Published in final edited form as:

Nutr Res. 2008 September ; 28(9): 600–608. doi:10.1016/j.nutres.2008.04.003.

Some intrusions in dietary reports by fourth-grade children are based on specific memories: data from a validation study of the effect of interview modality

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Abstract

In dietary recall for a specified target period, an intrusion denotes an item reported eaten that was not consumed during that period. Intrusions may denote items available during the specified period, items consumed during other periods, or items from general knowledge of dietary intake. To investigate a cognitive basis of intrusions, we analyzed data from a dietary-reporting validation study in which 69 fourth-grade children were observed eating two school meals (breakfast; lunch) and interviewed that evening about that day's intake in person or by telephone. Of 450 items reported eaten for school meals, 82 were intrusions. Observations and school foodservice production records were used to determine whether items denoted by intrusions were available in school foodservice environments on the interview day, as many as three school days prior to the interview day, and the day following the interview. Availability of items denoted by intrusions decreased backward over days from the interview day, and decreased from the interview day to the following day. Among 40 children who reported at least one intrusion, mean number of intrusions (controlling for number of items reported) increased as interviews occurred later in the week. These results are consistent with the idea that some intrusions are based on specific memories of items encountered but not eaten during the target period, or encountered before the target period. Other intrusions are likely based on general dietary knowledge. It may be possible to design interview techniques to reduce the occurrence of intrusions that are incorrectly based on specific memories.

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Keywords

validity (epidemiology); nutrition assessment; mental recall; diet surveys; child

1. Introduction

Information about what individuals eat is collected to investigate diet-disease relationships, to monitor whether the dietary intakes of populations meet public health goals, and to assess the effectiveness of public health interventions. One method used to collect such information is *dietary recall*, in which an individual is asked to report everything that he or she ate and drank during a specified target period [1]. For example, National Health and Nutrition Examination Survey respondents provide dietary recalls about two different, nonconsecutive 24-hr periods—once in person and subsequently by telephone [2,3]. For this survey, children as young as 12 years of age are asked to provide dietary intake information without the assistance of their parents [2]. The accuracy with which individuals report their dietary intake affects inferences about diet-disease relationships, about whether the intakes of populations meet public health goals, and about the effectiveness of public health interventions.

In validation studies conducted to evaluate the accuracy of dietary reports, information reported by individuals about their intake is compared to reference information about their intake obtained by another method that, ideally, does not rely on the individuals' memories (e.g., observation) [1]. When reported food items are compared to reference food items, two types of errors may be identified: Omissions are reference items that were not reported, and intrusions denote items that are not reference items. For example, in studies of fourth-grade children's dietary reporting accuracy, we have found notable intrusion rates (proportions of reported items that are intrusions), even when the interval between the end of the target period and the interview was brief and no meals intervened during that interval (e.g., [4,5]). Ideally, dietary data collection methods should minimize omissions and reporting of intrusions, and maximize reporting of matches (reference items that are reported) [6].

An understanding of the cognitive bases of intrusions might contribute to the design of protocols for collecting dietary information in which children would report fewer intrusions. For this article, we assessed the extent to which intrusions in children's reports about what they ate for specific school meals can be explained as being based on specific memories (e.g., about items from school meals other than those about which they are to report, or items available at but not eaten for the meals about which they are to report) rather than as being based on general knowledge of school meal intake. By a *specific memory*, we mean a memory representation that originates in reality as the result of a child's encounter with an item (e.g., consuming it; seeing it on his or her tray, or elsewhere in the school foodservice environment). (We consider only reports of school meals, because for only school meals was it feasible to collect reference information.) It is plausible that the occurrence of intrusions that are based on specific memories might be influenced by design aspects of the interview protocol (see, e.g., [7,8]). Therefore, finding that at least some intrusions are based on specific memories would motivate efforts to design interview protocols to reduce the occurrence of such intrusions.

