when an option was correctly reported versus misreported were compared using two-sample tests of proportion. For the five studies separately and combined, the frequency distributions of breakfast reports with zero to five intrusions when an option was correctly reported versus misreported were compared using Fisher's Exact Tests.

Logistic regression models were fit to investigate each of five research questions (RQs): RQ1) the likelihood that a reported item was a beverage intrusion; RQ2) the likelihood that a reported item was a bread/grain intrusion; RQ3) the likelihood that an option was misreported; RQ4) the likelihood that a reported item was an intrusion when an option was misreported; and RQ5) the likelihood that a reported item was an intrusion when an option was correctly reported. Meal components analyses were conducted only for beverage intrusions and bread/grain intrusions in breakfast reports due to the limited number of intrusions for the remaining meal components, as shown in Table 3. For each RQ, data for each of the five studies were analyzed separately to determine whether study-specific covariates were associated with the outcome of interest, and then data from all five studies were pooled for combined analyses. Study indicator variables were included in the combined analyses. Because some children had two interviews (and thus could have two breakfast reports), and because each breakfast report could have multiple intrusions (regardless of whether a breakfast option was correctly reported or misreported), each model was interpreted using empirical standard errors from the modified sandwich variance estimator, so p values are conservative (Williams, 2000).

Predictors in each model included main effects for race, sex, and age/sex BMI percentile, as well as the interaction of sex and age/sex BMI percentile. Models for each individual study also included study-specific covariates. For models of Study 1 data, the study-specific covariates were sequence (first or second interview for each child), reporting-order prompts (forward; reverse), and the interaction of reporting-order prompts and sex. That interaction was included because previously-published analyses at the food-item level, for school breakfast and school lunch combined, showed that slightly more boys had lower (i.e., better) intrusion rates with reverse- than forward-order prompts (p = 0.095) (Baxter, Thompson, Smith et al., 2003). For models of Study 2 data, the study-specific covariate was interview modality (in person; by telephone). For models of Study 3 data, the study-specific covariate was interview format (meal; open). For models of Study 4 data, the study-specific covariates were protocols (24M; 24A; 24E; PDM; PDA; PDE) created by crossing the two target periods (prior 24 hours [24]; previous day [PD]) with three interview times (morning [M]; afternoon [A]; evening [E]). For models of Study 5 data, the study-specific covariate was protocol (24E; PDM). Analyses used Stata (9.2, Stata, Inc., College Station, TX, USA) and SAS (9.0, SAS Institute, Inc., Cary, NC, USA).

Results

Table 2 shows, for the studies separately and combined, and for when a breakfast option was correctly reported and misreported, information about numbers of items observed eaten and numbers of items reported eaten for breakfast, interviews for which no meals reported met criteria to be considered school breakfast, breakfast reports with intrusions, breakfast reports with zero to five intrusions, and intrusions in breakfast reports. For all five studies combined, of the 429 interviews of 284 children, 337 interviews of 248 children contained a breakfast report; these 337 breakfast reports were included in analyses for the current article. Of these 337 breakfast reports, an option was correctly reported in 240 breakfast reports by 198 children and misreported in 97 breakfast reports by 85 children. (Some children who were observed and interviewed twice had one correctly reported option and one misreported option.)

Of the 240 breakfast reports of a correctly reported option, there were 94 intrusion-free reports (see Table 2) by 87 children in which 237 items were reported eaten; in the remaining 146 breakfast reports by 130 children, 203 of 471 items reported eaten were intrusions. Thus, there was an average of 0.85 intrusions per breakfast report of a correctly reported option. A breakfast report of a correctly reported option could have one or more intrusions if, compared to what was observed eaten, the wrong items were reported eaten (e.g., flake-shaped RTE cereal observed but donut-shaped RTE cereal reported; sausage biscuit observed but pancakes reported; white milk observed but chocolate milk reported; apple juice observed but orange juice reported) or if non-zero amounts of correct items were reported, but for which amounts observed eaten were none.

Of the 97 breakfast reports of a misreported option, there were eight intrusion-free reports (see Table 2) in which 10 items were reported eaten. Each of these eight breakfast reports of a misreported option had zero intrusions either because only a beverage (i.e., beverage only option) was reported eaten and it matched a beverage observed eaten from a cold option (one child) or a hot option (six children), or because items from a hot option were reported eaten and they matched items observed eaten from a hot option when items from a cold option were also observed eaten (one child). In the remaining 89 breakfast reports of a misreported option (by 81 children), 189 of 246 items reported eaten were intrusions. Thus, there was an average of 1.95 intrusions per breakfast report of a misreported option.

The proportion of intrusion-free breakfast reports in Table 2 was greater when an option was correctly reported than misreported for Study 1 (0.35 vs. 0.11, p = 0.0003), Study 2 (0.53 vs.

0, p = 0.0026), Study 4 (0.38 vs. 0.07, p = 0.0177), and Study 5 (0.33 vs. 0.07, p = 0.0335) as well as for all five studies combined (0.39 vs. 0.08, p < 0.001) (two-sample tests of proportion). For Study 3, the difference was marginally significant (0.42 vs. 0, p = 0.0597), probably due to the small sample of children.

The frequency distributions of breakfast reports with zero to five intrusions for correctly reported versus misreported options in Table 2 differed for all five studies separately and combined (p values < 0.0422, Fisher's Exact Tests). When intrusion-free breakfast reports were excluded, the frequency distributions of breakfast reports with one to five intrusions for correctly reported versus misreported options in Table 2 differed for Studies 1, 3, and 5 as well as for all five studies combined (p values < 0.0456), but not for Studies 2 and 4 (p values > 0.2181) (Fisher's Exact Tests). The frequency distributions illustrate that linking of intrusions was more pronounced when an option was misreported than correctly reported. For example, as Table 2 shows, for all five studies, there were two or more intrusions per breakfast report in 64 of 97 reports (66%) of a misreported option, but in only 42 of 240 reports (18%) of a correctly reported option, and there were three or more intrusions per breakfast report in 30 of 97 reports (31%) of a misreported option, but in only 9 of 240 reports (4%) of a correctly reported option.

Table 3 shows intrusions by meal component for all five studies separately and combined when an option was correctly reported and misreported. When an option was correctly reported, the largest percentages of intrusions were beverages (49% to 63%) and breads/grains (13% to 25%). When an option was misreported, although the largest percentages of intrusions were also beverages (42% to 48%) and breads/grains (42% to 55%), proportionately more intrusions were breads/grains, and of those intrusions, proportionately more were RTE cereal, and proportionately more RTE cereal intrusions occurred when a hot option (which never included RTE cereal) was observed eaten. Specifically, in Table 3, for all five studies combined, the 41 bread/grain intrusions in 39 breakfast reports by 39 children with a correctly reported option included 19 RTE cereal intrusions; for most (n = 16) of these 19 RTE cereal intrusions, although a cold option was both observed eaten and reported eaten, a wrong RTE cereal was reported eaten. In contrast, in Table 3, for all five studies combined, the 97 bread/grain intrusions in 73 breakfast reports by 67 children with a misreported option included 69 RTE cereal intrusions; for most (n = 62) of these 69 RTE cereal intrusions, a hot option was observed eaten.