For an individual asked to report dietary intake for a specified target period, the correct responses are items consumed during that period. Incorrect responses might include items encountered but not eaten during the specified period, items eaten or encountered during other periods, and items that the individual generally eats. Suppose that an individual who is to report dietary intake for a particular day generally drinks orange juice for breakfast, drank

orange juice for breakfast on the target day, and drank orange juice for breakfast on the day before the target day. The dietary recall instructions intend that a retrieved memory of orange juice be reported only if evaluation of that memory leads the individual to attribute that memory to the target day.¹

Intrusions may be based on specific memories that should not be reported. Many models of how information is represented in memory assume that context information is associated with item information [e.g., 10–13] and that such context information may be used to localize an item in a context or to judge whether an event actually occurred. If context information is represented with low fidelity, or decision processes during retrieval cannot discriminate information about similar contexts, items from contexts similar to the target context may be reported. Context information associated with memory representations of items available—but not eaten—for to-be-reported meals is likely very similar to context information associated with memory representations of eaten items. In addition, it is plausible that, other contextual aspects being equal (e.g., physical location; social environment), contextual similarity increases with temporal proximity, so that the context information associated with items available during temporally adjacent periods would be more similar than that associated with items available in temporally nonadjacent periods.

It is also possible that intrusions may be based on individuals' general knowledge of their dietary intake. Substantial evidence shows that reports and judgments are influenced by prior knowledge or assumptions; intrusions may be based on such knowledge (e.g., [9,14]).

Specific memories and general knowledge are not mutually exclusive potential bases of intrusions: In any dietary recall, some intrusions might be based on specific memories, whereas others might be based on general knowledge. (See [7] for an elegant demonstration of the occurrence in a single experiment of intrusions from two sources that are analogous to those we have discussed [although this experiment did not concern dietary intake reporting].)

For this article, we examined intrusions in data from a previously conducted dietary-reporting validation study in which each of 69 fourth-grade children was observed eating school breakfast and school lunch on a single day, and interviewed that evening about his or her dietary intake for that day [15]. For each child, intrusions for the two school meals were identified by comparing food items reported eaten for those meals to food items observed eaten at those meals.

We based two predictions on the idea that intrusions occur, at least in part, because the fidelity of the representation of context information associated with retrieved specific memories is low, or because decision processes during retrieval cannot perfectly discriminate context information for similar contexts. First, the availability in the school foodservice environment of a food item denoted by an intrusion should decrease as time (in days) before the interview increases. Intrusions in an evening interview about that day's intake should denote food items that were more available on the interview day than on the previous day, more available on the previous day than on the day before that, and so on. In addition, the availability of items denoted by intrusions should be higher on the interview day than on the day following the interview, because at the time of the interview, items available on the following day could not yet have been encoded with context information. Following day availability should be no higher than that for any other day. Second, unless

¹In a dietary-reporting validation study, a reported item that matches an observed item is scored as a match. In practice, researchers who conduct such validation studies have no way to determine whether the memorial basis of a match is a correct specific memory, an incorrect specific memory, or general knowledge (see [9, pages 272–273]).

children establish stricter reporting criteria as interviews occur later in the week, the later in the week that a child is interviewed, the likelier he or she should be to report at least one intrusion, and the more intrusions he or she should report (controlling for number of items reported). The environment in which school meals are eaten is similar from one school day to another, but differs from the environment in which meals are eaten on nonschool days; thus, over a week, memory representations of school meal items may accumulate that are difficult to discriminate.

In contrast, intrusions may be reports of items from an individual's general dietary knowledge. If so, then (as an alternative to the first prediction) the availability of items denoted by intrusions should not be related to time relative to the interview day, and (as an alternative to the second prediction) reporting of intrusions by individual children should not be related to time relative to the interview day. Certain items are omnipresent both in the school foodservice environment and in the diets of individual children. Therefore a child, when asked to recall his or her intake for a day, may report some items that he or she can attribute with certainty to that target day, but may supplement these reports by sampling his or her general knowledge of school meals, determining that some of these retrieved memories satisfy some criterion for being reported for the target day, and reporting those items. Some of these may be items that the child did not eat on the target day. If children report dietary intake this way, the availability of items denoted by intrusions would not depend systematically on time relative to the interview day, nor, controlling for number of items reported, would either the likelihood that a child would report an intrusion or the number of intrusions he or she reports be related to the number of days between the interview day and the last nonschool day.

2. Methods and materials

2.1 Participants and procedures

For this article, we evaluated these predictions by conducting new analyses on data from a study of the effect of interview modality (in-person versus telephone) on children's dietary reporting accuracy [15]. The original publication provides details concerning the participants and procedures; we summarize these here. Approval was obtained from appropriate institutional review boards for data collection and for the secondary analyses described in this article.