In Table 3, for all five studies combined, the 110 beverage intrusions in 97 breakfast reports by 89 children with a correctly reported option included 43 milk intrusions and 66 juice intrusions. Milk was part of both breakfast options from which children selected each school day; these 43 milk intrusions occurred when 8 cold and 35 hot options had been observed eaten. Juice was usually available with a cold breakfast option, and sometimes available with a hot breakfast option; these 66 juice intrusions occurred when 26 cold and 40 hot options had been observed eaten. In contrast, in Table 3, for all five studies combined, the 84 beverage intrusions in 66 breakfast reports by 59 children with a misreported option included 40 milk intrusions and 43 juice intrusions. These 40 milk intrusions occurred when 3 cold, 33 hot, and 4 beverage only options had been observed eaten, and these 43 juice intrusions occurred when 3 cold, 33 hot, 3 beverage only, and 4 mixed options had been observed eaten.

When an option was misreported, linking of intrusions occurred in 64 breakfast reports by 58 children with 164 intrusions total; most (n = 131) of these 164 intrusions occurred in 50 breakfast reports by 47 children when a hot option was observed eaten but a cold option was misreported eaten. Of these 50 reports, six breakfast reports by six children each had four intrusions (RTE cereal, crackers, milk, juice), 19 breakfast reports by 18 children each had three intrusions (RTE cereal, milk, and juice in each of seven reports by seven children; RTE cereal, crackers, and juice in each of eight reports by seven children; RTE cereal, crackers, and milk in each of three reports by three children; and RTE cereal and two different milk flavors in one report by one child), and 25 breakfast reports by 25 children each had two intrusions (RTE cereal and milk in each of 12 reports by 12 children; RTE cereal and juice in each of seven reports by seven children; RTE cereal and crackers in each of six reports by six children). Of interest was the finding that the anticipated linking of a RTE cereal intrusion with a milk intrusion did not occur in 21 of these 50 breakfast reports when a hot option was observed eaten but a cold option was misreported eaten. (For 12 of these 21 breakfast reports, the milk observed eaten as part of a hot option matched the milk reported eaten as part of a misreported cold option.)

When an option was correctly reported, intrusions not only occurred, but linking of intrusions also occurred in 42 breakfast reports by 41 children with 99 intrusions total; most (n = 80) of these 99 intrusions occurred in 33 breakfast reports by 33 children when a hot option was both observed eaten and reported eaten. Of these 33 reports, two breakfast reports by two children each had five intrusions, two breakfast reports by two children each had four intrusions, four breakfast reports by four children each had three intrusions, and 25 breakfast reports by 25 children each had two intrusions. Although these children had a correctly reported option (because they were observed and reported having eaten items from a hot option), these children reported the wrong items from a hot option. For example, one child's breakfast report of a hot option contained three intrusions because the child was observed to have eaten a hot option that contained sausage biscuit, grits, and apple juice, but reported having eaten French toast, strawberries, and white milk.

Table 4 shows the number of breakfast options observed eaten by reported eaten for each study by study-specific condition, and for all five studies combined; cell values in italics indicate breakfast options reported eaten that were further classified as correctly reported (defined in footnote g of Table 2). For each study, when a cold option was observed eaten, a hot option was rarely misreported eaten; however, when a hot option was observed eaten, a cold option was often misreported eaten. For children who were interviewed twice (either within Study 1 or across Studies 4 and 5), the asymmetrical tendency to misreport a cold option when a hot option was observed eaten did not depend on whether children were consistent or inconsistent in which breakfast option was observed eaten. Of the 121 children who were each observed and interviewed twice for Study 1, observations indicated that breakfast options were consistently eaten by 67 children (with cold options by 10 children, hot options by 56 children, and beverage only by 1 child) and inconsistently eaten by 54 children. In Table 4, the last two sections for Study 1 show that the tendency for children to misreport a cold option when a hot option was observed eaten was fairly frequent when a hot option was consistently observed eaten (21 ÷[112 − 32] = 26%), and even more frequent when options observed eaten were inconsistent (17 ÷ [50 − 10] = 43%). A similar pattern was found for the 24 children who were each observed and interviewed once for Study 4 and once for Study 5; for these 24 children, observations indicated that breakfast options were consistently eaten by 12 children (with cold options by two children, hot options by nine children, and beverage only by one child) and inconsistently eaten by 12 children. In Table 4, the sections for these 24 children in Study 4 and Study 5 show that the tendency for children to misreport a cold option when a hot option was observed eaten was frequent when a hot option was consistently observed eaten (6 ÷ [18 − 1] = 35%) and when options observed eaten were inconsistent (3 ÷ [8 − 1] = 43%).

RQ1: Likelihood that a reported item was a beverage intrusion

In the separate analyses by study, for Study 3, the likelihood that a reported item was a beverage intrusion was lower for open format interviews than meal format interviews (odds ratio [OR] = 0.357, p = 0.039). In breakfast reports for Study 3, open format interviews had 3 beverage intrusions of 19 items reported eaten (16%) and meal format interviews had 7 beverage intrusions of 28 items reported eaten (25%) (data not in tables). For Study 4, the likelihood that a reported item was a beverage intrusion was lower for 24A interviews than PDM interviews (OR = 0.354, p = 0.051); post hoc contrasts indicated a lower likelihood for 24A interviews than PDE interviews (χ^2 = 4.34, p = 0.0373). In breakfast reports for Study 4, 24A interviews had 4 beverage intrusions of 29 items reported eaten (14%), PDM interviews had 7 beverage intrusions of 23 items reported eaten (30%), and PDE interviews had 8 beverage intrusions of 28 items reported eaten (29%) (data not in tables). For Study 5, the likelihood that a reported item was a beverage intrusion was lower for Black children than White children (OR = 0.272, p = 0.002), and the interaction of sex and age/sex BMI percentile was significant (OR = 1.038, p = 0.009). In breakfast reports for Study 5, Black children had 16 beverage intrusions of 77 items reported eaten (21%) and White children had 10 beverage intrusions of 28 items reported eaten (36%) (data not in tables). Also, in breakfast reports for Study 5, low-BMI girls had 9 beverage intrusions of 24 items reported eaten (38%), low-BMI boys had 3 beverage intrusions of 26 items reported eaten (12%), high-BMI girls had 5 beverage intrusions of 26 items reported eaten (19%), and high-BMI boys had 9 beverage intrusions of 29 items reported eaten (31%) (data not in tables). For Studies 1 and 2, the likelihood that a reported item was a beverage intrusion was not significantly associated with race, sex, age/sex BMI percentile, the interaction of sex and age/sex BMI percentile, or any of the study-specific covariates.

When data were combined across all studies, the likelihood that a reported item was a beverage intrusion was lower for Study 2 than Study 5 (OR = 0.465, p = 0.014); post-hoc contrasts indicated a lower likelihood for Study 2 than Study 1 (χ^2 = 4.38, p = 0.0364) and Study 4 (χ^2 = 6.33, p = 0.012). In breakfast reports, Study 2 had 23 beverage intrusions of 175 items reported eaten (13%), Study 5 had 26 beverage intrusions of 105 items reported eaten (25%), Study 1 had 99 beverage intrusions of 483 items reported eaten (20%), and Study 4 had 36 beverage intrusions of 154 items reported eaten (23%) (data not in tables).