During the 2001–2002 school year, all 799 fourth graders from 10 elementary schools in one public school district were invited to participate; these schools were chosen to ensure selection of a sample of children with high school-meal participation. From the 451 children who provided written child assent and parental consent to participate in the study, 69 were selected randomly, subject to the constraint that there be roughly equal numbers in each of four race (black, white) $\times$ sex groups. The mean age of the 69 children, at the time of their interviews, was 10.15 years (SD 0.55 years).

Observations were conducted on Mondays through Thursdays over six weeks (except on two Monday holidays). Children who obtained meals at school were observed for entire meal periods. For as many as three children simultaneously, each observer recorded (a) the items on children's trays and (b) amounts of items eaten, in servings. Interobserver reliability was assessed throughout the study; over 10 assessments in each of which two dietitians observed the same child (who was not subsequently interviewed), the average agreement between observers to within $\frac{1}{4}$ -serving on amounts eaten was 93% [15]. Children knew in general that they were being observed, but did not know who would be interviewed or what the interview modality would be.

Within each race $\times$ sex group, children were assigned randomly to be interviewed in person or by telephone, but with half interviewed in each modality. Interviews were conducted between 6:30 p.m. and 9:00 p.m. on the observation day. Interviewers used a multiple-pass protocol. The child was to describe and quantify (in servings) everything consumed that day. In no case had the interviewer observed either of the interviewed child's school meals. Each interview was audio-recorded and later transcribed. Quality control for interviews was monitored by daily assessment of a randomly selected interview on a structured list of criteria, including agreement among the interview form, the audiotape, and a transcript of the interview typed by the interviewer following the interview; over these assessments of 22 of the 69 interviews, 97% applicable criteria were rated "adequate", and only 3% were rated "needs improvement" [15].

Reported items were treated as reports about items eaten at school meals only if the child identified "school" as the location at which the meal was eaten; referred to breakfast as "school breakfast" or "breakfast"; referred to lunch as "school lunch" or "lunch"; reported the mealtime within an hour of the observed mealtime; and reported consuming a nonzero quantity of the item [15]. For each child, each item reported for a school meal was classified as a match or as an intrusion according to whether the child was observed eating that item at that school meal. A reported item was treated as matching a reference item unless it was clear that the report did not describe an item that the child was observed eating; this might overclassify reported items as matches (and underclassify them as intrusions). Footnote b of Table 1 provides examples.

2.2 Availability of food items in school foodservice environments

For each intrusion reported for a school meal (breakfast or lunch), we were interested in the availability of that item in the school foodservice environment of the child who reported it at that meal on (a) the interview day (which was also the observation day), (b) each school day that preceded the interview day during that week, and (c) the day that followed the interview day, which was always a school day. All school days within each week were contiguous.

We constructed an item availability file in which each entry was a food item available in a particular school's foodservice environment for a particular meal on a particular day. The core set of 972 entries was compiled from school foodservice daily production records (completed by school foodservice personnel to comply with federal regulations). To these, we added 87 entries for items that children were observed eating but that were not in the production records. (As observations were not conducted at every school meal for which item availability was of interest, such ascertainment of availability by observation was not complete.) Finally, we added 84 entries for items that we assumed were available in particular school foodservice environments for particular meals even though those items were neither listed in the production records nor observed. For example, if hot dog was on the production record for a particular meal, but mustard was not, we assumed that mustard was available for that meal.

The production records listed certain items (e.g., milk, cereal, juice, jelly) in general terms, but never listed the specific kinds or flavors of these items. Among the items offered daily for breakfast were juice, ready-to-eat cereal, and graham or animal crackers; in addition, milk was available daily for both breakfast and lunch. Thus, we considered all kinds or flavors of milk, juice, ready-to-eat cereal, and crackers to have been available daily for breakfast, and all kinds and flavors of milk to have been available daily for lunch. These were included in the core set of entries. On days that jelly was available for breakfast, we considered all flavors of jelly to have been available; these, too, were included in the core set of entries. Ice cream, although never listed on the production records, was observed to be

available for purchase in the school foodservices of most schools on most school days; thus, we assumed that various kinds of ice cream were available at every lunch.

For each intrusion reported by a child for a school meal, we used the item availability file to determine whether the reported item was available in the foodservice environment of that child's school for that meal (a) on the interview day, (b) on as many school days during that week as preceded the interview day (from 0 to 3), and (c) on the day that followed the interview day.