RQ2: Likelihood that a reported item was a bread/grain intrusion

In the separate analyses by study, for Studies 1, 2, 3, 4, and 5, the likelihood that a reported item was a bread/grain intrusion was not significantly associated with race, sex, age/sex BMI percentile, the interaction of sex and age/sex BMI percentile, or any of the study-specific covariates.

When data were combined across all studies, the likelihood that a reported item was a bread/grain intrusion was lower for Study 2 than Study 5 (OR = 0.304, p = 0.005); post-hoc contrasts indicated a lower likelihood for Study 2 than Study 1 (χ^2 = 12.85, p < 0.001). In breakfast reports, Study 2 had 11 bread/grain intrusions of 175 items reported eaten (6%), Study 5 had 19 bread/grain intrusions of 105 items reported eaten (18%), and Study 1 had 85 bread/grain intrusions of 483 items reported eaten (18%) (data not in tables).

RQ3: Likelihood that an option was misreported

In the separate analyses by study, for Study 4, the likelihood than an option was misreported was lower for 24M interviews than PDM interviews (OR = 0.080, p = 0.036); also, for Study 5, the likelihood was lower for 24E interviews than PDM interviews (OR = 0.186, p = 0.051). As Table 4 shows, for Study 4, misreported options for 24M were 1 ÷ (10 − 1) = 11% and for PDM were 4 ÷ (10 − 3) = 57%; for Study 5, misreported options for 24E were 4 ÷ (20 − 1) = 21% and for PDM were 10 ÷ (20 − 1) = 53%. For Studies 1, 2, and 3, the likelihood that an option was misreported was not significantly associated with race, sex, age/sex BMI percentile, the interaction of sex and age/sex BMI percentile, or any of the study-specific covariates.

When data were combined across all studies, the likelihood that an option was misreported was not significantly associated with race, sex, age/sex BMI percentile, or the interaction of sex and age/sex BMI percentile; also, there were no significant differences across studies in the likelihood that an option was misreported.

RQ4: Likelihood that a reported item was an intrusion when an option was misreported

In the separate analyses by study, for Study 4, the likelihood that a reported item was an intrusion when an option was misreported was lower for 24A interviews than PDM interviews (OR = 0.254, p = 0.040). In breakfast reports of a misreported option for Study 4, 24A interviews had 4 intrusions of 8 items reported eaten (50%) and PDM interviews had 9 intrusions of 13 items reported eaten (69%) (data not in tables). For Studies 1 and 5, the likelihood that a reported item was an intrusion when an option was misreported was not significantly associated with race, sex, age/sex BMI percentile, the interaction of sex and age/sex BMI percentile, or any of the study-specific covariates. Study 2 (n = 8) and Study 3 (n = 4) lacked enough misreported options to estimate the model in the separate analyses by study for RQ4.

When data were combined across all studies, the likelihood that a reported item was an intrusion when an option was misreported was lower in Study 4 than Study 5 (OR = 0.276, p = 0.015). In breakfast reports of a misreported option, Study 4 had 27 intrusions of 43 items reported eaten (63%) and Study 5 had 31 intrusions of 37 items reported eaten (84%) (data not in tables). Study 2 (n = 8) and Study 3 (n = 4) were not included in the combined study analysis for RQ4 due to their small numbers of misreported options.

RQ5: Likelihood that a reported item was an intrusion when an option was correctly reported

In the separate analyses by study, for Study 5, the likelihood that a reported item was an intrusion when an option was correctly reported was lower for Black children than White children (OR = 0.215, p = 0.002). In breakfast reports of a correctly reported option for Study 5, Black children had 13 intrusions of 52 items reported eaten (25%) and White children had 7 intrusions of 16 items reported eaten (44%) (data not in tables). For Studies 1, 2, 3, and 4, the likelihood that a reported item was an intrusion when an option was correctly reported was not significantly associated with race, sex, age/sex BMI percentile, the interaction of sex and age/sex BMI percentile, or any of the study-specific covariates.

When data were combined across all studies, the likelihood that a reported item was an intrusion when an option was correctly reported was not significantly associated with race, sex, age/sex BMI percentile, or the interaction of sex and age/sex BMI percentile; also, there were no significant differences across studies in the likelihood that a reported item was an intrusion when an option was correctly reported.

Discussion

Across the five studies, almost half (48%) of all intrusions occurred in the 29% of breakfast reports in which a breakfast option was misreported, with an average of 1.95 intrusions per breakfast report; however, the other half (52%) of all intrusions occurred in the 71% of breakfast reports in which a breakfast option was correctly reported, with an average of 0.85 intrusions per breakfast report. A larger proportion of breakfast reports were intrusion-free when a breakfast option was correctly reported than misreported. Linking of intrusions was especially evident in breakfast reports of a misreported option. Specifically, there were two or more intrusions in two-thirds of breakfast reports of a misreported option, but in only one-fifth of breakfast reports of a correctly reported option, and there were three or more intrusions in almost one-third of breakfast reports of a misreported option, but in only one-twentieth of breakfast reports of a correctly reported option.

Asymmetry was evident in misreported breakfast options; specifically, children observed eating a cold option rarely misreported a hot option, but children observed eating a hot option often misreported a cold option. The Introduction mentioned a similar result from another dietary-reporting validation study with fourth-grade children (Baxter, Hardin, Royer et al., in press) that was not included in the analyses for the current article. Potential explanations for this result may be found by distinguishing between episodic and semantic memory. According to Tulving (1972), episodic memories are context-bound (i.e., particular events occurred in particular contexts) while semantic memories are situation-independent knowledge (e.g., general information). Smith et al. (1991) put this into the dietary realm by referring to an individual's memory for particular meals and snacks as *specific memories* (i.e., episodic) and to an individual's knowledge about his or her personal dietary intake as *generic information* (i.e., semantic). Furthermore, Smith et al. suggested that intrusions would be expected if dietary reporting involves compromises between specific memories and generic information. Eating is a recurring autobiographical event. Specific episodes of recurring autobiographical events are difficult to recall (Bradburn, Rips, & Shevell, 1987; Means & Loftus, 1991). Perhaps children who had difficulty remembering a specific hot option eaten for the school breakfast episode for the target period in that dietary recall reverted to misreporting a more generic cold option which included RTE cereal each school day. Alternatively, a misreported cold option could refer either to a cold option eaten for school breakfast for another target period, or to a cold option eaten for breakfast at home (instead of at school).

Differences in meal component categorization of intrusions were evident in misreported breakfast options: There were proportionately more bread/grain intrusions (with more RTE cereal intrusions) when an option was misreported than correctly reported, and there were proportionately more RTE cereal intrusions when a cold option was misreported for a hot option that had been observed eaten. This could be because RTE cereal was a defining characteristic of reporting a cold breakfast option. This would almost certainly have implications for nutrient profiles estimated from dietary recalls. For example, across the five studies, the average energy and macronutrient contents of a cold option and a hot option (when an entire option was consumed) were 354 and 451 kilocalories, 10.7 and 14.8 grams of protein, 64.3 and 75.4 grams of carbohydrate, and 6.7 and 11.6 grams of fat, respectively.

Milk intrusions that occurred because the wrong milk flavor was reported would have nutritional implications for energy but probably not for calcium. Juice intrusions that occurred because a wrong juice was reported (e.g., apple observed but orange reported) could have nutritional implications for vitamin C and beta carotene and possibly energy, depending on the juice. Juice intrusions that occurred when a cold option with juice was misreported instead of a hot option with fruit would have nutritional implications for fiber.

Children's race was not a significant covariate when combined data from all five studies were analyzed. However, when only Study 5 data were analyzed, for Black children compared to White children, a reported item was less likely to be a beverage intrusion, and a reported item was less likely to be an intrusion when an option was correctly reported. Likewise, neither children's age/sex BMI percentile nor the interaction of sex and age/sex BMI percentile was a significant covariate when combined data from all five studies were analyzed. However, when only Study 5 data were analyzed, the interaction of sex and age/sex BMI percentile was significant, with larger proportions of reported items being beverage intrusions for low-BMI girls and high-BMI boys than for low-BMI boys and high-BMI girls. For each study, the sample was stratified by race (and sex) and ranged from 50% to 75% Black (see Table 1). As mentioned previously, children were observed and interviewed irrespective of age/sex BMI percentile for

Studies 1, 2, 3, and 4; however, only children of low BMI or high BMI were observed and interviewed for Study 5 according to its design (Baxter et al., 2006). Additional dietary-reporting validation studies are needed to better understand the accuracy of dietary recalls by children of various age/sex BMI percentiles and races.

The combination of target period and interview time was associated with beverage intrusions, bread/grain intrusions, misreported breakfast options, and intrusions in misreported breakfast options. In breakfast reports for Study 4, a reported item was less likely to be a beverage intrusion in 24A interviews than PDM interviews and PDE interviews. A breakfast option was less likely to be misreported in breakfast reports in 24M interviews than PDM interviews in Study 4, and less likely in 24E interviews than PDM interviews in Study 5. In breakfast reports for Study 4, a reported item was less likely to be an intrusion when an option was misreported in 24A interviews than PDM interviews. When combined data from all five studies were analyzed, a reported item was less likely to be a beverage intrusion in breakfast reports for Study 2 (for which all of the interviews concerned the same day's intake and were conducted in the evening) than Study 5 (for which half of the interviews were 24E and half were PDM), Study 1 (for which all of the interviews were PDM), and Study 4 (for which 10 interviews each were 24M, 24A, 24E, PDM, PDA, and PDE); furthermore, a reported item was less likely to be a bread/grain intrusion in breakfast reports for Study 2 than Study 5 and Study 1. Possible explanations for these results are that the retention interval between eating and reporting was longer for interviews about intake for the previous day than the same day and the prior 24 hours, and there was an intervening breakfast between the to-be-reported breakfast and the interview for PDM interviews, PDA interviews, and PDE interviews, but not for 24M interviews, 24A interviews, or 24E interviews. Target period and interview time are two aspects of dietary recalls that are determined by the logistics and design of the study. The previous-day target period is used in two prominent 24-hour dietary recall protocols — NDSR, which was created by the Nutrition Coordinating Center at the University of Minnesota with funding from the National Heart, Lung, and Blood Institute for use in research studies (Dennis, Ernst, Hjortland, Tillotson, & Grambsch, 1980; Regents of the University of Minnesota, n. d.), and AMPM, which was developed by the USDA for use in national nutrition surveys (Bliss, 2004; Dwyer, Picciano, & Raiten, 2003; Raper, Perloff, Ingwersen, Steinfeldt, & Anand, 2004; US Department of Agriculture, n. d.). The interview time can be morning, afternoon, or evening for these two prominent 24-hour dietary recall protocols; however, interview time is often given little, if any, mention in publications of studies that utilize dietary recalls.

Interview format, which was manipulated in Study 3 between open format and meal format, was associated with beverage intrusions. Despite the small sample of children for Study 3, a reported item was less likely to be a beverage intrusion in breakfast reports for open format interviews than meal format interviews. Interview format is determined by the protocol(s) that interviewers are to follow to conduct dietary recalls, and the extent to which interviewers abide by the protocols. Computer software for two prominent 24-hour dietary recall multiple-pass protocols (which were mentioned previously and which both use the previous-day target period) is programmed for a specific interview format. The NDSR software is programmed for a time/forward format (similar to the first part of footnote e of Table 1) for all passes (Regents of the University of Minnesota, n. d.). The AMPM software is programmed for an open format (i.e., free or no time instructions; similar to the first part of footnote g of Table 1) during the first three passes and time/forward prompts during the final review pass (Bliss, 2004;Raper et al., 2004;US Department of Agriculture, n. d.). To our knowledge, no dietary-reporting validation study has compared the interview format of the NDSR protocol to that of the AMPM protocol to investigate differences in dietary reporting accuracy by children (or adults).

Although intrusions from correctly reported and misreported breakfast options in school breakfast reports were the focus of this article, dietary recalls in each of the five validation studies concerned intake for either a 24-hour period or an entire day. It is important for readers to realize this because a previous analysis found that the accuracy with which children reported a single meal (i.e., school lunch) within a 24-hour recall was lower than their accuracy for reporting only the single meal (Baxter & Thompson, 2002).

A limitation of this investigation is that data already collected in one school district for five dietary-reporting validation studies were utilized. Because each study had a specific focus and design, it was necessary to analyze each study separately (due to variations across the five studies in reporting-order prompts, interview modality, interview format, target period, and interview time), and then to analyze all five studies combined.

An important strength of this investigation is that the validation method for each study — observation of school breakfast — was independent of the child's memory. Another strength is that observations were conducted in a setting and manner that was natural to children; thus, there was potentially less reactivity than in a laboratory or clinical research center setting. Also, inter-observer reliability and quality control for interviews were both assessed regularly throughout data collection for each study.

In summary, in breakfast reports in children's dietary recalls, although intrusions occurred in both correctly reported and misreported school breakfast options, on average, there were more intrusions per breakfast report for misreported school breakfast options than correctly reported breakfast options. Asymmetry was evident in misreported breakfast options; specifically, misreports were usually incorrect reports of a cold option (i.e., RTE cereal) when a hot option was observed eaten. Such misreports would undoubtedly have implications for nutrient profiles of reported intake at school breakfast; this might lead to different conclusions about benefits commonly attributed to eating school breakfast and especially RTE cereal. For the current investigation, nutrient analysis was intentionally avoided (a) because children (and adults) report intake as food and beverage items, not energy and nutrients, and (b) to focus attention on the under-recognized problem of intrusions and the effect that methodological aspects such as target period, interview time, reporting-order prompts, and interview format may have on intrusions in breakfast reports in children's dietary recalls. Methodological aspects are under the direct control of investigators; thus, the decisions that investigators make concerning a study's design and methods have implications for intrusions in dietary recalls. Dietary assessment could be improved by giving due consideration to methodological aspects when designing studies. Because such study features may influence dietary reporting accuracy, details concerning methodological aspects of dietary recalls should be included in publications of results of studies that utilize dietary recalls.