Consider two examples from Wednesday interviews about Wednesday's intake: First, if a child reported drinking apple juice for school breakfast but had not been observed drinking apple juice, then apple juice was classified as an intrusion. The item availability file would have shown that all types of juice, including apple juice, had been available for breakfast in the foodservice environment of the child's school on the interview day, on each of the two school days before the interview day that week, and on the day that followed the interview day. Second, if a child reported having eaten a tuna sandwich for school lunch and had not been observed eating such a sandwich, then the tuna sandwich was classified as an intrusion. The item availability file would have shown information about the availability of tuna sandwiches for lunch in the foodservice environment of that child's school for the school days of that week (e.g., not available on Wednesday, available on Tuesday, and not available on Monday or on Thursday).

2.3 Analytic methods

We evaluated regression models in each of which a response variable was regressed on a time predictor and other plausible predictors (i.e., interview modality, sex, and race). Because any child could report multiple intrusions, tests used empirical standard errors from the modified sandwich variance estimator, so *P* values are conservative (see [16]).

Item availability—We used separate random effects logistic regression models to evaluate whether there were (a) a linear trend in availability of items denoted by intrusions over school days within the week of the interview, up to and including the interview day, and (b) a difference in availability between the interview day and the day that followed it. Models included a random error term for each child who reported at least one intrusion, so clustering of intrusions within children was expressed in the model, and also included interview modality, sex, and race.

Intrusions in children's reports—We used logistic regression to evaluate whether the likelihood that a child reported at least one intrusion depended on the number of days between the interview day and the preceding nonschool day. We regressed a binary indicator of whether a child reported at least one intrusion on number of school days before the interview day within the interview week, number of reported items, interview modality, sex, and race. To determine whether there was a trend in number of intrusions, controlling for number of reported items, over number of days within a week between the interview day and the preceding nonschool day, we evaluated a Poisson regression model in which we regressed the number of intrusions on number of school days before the interview day within the interview week, interview modality, sex, and race; we included number of reported items as an exposure variable.

3. Results

For school meals, the 69 children reported eating 450 items, of which 82 were intrusions. Forty children reported at least one intrusion; one child reported six. The top three rows of Table 1 show, for each interview modality, the number of children interviewed, the total

number of intrusions reported for two school meals, and information about intrusions per interviewed child. The fourth row of Table 1 shows the distribution for each interview modality of children with 0 to 6 intrusions; these were not statistically different ($P = .8$, two-tailed Fisher's exact test).

The bottom four rows of Table 1 show, for each interview modality, information about numbers of items observed eaten and numbers of items reported eaten for two school meals; we present means of both weighted and unweighted versions of these variables.² Children assigned to the two interview modalities differed significantly in none of these measures (every $t(67) < 1.37$; every $P > .17$). Further, mean intrusion rates (in-person: 0.19; telephone: 0.16; based on weighted numbers of items observed eaten and items reported eaten) did not differ significantly [15]. Although none of these comparisons suggested that interview modality systematically influenced intrusions, we included interview modality as a predictor in each regression model.

3.1 Item availability

Table 2 shows how many children reported various numbers of intrusions in interviews on days preceded by various numbers of school days during the week of the interview (e.g., each of five children reported two intrusions in an interview on the first school day of a week). For every intrusion, we ascertained the availability of the denoted item in the school foodservice environment of the child who reported it at the meal for which it was reported for the interview day, for any school day(s) before the interview day during that week, and for the day following the interview day. This binary indication of availability was the response variable in the regression analyses. For example, the tuna sandwich reported for school lunch in a Wednesday interview that was an intrusion would have contributed three cases to the analysis of whether there was a systematic trend in availability of items denoted by intrusions over school days up to and including the interview day during that week—one for Wednesday, one for Tuesday, and one for Monday. As shown in Table 2, given the numbers of intrusions reported on various days, there were 196 such cases for this analysis. For the comparison of availability between the interview day and the following day, there were 164 cases, because for every intrusion, availability could be ascertained for both the interview day and the following day.

The proportions of items denoted by intrusions available in school foodservice environments on the interview day and 1, 2, and 3 school days before the interview day were 0.78, 0.65, 0.53, and 0.53, respectively, and that for the day following the interview was 0.55. These are from ratios of 64/82, 36/55, 21/40, 10/19, and 45/82, respectively, in each of which the numerator is the number of items denoted by intrusions available on the specified day, and the denominator is the number of intrusions for which availability could be checked.³ (Availability could be checked for every intrusion for the interview day and the day following, but for decreasing numbers of intrusions for larger numbers of preceding days.) The proportion of items denoted by intrusions available in school foodservice environments tended to decrease backward in time from the interview day, and decreased from the interview day to the following day.

²In previous publications (e.g., [4,15]), we have weighted items, assigning a higher value to combination entrées and a lower value to condiments than to all other types of items (e.g., fruits; desserts; beverages). In the analyses for this article, all intrusions were treated equally, so unweighted values are more relevant.

³Of the 176 ascertainties that items denoted by intrusions were available in school foodservice environments at particular meals (which is the sum of the numerators of these ratios), only one was from an observation rather than from a core entry or an assumption. Core entries and assumptions were uniform over schools, days, and meals, whereas observations might have been biased: The item availability file would have included an observation-based entry only if an observer happened to observe a particular meal at a particular school. That only one finding was from an observation should assuage any concern that the pattern of proportions is a consequence of any such bias.

For the logistic regression of item availability on trend over school days up to and including the interview day, interview modality, sex, and race, $\chi^2(4) = 8.55$, $P = .07$. The coefficient for trend over school days up to and including the interview day was significant ($z = 2.74$, $P = .006$); for the coefficient of every other variable, absolute value of $z < 1.03$, $P > .3$. In a model with only school days as a predictor, $\chi^2(1) = 7.31$, $P = .007$; the odds ratio for the trend over days up to and including the interview day was 1.71, which is the daily increase in the odds that an item denoted by an intrusion was available in the school foodservice environment.

For the logistic regression of item availability on the difference between the interview day and the following day, interview modality, sex, and race, $\chi^2(4) = 12.83$, $P = .012$. The coefficient for the contrast between the interview day and the following day was significant ($z = -3.47$, $P = .001$); for the coefficient of every other variable, absolute value of $z < 1.04$, $P > .3$. In a model with only the contrast between days as a predictor, $\chi^2(1) = 12.19$, $P = .0005$; the odds ratio for the contrast was 0.19, which means that the odds of availability of an item denoted by an intrusion on the following day was 0.19 of the odds on the interview day.

Of the 82 intrusions, 42 were in reports of breakfast. These consisted of 23 beverages (12 milks, 11 juices), 11 breads/grains (7 ready-to-eat cereals, 3 crackers, 1 biscuit), 3 condiments, 2 fruits, 2 meats, and 1 combination entrée. As described earlier, all kinds or flavors of milk, juice, ready-to-eat cereal, and crackers were considered to be available at every breakfast, so 33 of the 42 breakfast intrusions could have been available at every breakfast. The other 40 intrusions were in reports of lunch. These included 13 beverages (10 milks, 3 juices), 8 vegetables, 5 fruits, 3 combination entrées, 3 entrées, 2 breads/grains, 2 condiments, 2 desserts, and 2 miscellaneous items (candy, chips). All kinds or flavors of milk were considered to be available at every lunch, so 10 of the 40 lunch intrusions could have been available at every lunch.

3.2 Propensity of children to report intrusions over days since the last nonschool day

The possibility that at least some intrusions result either from specific memories being encoded with low-fidelity context information, or from decision processes that cannot perfectly discriminate context information from similar contexts, suggests that over a week, intrusions will be increasingly likely in children's reports about their school meal intake for a single day. This would be reflected both in the likelihood that an interviewed child would report at least one intrusion and in the number of intrusions reported (given report of some number of items). One child reported no meals that met the criteria to be considered school meals; the analyses reported in this section are of data from the 68 children whose reports met the criteria.

For children interviewed on days such that there were 0, 1, 2, and 3 days between the last nonschool day and the interview day, the ratios of number of children whose reports included at least one intrusion to number of children who reported school meals were 15/21, 10/20, 9/16, and 6/11, respectively (see Table 2); these correspond to proportions of 0.68, 0.5, 0.56, and 0.55. The test of the logistic regression of the presence of at least one intrusion in a child's report on days, interview modality, number of reported items, sex, and race was not significant, $\chi^2(5) = 5.92$, $P = .31$. There was no systematic trend in proportion of children with at least one intrusion over number of days between the last nonschool day and the interview day.