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References

Albertson AM, Anderson GH, Crockett SJ, Goebel MT. Ready-to-eat cereal consumption: Its relationship with BMI and nutrient intake of children aged 4 to 12 years. Journal of the American Dietetic Association 2003;103:1613–1619. [PubMed: 14647087]

Baglio ML, Baxter SD, Guinn CH, Thompson WO, Shaffer NM, Frye FHA. Assessment of interobserver reliability in nutrition studies that use direct observation of school meals. Journal of the American Dietetic Association 2004;104:1385–1393. [PubMed: 15354155]

Baranowski T, Dworkin R, Henske JC, Clearman DR, Dunn JK, Nader PR, Hooks PC. The accuracy of children's self-reports of diet: Family Health Project. Journal of the American Dietetic Association 1986;86:1381–1385. [PubMed: 3760429]

Barton BA, Eldridge AL, Thompson D, Affenito SG, Striegel-Moore RH, Franko DL, Albertson AM, Crockett SJ. The relationship of breakfast and cereal consumption to nutrient intake and body mass index: The National Heart, Lung, and Blood Institute Growth and Health Study. Journal of the American Dietetic Association 2005;105:1383–1389. [PubMed: 16129079]

Baxter SD, Hardin JW, Royer JA, Guinn CH, Smith AF. Data from a validation study of reporting accuracy over multiple recalls, and school foodservice production records provide insight into the origins of intrusions (reports of uneaten food items) in children's dietary recalls. Journal of the American Dietetic Association. in press

Baxter SD, Hardin JW, Smith AF, Royer JA, Guinn CH. Children's dietary recalls from three validation studies: Types of intrusion vary with retention interval. Applied Cognitive Psychology. in press

Baxter SD, Royer JA, Hardin JW, Guinn CH, Smith AF. Fourth-grade children are less accurate in reporting school breakfast than school lunch during 24-hour dietary recalls. Journal of Nutrition Education and Behavior 2007;39:126–133. [PubMed: 17493562]

Baxter SD, Smith AF, Guinn CH, Thompson WO, Litaker MS, Baglio ML, Shaffer NM, Frye FHA. Interview format influences the accuracy of children's dietary recalls validated with observations. Nutrition Research 2003;23:1537–1546. [PubMed: 16724161]

Baxter SD, Smith AF, Litaker MS, Guinn CH, Nichols MN, Miller PH, Kipp K. Body mass index, sex, interview protocol, and children's accuracy for reporting kilocalories observed eaten at school meals. Journal of the American Dietetic Association 2006;106:1656–1662. [PubMed: 17000199]

Baxter SD, Smith AF, Litaker MS, Guinn CH, Shaffer NM, Baglio ML, Frye FHA. Recency affects reporting accuracy of children's dietary recalls. Annals of Epidemiology 2004;14:385–390. [PubMed: 15246326]

Baxter SD, Thompson WO. Accuracy by meal component of fourth-graders' school lunch recalls is less when obtained during a 24-hour recall than as a single meal. Nutrition Research 2002;22:679–684.

Baxter SD, Thompson WO, Davis HC. Trading of food during school lunch by first- and fourth-grade children. Nutrition Research 2001;21:499–503.

Baxter SD, Thompson WO, Litaker MS, Guinn CH, Frye FHA, Baglio ML, Shaffer NM. Accuracy of fourth-graders' dietary recalls of school breakfast and school lunch validated with observations: In-person versus telephone interviews. Journal of Nutrition Education and Behavior 2003;35:124–134. [PubMed: 12773283]

Baxter SD, Thompson WO, Smith AF, Litaker MS, Yin Z, Frye FHA, Guinn CH, Baglio ML, Shaffer NM. Reverse versus forward order reporting and the accuracy of fourth-graders' recalls of school breakfast and school lunch. Preventive Medicine 2003;36:601–614. [PubMed: 12689806]

Bliss RM. Researchers produce innovation in dietary recall. Agricultural Research 2004;52(6):10–12.

Bradburn NM, Rips LJ, Shevell SK. Answering autobiographical questions: The impact of memory and inference on surveys. Science 1987;236:157–161. [PubMed: 3563494]

Centers for Disease Control and Prevention, & US Department of Health and Human Services. (n. d.). BMI - Body Mass Index: About BMI for Children and Teens. Retrieved January 25, 2008, from www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/about_childrens_BMI.htm

Crepinsek MK, Singh A, Bernstein LS, McLaughlin JE. Dietary effects of universal-free school breakfast: Findings from the Evaluation of the School Breakfast Program Pilot Project. Journal of the American Dietetic Association 2006;106:1796–1803. [PubMed: 17081831]

Dennis B, Ernst N, Hjortland M, Tillotson J, Grambsch V. The NHLBI Nutrition Data System. Journal of the American Dietetic Association 1980;77:641–647. [PubMed: 6893713]

Dwyer J, Picciano MF, Raiten DJ. Future Directions for What We Eat in America--NHANES: The Integrated CSFII-NHANES. Journal of Nutrition 2003;133:576S–581S. [PubMed: 12566506]

Friedman BJ, Hurd-Crixell SL. Nutrient intake of children eating school breakfast. Journal of the American Dietetic Association 1999;99:219–221. [PubMed: 9972192]

Gordon AR, Devaney BL, Burghardt JA. Dietary effects of the National School Lunch Program and the School Breakfast Program. American Journal of Clinical Nutrition 1995;61:221S–231S. [PubMed: 7832169]

Gordon AR, McKinney P. Sources of nutrients in students' diets. American Journal of Clinical Nutrition 1995;61:232S–240S. [PubMed: 7832170]

Lohman, TG.; Roche, AF.; Martorell, R. Anthropometric Standardization Reference Manual. Champaign, IL: Human Kinetics Books; 1988.

Maternal and Child Health Bureau. (n. d.). Accurately weighing & measuring: technique. Retrieved January 25, 2008, from http://depts.washington.edu/growth/module5/text/intro.htm

Means B, Loftus EF. When personal history repeats itself: Decomposing memories for recurring events. Applied Cognitive Psychology 1991;5:297–318.

Nicklas TA, Myers L, Berenson GS. Impact of ready-to-eat cereal consumption on total dietary intake of children: The Bogalusa Heart Study. Journal of the American Dietetic Association 1994;94:316–318. [PubMed: 8120300]

Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. Journal of the American Dietetic Association 2005;105:743–760. [PubMed: 15883552]

Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. An overview of USDA's Dietary Intake Data System. Journal of Food Composition and Analysis 2004;17:545–555.

Regents of the University of Minnesota. (n. d.). NDSR Nutrition Data System for Research 2007. Minneapolis, MN:

Ruxton CHS, Kirk TR. Breakfast: A review of associations with measures of dietary intake, physiology and biochemistry. British Journal of Nutrition 1997;78:199–213. [PubMed: 9301411]

Shaffer NM, Baxter SD, Thompson WO, Baglio ML, Guinn CH, Frye FHA. Quality control for interviews to obtain dietary recalls from children for research studies. Journal of the American Dietetic Association 2004;104:1577–1585. [PubMed: 15389417]

Simons-Morton BG, Baranowski T. Observation in assessment of children's dietary practices. Journal of School Health 1991;61:204–207. [PubMed: 1943043]

Simons-Morton BG, Forthofer R, Huang IW, Baranowski T, Reed DB, Fleishman R. Reliability of direct observation of schoolchildren's consumption of bag lunches. Journal of the American Dietetic Association 1992;92:219–221. [PubMed: 1737906]

Smith AF, Baxter SD, Hardin JW, Guinn CH, Royer JA, Litaker MS. Validation-study conclusions from dietary reports by fourth-grade children observed eating school meals are generalisable to dietary reports by comparable children not observed. Public Health Nutrition 2007;10:1057–1066. [PubMed: 17381934]

Smith AF, Jobe JB, Mingay DJ. Retrieval from memory of dietary information. Applied Cognitive Psychology 1991;5:269–296.

Tulving, E. Episodic and semantic memory. In: Tulving, E.; Donaldson, W., editors. Organization of Memory. New York: Academic Press; 1972. p. 381-403.

US Department of Agriculture. (n. d.). USDA Automated Multiple-Pass Method. Retrieved January 25, 2008, from http://www.ars.usda.gov/Services/docs.htm?docid=7710

US Department of Agriculture, & Economic Research Service. (n. d.). The Food Assistance Landscape, FY 2006 Annual Report. Retrieved January 25, 2008, from http://www.ers.usda.gov/Publications/EIB6-4

US Department of Agriculture, & Food and Nutrition Service. (n. d.). Road to SMI Success - A Guide for School Foodservice Directors. Retrieved January 25, 2008, from http://www.fns.usda.gov/tn/Resources/roadtosuccess.html

Williams RL. A note on robust variance estimation for cluster-correlated data. Biometrics 2000;56:645–646. [PubMed: 10877330]

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Table 1

Details by study relevant to the current analyses

	Study 1 (Baxter, Thompson, Smith et al., 2003)	Study 2 (Baxter, Thompson, Litaker et al., 2003)	Study 3 (Baxter, Smith et al., 2003)	Study 4 (Baxter et al., 2004)	Study 5 (Baxter et al., 2006)
Focus of evaluation	Reporting-order prompts (forward [morning-to-evening]; reverse [evening-to-morning])	Interview modality (in person; by telephone)	Interview format (meal; open)	Target period (prior 24 hours; previous day) and interview time (morning; afternoon; evening)	Body mass index (BMI), sex, and protocol (about prior 24 hours in an evening interview; about previous day in a morning interview)
Dates of observations and interviews	January through May, 2001	January through February, 2002	March, 2002	August through September, 2002	December, 2002
n of schools and 4th-grade classes	11 schools; 44 classes	10 schools; 42 classes	8 schools; 16 classes	6 schools; 24 classes	6 schools; 24 classes
Mean % of children (range) eligible for free or reduced-rice school meals	60% (33% to 74%)	59% (27% to 79%)	58% (27% to 72%)	70% (58% to 82%)	70% (58% to 82%)
n (%) of children who agreed to participate	669 (73%)	451 (56%)		312 (70%)	
n of observers	4	3	3	2	2
n of interviewers	4	2	1	2	3
n (race; sex) of children observed and interviewed [a]	121 (50% Black; 48% girls)	69 (54% Black; 57% girls)	23 (65% Black; 57% girls)	60 (70% Black; 50% girls)	20 *low BMI* (75% Black; 50% girls); 20 *high BMI* (75% Black; 50% girls) [b]
Interviews per child	2 separated by ≥ 29 days	1	1	1	1
Payment (mailed check) per interview	$10	$25	$25	$15	$15
Target period [c]	Previous day	Same day	Same day	Prior 24 hours (n = 30; 10 per time) or previous day (n = 30; 10 per time)	Prior 24 hours (20 evening) or previous day (20 morning)
Interview time [d]	Morning	Evening	Evening	Morning (n = 20); afternoon (n = 20); evening (n = 20)	Morning (n = 20; 10 per BMI group); evening (n = 20; 10 per BMI group)
Interview modality	In person at school	In person (n = 36; in research van parked outside child's home) or by telephone (n = 33)	By telephone	In person at school (20 morning; 20 afternoon) or by telephone (20 evening)	In person at school (20 morning) or by telephone (20 evening)
Initial instructions and prompts for interviews	Two interviews per child – one Time/forward and one Time/reverse [e]	Time/forward [f]	Either Meal or Open [g]	Time/forward [h]	
Date and time of weight/height measurements	March, 2001; afternoon	March, 2002; afternoon		November, 2002; morning	
n of children observed and interviewed but not measured [i]	0	2	1	2	0

[a] An individual child was interviewed only once and for only one study, with two exceptions. First, in Study 1, each child was interviewed twice, separated by at least 29 days, with each interview concerning the previous day's intake. Second, in Study 5, the 40 children interviewed were a subset of 120 children who each were interviewed once about three to four months earlier that same school year for another study that included the 60 children in Study 4 and another 60 children interviewed without having been observed (Smith et al., 2007). Specifically, in Study 5, of the 40 children interviewed, 24 children had been observed and interviewed and the remaining 16 children had been interviewed without being observed.

[b] Children of *low BMI* had an age/sex BMI percentile ≥ 5^{th} and < 50^{th} and children of *high BMI* had an age/sex BMI percentile ≥ 85^{th}.

[c] Target period: *previous day* (midnight to midnight of the day before the interview); *same day* (from the time the child woke up that morning until when the interview began); *prior 24 hours* (from 24 hours before the interview to when the interview began).

[d]Interview time: *morning* (after breakfast at school but before lunch); *afternoon* (after lunch but before school ended for the day); *evening* (between 6:30 p.m. and 9:00 p.m.).

[e]Study 1: *Time/forward* – "After you got up yesterday morning, when was the first time you had something to eat or drink? What did you eat or drink at that time? Going forwards through yesterday, when was the next time after [time]…" *Time/reverse* – "Before you went to bed yesterday evening, when was the last time you had something to eat or drink? What did you eat or drink at that time? Going backwards through yesterday, when was the last time before [time]…"

[f]Study 2: *Time/forward* – "After you got up today, when was the first time you had something to eat or drink? What did you eat or drink at that time? When was the next time after [time]…"

[g]Study 3: *Meal* – "Did you have ___ today? [If yes] What did you eat or drink…" The blank was filled with each of following: breakfast; lunch; dinner; anything between breakfast and lunch; anything between lunch and dinner; and anything after dinner. *Open* – "Tell me everything you ate and drank today. Include everything …even snacks."

[h]Studies 4 and 5: *Time/forward* – "After you got up yesterday/this morning, when was the first time you had something to eat or drink? What did you eat or drink at that time? When was the next time after [time]…?" For prior 24 hour interviews, children were asked to report intake for the interview day first, followed by intake for the previous day, to complete the 24 hours.

[i]These 5 children (who moved to schools not in the study before weight and height measurements were obtained) were excluded from analyses for the current article. The Study 2 children were both interviewed by telephone. The Study 3 child was interviewed using meal format. In Study 4, one child was interviewed about the prior 24 hours in an afternoon interview and the other child was interviewed about the previous day in an evening interview.