For children who were interviewed on days such that there were 0, 1, 2, and 3 days between the last nonschool day and the interview day, mean intrusion rates were 0.21, 0.10, 0.22, and 0.26, respectively. Consistent with this pattern, the test of the Poisson regression of number

of intrusions on number of days, interview modality, number of reported items, race, and sex was not significant, likelihood ratio $\chi^2(4, N = 68) = 2.07, P = .72$. Thus, overall, hypotheses concerning the likelihood that children would report intrusions and concerning the likelihood that a reported item was an intrusion (controlling for number of reported items in each case) as interviews occurred later in a week were not supported.

Children who reported intrusions may have adopted laxer response criteria than children who did not; if so, the former children would have reported eating more items than the latter children. More items were reported eaten by the 40 children who reported at least one intrusion (*Median* = 7, interquartile range = 3) than by the 28 children who reported no intrusions (*Median* = 6, interquartile range = 3.5); $z = 1.59, P = .057$ (one-tailed Wilcoxon rank-sum test). We therefore analyzed the likelihood that a reported item was an intrusion (controlling for number of items reported) over days for the 40 children who reported at least one intrusion: For these children, mean intrusion rates for interviews with 0, 1, 2, and 3 school days between the last nonschool day and the interview day were 0.30, 0.19, 0.38, and 0.47, respectively. The zero-truncated Poisson regression of number of intrusions on number of days between the last nonschool day and the interview day, interview modality, number of items reported, sex, and race yielded a likelihood ratio $\chi^2(4, N = 40) = 11.95, P = .02$. Only the coefficient for days was significant ($z = 2.57, P = .01$); for the coefficient of every other variable, absolute value of $z < 1.29, P > .19$.

4. Discussion

4.1 Summary of results

From the assumption that context similarity decreases as temporal distance increases and the hypothesis that intrusions might be based on specific memories of uneaten items from the target period or items from periods before the target period, we predicted that availability in the school foodservice environment of school meal items denoted by intrusions would decrease over school days before the target day (which was both the observation day and the interview day), and decrease from the target day to the following day. These predictions were confirmed.

We also predicted that if children misattribute retrieved specific memories to the target period, (a) the likelihood that a child would report at least one intrusion would increase as the number of school days between the interview day and the last nonschool day increased, and (b) number of intrusions (controlling for number of items reported) would increase as the number of days between the interview day and the last nonschool day increased. Neither of these predictions was supported for the entire sample. However, the children who reported at least one intrusion tended to report having eaten more items than those who reported no intrusions, which suggests that the former children adopted laxer reporting criteria. For children who reported at least one intrusion, mean number of intrusions (controlling for number of items reported) tended to increase with number of days between the interview day and the last nonschool day.

4.2 Implications

These results implicate specific memories from periods that are temporally close to the target period, including the target period itself, as bases of intrusions in children's recalls of school meal intake, but do not implicate such specific memories exclusively. For example, although there was a trend of increasing availability of items denoted by intrusions in school foodservice environments over school days up to and including interview days, and items denoted by intrusions were more available on interview days than on days following interviews, over half of the items denoted by intrusions were available in school foodservice

environments on days following interviews. Items available on days following interviews could not have been intruded because they had been encoded with low-fidelity context information: At the times of interviews, those items had not been encoded with any following-day context information at all. The omnipresence of some items in school foodservice environments suggests that some items may be intruded because it is plausible to children that those items were consumed during the target period. General knowledge is likely a source of intrusions; that some intrusions are based on of specific memories about items encountered during periods before the target period does not preclude intrusions based on general knowledge.

Aspects of dietary-recall interviewing methodology may differentially affect intrusions based on specific memories and intrusions based on general knowledge. In the survey research literature, including items from prior periods in a report about a specified target period is called forward telescoping (e.g., [17–20]), which has been shown to be reducible by questioning techniques that appear to be effective by enhancing respondents' attention to temporal information [8,18,20]. In children's dietary recalls, intrusions based on specific memories from before the target period might be reduced by encouraging children to better use or resolve the context information—particularly temporal information—associated in memory with item information: The goal would be to design dietary-recall interview protocols that emphasize retrieval of context information and maximize the effectiveness with which it is used. For example, before beginning a dietary recall for a specified period, a child might be asked to report about other aspects of that period that might identify it uniquely (e.g., what he or she was wearing; what he or she studied in classes; with whom he or she interacted during school recess). Whether such an approach would reduce the occurrence of intrusions based on specific memories (and improve overall dietary-reporting performance) sufficiently to justify added monetary cost and respondent burden must be resolved empirically. However, even if intrusions based on specific memories were reduced, it may not be possible to reduce intrusion rates to zero, because there may be a rate of intrusions based on general knowledge that, in spite of cognitive effort by respondents, is irreducible [7].

4.3 Limitations and strengths

Among the limitations of this study, inherited from the original validation study, were the relatively small numbers of participating children and intrusions. The original validation study was designed to investigate the dietary reporting accuracy only of fourth-grade children, so provided no information about developmental trends in the reporting of intrusions. In addition, our knowledge of what each child actually ate was limited to school meals on one day.

That our analysis was limited to school meals may limit the generalizability of our conclusions. First, the extent to which items are recurring rather than unique in an individual's dietary environment may influence the overall level of intrusions; the extent to which items recur in school foodservice environments may be high due to daily availability of certain items at breakfast and lunch and to the use of repeating menu cycles by school foodservices. The children that we observed and interviewed obtained both breakfast and lunch in school, and so were members of a distinct subset of children who attend school. However, millions of children eat school meals each day [21]. Second, the omnipresence of certain items in the school foodservice environment limited our ability to discriminate between the explanations of the sources of intrusions that we considered: Many of the items that were denoted by intrusions were available in school foodservice environments every day, so it was impossible to know whether any intrusion was based on a specific memory or on general knowledge. In addition, because the production records were not specific for certain items (e.g., milk, ready-to-eat cereal, juice, crackers, jelly), we treated all types and

flavors of these items as available at the meals at which they were routinely served. To achieve more specificity in evaluating our hypotheses would require, at least, production records in which items were described more precisely. Even more specificity could be achieved by conducting dietary-reporting validation studies with consecutive days of observation per child; this would permit information about availability to be augmented by information about actual consumption by specific children.

The data for this study were collected over a six week period in the middle of a school year (viz., in January and February); thus, these data do not permit assessment of the relationship of dietary reporting performance (particularly the reporting of intrusions) to time of the school year at which data are collected.

The original validation study had several notable strengths. First, observation was used to validate children's reports. Second, the sex and race distribution of children who provided child assent and parental consent to participate mirrored that of the population of fourth-grade children at the schools from which children were recruited. Third, many more children agreed to participate than were interviewed, which made it difficult for individual children to know who was being observed and would be interviewed that evening.

4.4 Final remark

The results reported in this article suggest multiple bases of intrusions in the school meal parts of dietary recalls by children. Because particular interviewing approaches may reduce the occurrence of certain intrusions—specifically, intrusions based on specific memories—these results may contribute to devising strategies for improving dietary data collection. Children eat meals at which parents are not present (e.g., at school), so parents cannot be expected to report their children's intake at those meals. More accurate dietary recalls from children would permit more efficient and effective evaluation of diet-disease relationships, monitoring of whether the dietary intakes of populations meet public health goals, and assessment of public health interventions.

Acknowledgments

Data collection was supported by grant R01 HL63189 and analyses for this article were supported by grant R01 HL73081; both grants were from the National Heart, Lung, and Blood Institute, National Institutes of Health. S. D. Baxter was Principal Investigator of both grants. A. F. Smith was Principal Investigator of a subcontract of R01 HL73081.

We appreciate the cooperation of the students and staff of Blythe, Goshen, Gracewood, Hephzibah, Lake Forest Hills, McBean, Monte Sano, National Hills, Rollins, and Willis Foreman Elementary Schools, and the Richmond County (Georgia) School Nutrition Program and Board of Education. We thank J. Whitney Keener for assistance in preparing the manuscript.

Funding: National Heart, Lung, and Blood Institute, R01 HL63189 and R01 HL73081.