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Table 2

Numbers of items observed eaten and items reported eaten for breakfast, interviews for which no meals reported met criteria to be considered school breakfast, breakfast reports with intrusions, breakfast reports with zero to five intrusions, and intrusions in breakfast reports, for when a breakfast option was correctly reported and misreported and for the studies separately and combined [a, b, c, d, e, f, g]

Breakfast option reported	Observed eaten for breakfast			Reported eaten for breakfast			Interviews not meeting criteria	Breakfast reports with intrusions		Breakfast reports with 0, 1, 2, 3, 4, & 5 intrusions [h]	Intrusions in breakfast reports
	Interviews	Number of items		Interviews	Number of items						
	n	Mean	SD	n	Mean	SD	n	n	%	n	n
Study 1											
Correctly reported	122	3.0	1.0	121	2.8	1.1	1 [i]	79	65.3	42, 59, 15, 4, 0, 1	106
Misreported	120	3.2	1.0	57	2.6	1.0	63	51	89.5	6, 16, 16, 16, 3, 0	108
Study 2											
Correctly reported	51	3.4	1.2	51	3.1	1.1	0	24	47.1	27, 18, 6, 0, 0, 0	30
Misreported	16	3.1	1.2	8	2.3	0.5	8	8	100.0	0, 4, 4, 0, 0, 0	12
Study 3											
Correctly reported	13	2.8	1.5	12	2.9	1.1	1 [i]	7	58.3	5, 6, 1, 0, 0, 0	8
Misreported	9	3.1	1.5	4	3.0	1.6	5	4	100.0	0, 1, 0, 2, 1, 0	11
Study 4											
Correctly reported	33	3.1	1.1	32	3.5	1.1	1 [i]	20	62.5	12, 9, 7, 1, 2, 1	39
Misreported	25	3.0	1.0	14	3.1	0.8	11	13	92.9	1, 2, 9, 1, 1, 0	27
Study 5											
Correctly reported	24	3.0	0.8	24	2.8	1.0	0	16	66.7	8, 12, 4, 0, 0, 0	20
Misreported	16	2.6	1.4	14	2.6	1.0	2	13	92.9	1, 2, 5, 5, 1, 0	31
All five studies											
Correctly reported	243	3.1	1.1	240	3.0	1.1	3 [i]	146	60.8	94, 104, 33, 5, 2, 2	203
Misreported	186	3.1	1.1	97	2.6	1.0	89	89	91.8	8, 25, 34, 24, 6, 0	189

[a] Table 1 provides information about the sample and design for each study.

[b] For school breakfast each day, children selected a *cold* (i.e., ready-to-eat [RTE] cereal, graham/animal crackers, milk, and juice [or rarely fruit]) or a *hot* (i.e., non-RTE-cereal entrée [e.g., sausage biscuit; pizza; bagel], milk, and fruit [or sometimes juice]) option.

[c] Reported items from dietary recalls were considered as reported eaten for school breakfast only if the child identified *school* as the location, referred to breakfast as *school breakfast* or *breakfast*, reported the mealtime to within one hour of the observed mealtime, and reported consuming nonzero quantities of items. If all of these criteria were met, then a recall contained a *breakfast report*.

[d] Examples of items reported eaten that differed from items observed eaten and were classified as *intrusions* included RTE cereals (e.g., flake-shaped observed, donut-shaped reported), milk flavors (e.g., strawberry observed, white reported), and fruit juices (e.g., orange observed, grape reported). Examples of items reported eaten that were similar to items observed eaten and were classified as *matches* included all kinds of white milk (e.g., whole, 1%, skim) and all types of breakfast pizza (e.g., cheese, sausage).

[e] Observed information for a child on a school morning was used to classify a breakfast option *observed* eaten as *cold* (if RTE cereal and/or graham/animal crackers was/were observed eaten), *hot* (if a non-RTE cereal entrée and/or fruit was/were observed eaten), *mixed* (if RTE cereal and/or graham/animal crackers was/were observed eaten as well as a non-RTE cereal entrée and/or fruit, with one or more items from the non-selected option obtained in a trade), *beverage only* (if only milk and/or juice was/were observed eaten), or *nothing* (if none of the breakfast was observed eaten).

[f] Information from a breakfast report was used to classify a breakfast option *reported* eaten as *cold* (if RTE cereal and/or graham/animal crackers was/were reported eaten), *hot* (if a non-RTE cereal entrée and/or fruit was/were reported eaten), *mixed* (if RTE cereal and/or graham/animal crackers was/were reported eaten as well as a non-RTE cereal entrée and/or fruit), *beverage only* (if only milk, juice, and/or some other beverage was/were reported eaten), or *no meal reported met criteria to be considered school breakfast*.

[g] A breakfast option reported eaten was further classified as *correctly reported* if it was the same as an option observed eaten for the respective dietary recall; otherwise, it was classified as *misreported*. Examples of options reported eaten that were classified as correctly reported included cold observed and reported; hot observed and reported; mixed observed and reported; and beverage

only observed and reported. (Note, an option was classified as correctly reported even if all items reported eaten were intrusions.) Examples of options reported eaten that were classified as misreported included cold observed but hot reported (and vice versa); mixed observed but cold reported (and vice versa); beverage only observed but hot reported (and vice versa); and cold, hot, mixed, or beverage only observed but no meal reported met criteria to be considered school breakfast.

[h] The proportion of intrusion-free breakfast reports was greater when an option was correctly reported than misreported for Study 1 ($p = 0.0003$), Study 2 ($p = 0.0026$), Study 4 ($p = 0.0177$), and Study 5 ($p = 0.0335$) as well as for all five studies combined ($p < 0.001$), but not for Study 3 ($p = 0.0597$) (two-sample tests of proportion). For all five studies separately and combined, the frequency distributions of breakfast reports with zero to five intrusions for correctly reported versus misreported options differed (p values < 0.0422, Fisher's Exact Tests). When intrusion-free breakfast reports were excluded, the frequency distributions of breakfast reports with one to five intrusions for correctly reported versus misreported options differed for Studies 1, 3, and 5 as well as for all five studies combined (p values < 0.0456), but not for Studies 2 and 4 (p values > 0.2181) (Fisher's Exact Tests).

[i] Nothing was observed eaten at three school breakfasts for one child in Study 1 (reverse-order prompts), one child in Study 3 (open format), and one child in Study 4 (previous day target period in an evening interview); two of these interviews did not contain meals that met criteria to be considered school breakfast, and for one interview (in Study 1), a child denied eating breakfast that day or ever.

Table 3

Number and percent of intrusions by meal component and study when a breakfast option was correctly reported and misreported [a]

Breakfast option reported	Meal component categorization of intrusions [b]														
	Beverage		Bread/grain		Combination entrée		Condiment		Fruit		Meat		Vegetable		*Total*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Study 1															
Correctly reported	52	49.1	26	24.5	15	14.2	4	3.8	7	6.6	2	1.9	0	0.0	*106*
Misreported	47	43.5	59	54.6	1	0.9	0	0.0	1	0.9	0	0.0	0	0.0	*108*
Study 2															
Correctly reported	18	60.0	6	20.0	0	0.0	3	10.0	2	6.7	1	3.3	0	0.0	*30*
Misreported	5	41.7	5	41.7	1	8.3	0	0.0	0	0.0	1	8.3	0	0.0	*12*
Study 3															
Correctly reported	5	62.5	1	12.5	0	0.0	0	0.0	0	0.0	1	12.5	1	12.5	*8*
Misreported	5	45.5	5	45.5	0	0.0	1	9.0	0	0.0	0	0.0	0	0.0	*11*
Study 4															
Correctly reported	23	59.0	5	12.8	3	7.7	3	7.7	1	2.6	4	10.3	0	0.0	*39*
Misreported	13	48.2	12	44.4	1	3.7	0	0.0	1	3.7	0	0.0	0	0.0	*27*
Study 5															
Correctly reported	12	60.0	3	15.0	1	5.0	1	5.0	2	10.0	0	0.0	1	5.0	*20*
Misreported	14	45.2	16	51.6	1	3.2	0	0.0	0	0.0	0	0.0	0	0.0	*31*
All five studies															
Correctly reported	110	54.2	41	20.2	19	9.4	11	5.4	12	5.9	8	3.9	2	1.0	*203*
Misreported	84	44.4	97	51.3	4	2.1	1	0.5	2	1.1	1	0.5	0	0.0	*189*

[a] Table 1 provides information about the sample and design for each study. Footnote b of Table 2 provides information about breakfast options from which children could select each school day. Footnote c of Table 2 provides information about criteria for reported items to be considered as reported eaten for school breakfast. Footnote d of Table 2 provides examples of items classified as intrusions. Footnote e of Table 2 explains how observed information for a child on a school morning was used to classify a breakfast option observed eaten. Footnote f of Table 2 explains how information from a breakfast report was used to classify a breakfast option reported eaten. Footnote g of Table 2 provides information about how a breakfast option reported eaten was further classified as correctly reported or misreported.