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Table 1

Summary statistics for a dietary-reporting validation study of two school meals (breakfast and lunch), by interview modality^a

	Interview modality	
	In-person	Telephone
Number of children interviewed	33	36
Number of intrusions reported for two school meals ^{b,c}	39	43
Mean (SD) number of intrusions reported for two school meals per interviewed child	1.18 (1.36)	1.19 (1.41)
Number of children who reported 0, 1, 2, 3, 4, 5, and 6 intrusions, respectively ^d	13, 9, 6, 4, 0, 0, 1	16, 8, 5, 4, 2, 1, 0
Mean (SD) weighted number of items observed eaten at two school meals ^e	8.4 (2.5)	8.9 (2.1)
Mean (SD) weighted number of items reported eaten at two school meals	6.7 (2.8)	7.2 (2.0)
Mean (SD) unweighted number of items observed eaten at two school meals	8.1 (2.7)	8.8 (2.2)
Mean (SD) unweighted number of items reported eaten at two school meals	6.1 (2.8)	6.9 (2.0)

^aEach of 69 fourth-grade children was observed eating two school meals and interviewed that evening about that day's intake either in person or by telephone. Within each of four race (black, white) × sex groups, assignment to interview modality was random, but with half interviewed in each modality.

^bAn intrusion is an item reported eaten at a school meal that was not observed eaten at that meal. For example, reported fruit juices (e.g., apple, orange), vegetables (e.g., green beans, broccoli), and milk flavors (e.g., chocolate, strawberry) that differed from what had been observed were classified as intrusions. However, any reported white milk (e.g., skim, whole) was classified as matching any observed white milk, and any reported pizza (e.g., cheese, pepperoni) was classified as matching any observed pizza.

^cReported items were treated as reports about items eaten at school meals only if the child identified "school" as the location at which the meal was eaten; referred to breakfast as "school breakfast" or "breakfast"; referred to lunch as "school lunch" or "lunch"; reported the mealtime to within an hour of the observed mealtime; and reported consuming a nonzero quantity of the item.

^dThese distributions were not statistically different ($P = .8$, two-tailed Fisher's exact test).

^eFor weighted items observed eaten and weighted items reported eaten, combination entrées (e.g., hamburger) were weighted twice as much as other types of items (e.g., fruits; vegetables; breads; desserts; beverages), and condiments (e.g., mayonnaise) were weighted one third as much. In the analyses for this article, all intrusions were treated equally, so unweighted values are more relevant. Children assigned to the two interview modalities did not differ significantly in any of weighted number of items observed eaten, weighted number of items reported eaten, unweighted number of items observed eaten, and unweighted number of items reported eaten (every $t(67) < 1.37$; every $P > .17$).

Table 2

Number of children with various numbers of intrusions in reports of two school meals (breakfast and lunch) in interviews on days preceded by various numbers of school days during the week of the interview, number of intrusions, and cases contributed to availability analysis^a

Number of intrusions per interview	Number of school days preceding the interview day during the week of the interview ^b				Row total children	Row total intrusions ^c
	0	1	2	3		
0	7 ^d	10	7	5	29	0
1	7	6	4	0	17	17
2	5	3	1	2	11	22
3	2	1	3	2	8	24
4	1	0	0	1	2	8
5	0	0	0	1	1	5
6	0	0	1	0	1	6
Column total children	22	20	16	11	69	
Column total intrusions ^e	27	15	21	19		82
Row total cases						
Cases contributed to analysis for trend in availability over days up to and including the interview day ^f	27	30	63	76	196	

^aFor information about the sample and design, see footnote a of Table 1. For the definition of intrusion and the criteria for reports to be treated as reports about items eaten at school meals, see footnotes b and c of Table 1, respectively.

^bDuring the six-week data collection period, there were two school holidays, each of which was on a Monday. The number of school days preceding the interview day during the week of the interview was 0 for all Monday interviews and for Tuesday interviews in weeks with a Monday holiday; 1 for Tuesday interviews in weeks that began on a Monday and for Wednesday interviews in weeks with a Monday holiday; 2 for Wednesday interviews in weeks that began on a Monday and for Thursday interviews in weeks with a Monday holiday; and 3 for Thursday interviews in weeks that began on a Monday.

^cRow total intrusions = (row total children) × (number of intrusions per interview) for that row.

^dOne child in this cell reported no meals that met the criteria to be considered school meals.

^eColumn total intrusions = sum over rows of ([number of children in row] × [number of intrusions per interview for the row]) for that column.

^fCases contributed to analysis for trend in availability over school days up to and including the interview day for each column = (column total intrusions) × (number of days for which availability could be ascertained [which is one more than the number of school days preceding the interview during the week of the interview]).