[b] Examples of food items in each meal component: *beverage* (milk; juice); *bread/grain* (ready-to-eat cereal; graham crackers; animal crackers; waffles; pancakes; biscuit; French toast; grits; muffin; bagel; toast); *combination entrée* (sausage biscuit; pizza; breakfast on a stick [pancake wrapped around link sausage on a stick]); *condiment* (syrup; jelly; ketchup); *fruit* (apple; strawberries; peaches; banana; applesauce); *meat* (egg; sausage; yogurt; ham); *vegetable* (hashbrowns).

Table 4

Breakfast option observed eaten by reported eaten for each of the five studies by study-specific condition, and for all five studies combined [a], [b]

Breakfast option observed	Breakfast option reported [c]				
	Cold	Hot	Mixed	Beverage only	No meal reported met criteria to be considered school breakfast
	- - - - - - number of breakfasts - - - - - -				
STUDY 1					
Forward-order prompts					
Cold	*19*	1	0	1	5
Hot	21	*40*	2	8	17
Mixed	0	1	0	0	0
Beverage only	1	1	0	*3*	1
Reverse-order prompts					
Cold	*27*	2	0	0	11
Hot	16	*31*	0	2	25
Mixed	1	0	0	0	2
Beverage only	0	0	0	*1*	2
Consistent [d]					
Cold	*14*	0	0	0	6
Hot	21	*50*	1	8	32
Beverage only	0	0	0	*2*	0
Inconsistent [e]					
Cold	*32*	3	0	1	10
Hot	17	*21*	0	2	10
Mixed	1	1	0	0	2
Beverage only	1	1	0	*2*	3
STUDY 2					
In person interview modality					
Cold	*7*	0	0	0	4
Hot	2	*14*	0	0	3
Mixed	1	0	0	0	0
Beverage only	0	0	0	*1*	1
Telephone interview modality					
Cold	*12*	0	0	0	0
Hot	3	*16*	0	0	0
Beverage only	0	2	1	0	0
STUDY 3					
Meal interview format					
Cold	*2*	1	0	0	1
Hot	2	*3*	0	0	0
Mixed	0	0	0	0	1
Open interview format					
Cold	*2*	0	0	0	0
Hot	1	*4*	0	0	3
Beverage only	0	0	0	*1*	0
STUDY 4 [f]					
Prior 24 hour target period in a morning interview (24M)					
Cold	*2*	0	0	0	1
Hot	1	*6*	0	0	0
Prior 24 hour target period in an afternoon interview (24A)					
Cold	*2*	0	1	0	0
Hot	1	*4*	0	0	0

Breakfast option observed	Breakfast option reported [c]				
	Cold	Hot	Mixed	Beverage only	No meal reported met criteria to be considered school breakfast
	- - - number of breakfasts - - -				
Beverage only	0	0	0	0	1
Prior 24 hour target period in an evening interview (24E)					
Cold	*2*	0	0	0	1
Hot	1	*3*	0	0	2
Beverage only	1	0	0	0	0
Previous day target period in a morning interview (PDM)					
Cold	*1*	1	0	0	1
Hot	1	*2*	0	0	1
Mixed	1	0	0	1	1
Previous day target period in an afternoon interview (PDA)					
Cold	*1*	0	0	0	0
Hot	2	*3*	0	1	3
Previous day target period in an evening interview (PDE)					
Hot	1	*6*	0	0	0
Mixed	1	0	0	0	0
STUDY 5 [f]					
Low-BMI group					
Cold	*7*	0	0	0	0
Hot	4	*3*	0	2	1
Beverage only	2	0	0	*1*	0
High-BMI group					
Cold	*8*	1	0	0	0
Hot	4	*5*	0	0	0
Beverage only	1	0	0	0	1
Prior 24 hour target period in an evening interview (24E)					
Cold	*11*	1	0	0	0
Hot	1	*3*	0	0	0
Beverage only	2	0	0	*1*	1
Previous day target period in a morning interview (PDM)					
Cold	*4*	0	0	0	0
Hot	7	*5*	0	2	1
Beverage only	1	0	0	0	0
24 CHILDREN IN STUDY 4 AND STUDY 5					
Consistent [d]					
Cold	*3*	1	0	0	0
Hot	6	*10*	0	1	1
Beverage only	1	0	0	0	1
Inconsistent [e]					
Cold	*7*	1	1	0	0
Hot	3	*4*	0	0	1
Mixed	2	0	0	0	1
Beverage only	2	0	0	*1*	1
ALL 429 BREAKFASTS BY 284 CHILDREN IN ALL 5 STUDIES					
Cold	*92*	6	1	1	24
Hot	60	*140*	2	13	55
Mixed	4	1	0	1	4
Beverage only	5	3	0	*8*	6

[a]Table 1 provides information about the sample and design for each study. Footnote b of Table 2 provides information about breakfast options from which children could select each school day. Footnote c of Table 2 provides information about criteria for reported items to be considered as reported eaten for school breakfast. Footnote e of Table 2 explains how observed information for a child on a school

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morning was used to classify a breakfast option observed eaten. Footnote f of Table 2 explains how information from a breakfast report was used to classify a breakfast option reported eaten. Footnote i of Table 2 provides information about three children who were observed to have eaten nothing at school breakfast.

[b]This table does not show individual rows for which all cell values = 0.

[c]In this table, cell values in *italics* indicate breakfast options reported eaten that were further classified as *correctly reported* (defined in footnote g of Table 2).

[d]The breakfast option observed eaten was *consistent* for 67 of 121 children who were each observed and interviewed twice for Study 1, and for 12 of 24 children who were each observed and interviewed once for Study 4 and once for Study 5.

[e]The breakfast option observed eaten was *inconsistent* for 54 of 121 children who were each observed and interviewed twice for Study 1, and for 12 of 24 children who were each observed and interviewed once for Study 4 and once for Study 5.

[f]In the separate analyses by study, for Study 4, the likelihood of misreporting an option was lower for 24M interviews than PDM interviews (OR = 0.080, $p = 0.036$), and for Study 5, the likelihood was lower for 24E interviews than PDM interviews (OR = 0.186, $p = 0.051$). As this table shows, for Study 4, misreported options for 24M were $1 \div (10 - 1) = 11\%$ and for PDM were $4 \div (10 - 3) = 57\%$, and misreported options for Study 5 for 24E were $4 \div (20 - 1) = 21\%$ and for PDM were $10 \div (20 - 1) = 53\%$.