5-1-2010

Marketing Healthful Eating to Children: The Effectiveness of Incentives, Pledges, and Competitions

Sekar Raju
Iowa State University, sraju@iastate.edu

Priyali Rajagopal
Southern Methodist University

Timothy J. Gilbride
University of Notre Dame

Marketing Healthful Eating to Children: The Effectiveness of Incentives, Pledges, and Competitions

Abstract

This research examines how school administrators can motivate children to make more healthful food choices using incentives, pledges, and competitions as interventions. A six-month field study was conducted across 55 elementary and middle schools, and the authors analyzed the data using a two-level Bayesian hierarchical linear model. All three interventions increased the choice of fruits and vegetables (the proportion of children choosing additional servings increased 3 to 24 percentage points) ten weeks after the interventions ended. However, younger (Grades 1 and 2) and older (Grades 3–8) children responded differently to the interventions. Although both younger and older children responded more favorably to the competition intervention than to the pledge or incentive interventions, the effects of the competition and incentive interventions were more pronounced among the younger children. A second field study, also with schoolchildren, examined the role of pledge reminders on adherence to the pledge. The presence of a visible reminder of a pledge resulted in significantly better outcomes than no reminder of a pledge.

Keywords

children, healthful eating, competition, pledge, incentives, cognitive development, hierarchical Bayesian linear models

Disciplines

Early Childhood Education | Educational Leadership | Health and Physical Education | Marketing | Organizational Behavior and Theory

Comments

This accepted article is published as Sekar Raju, Priyali Rajagopal, and Timothy Gilbride (2010), “Marketing Healthful Eating to Children: The Effectiveness of Incentives, Pledges and Competitions.” Journal of Marketing, 74(3);93-106. Doi: 10.1509/jmkg.74.3.093. Posted with permission.

Marketing Healthy Eating to Children: The Effectiveness of Incentives, Pledges and Competitions

Sekar Raju

Priyali Rajagopal

Timothy J. Gilbride

Sekar Raju is Assistant Professor of Marketing, Iowa State University, Gerdin Business Building, Ames, IA 50011 (phone: 515-294 8463, email: sraju@iastate.com); Priyali Rajagopal is Assistant Professor of Marketing, Southern Methodist University, 6212 Bishop Blvd., Dallas TX 75275-0333, (phone: 214-768 3965, email: priyalir@smu.edu); Timothy J. Gilbride is Assistant Professor of Marketing, University of Notre Dame, 315 Mendoza College of Business, Notre Dame IN 46556 (phone: 574-631 9987, email: tgilbrid@nd.edu). The authors thank the P2 Collaborative of Western New York for conducting the first field study under the title "Be a Power Eater: The Good Food for Great Kids Program" and providing access to the data and the various donors who made it possible to conduct the first study. The authors are grateful to Roger Kerin, Nicole Montgomery, Betsy Moore, K V Rajagopal, Sridhar Ramaswami, Rao Unnava, and William Wilkie for their comments on previous versions of this paper. The authors also greatly appreciate the invaluable guidance of the editor and reviewers.

Marketing Healthy Eating to Children: Effectiveness of Incentives, Pledges and Competitions

This research examines how school administrators can motivate children to make more healthy food choices using incentives, pledges and competitions as interventions. A six month long field study was conducted across 55 elementary and middle schools and the data were analyzed using a two level Bayesian hierarchical linear model. It was found that all three interventions increased fruit/vegetable choice (the proportion choosing additional servings increased 3 to 24 percentage points) ten weeks after the interventions ended. However, younger (grades 1 and 2) and older (grades 3 to 8) children responded differently to the interventions. While both younger and older children responded more favorably to the competition intervention than the pledge or incentive alone interventions, the effect of the competition and incentive alone interventions were more pronounced among the younger children. A second field study, also with school children, examined the role that pledge reminders had on adherence to the pledge. It was found that the presence of a visible reminder of a pledge resulted in significantly better outcomes than no reminder of a pledge.

Keywords: children, healthy eating, competition, pledge, incentives, cognitive development, hierarchical Bayesian linear models

Research has shown that it is easier to develop healthy eating habits among children than in adults (Klein-Hessling, Lohaus and Ball 2005) and that eating patterns established in childhood tend to persist throughout life (Lien, Lytle, and Klepp 2001; Lowe et al. 2004). However, statistics indicate that children fail to meet the recommended daily consumption levels of fruits and vegetables in the United States (United States Department of Agriculture 2001). For example, one study reports that only 5% of elementary and middle school children had eaten the recommended servings of fruits and vegetables (Brady et al. 2000). A recent report by the CDC found that only 32% of high school students reported eating the recommended serving of fruits (2 servings) and only 13% reported eating the recommended servings of vegetables (3 servings) each day (CDC 2009a). These findings together suggest that children may be vulnerable to a variety of significant health risks due to a lack of adequate intake of healthy foods. However, if they can be motivated to eat healthy, the benefits are likely to be long-lasting. This underscores the need to examine ways by which children can be motivated to eat healthy.

In this regard, schools constitute an important environment that shape children's nutritional habits (Perez-Rodrigo and Aranceta 2001). With more than 53 million children in attendance in American schools on a regular basis, it is not surprising that schools are under increasing pressure to offer more healthy meals in their lunches. While increasing the availability of healthy foods at school lunches should improve children's diets, often school administrators face the additional challenge of successfully motivating children to choose the healthy foods. Our research focuses on exploring interventions that can help school administrators' market healthy food choices to children in their schools. To this end, we examine the effectiveness of three interventions (incentives, pledges, and competitions) that can be used to increase healthy eating choices among school children.

These interventions are compatible with four criteria important to school administrators – effectiveness, ease of implementation, scalability, and cost (e.g. Action for Healthy Kids 2004, 2006). Incentives, pledges and competitions can be implemented in an easy and relatively inexpensive manner. In addition, they can be scaled to large school settings as we demonstrate in our studies which examine the effects of these interventions in actual school settings. Pledges and competitions have been found to be effective at changing behavior in adult populations (e.g. Chen and Komorita 1994; Klem and Klesges 1988), but few studies have examined their application among young children. We suggest that the effectiveness of these interventions will depend on the level of cognitive development achieved by the child and predict that younger children (cognitively less developed) will respond differently to the interventions compared to older children who are more cognitively developed. To the best of our knowledge, this differential effect has not been examined in prior literature.

The data for this research come from two field experiments. Study 1 was conducted to test the effectiveness of competitions and pledges in changing food choices of students from 55 elementary and middle schools over a six month period. Overall, the results suggest that all the three interventions- incentives, competitions, and pledges, can improve healthy food choices, however, the relative effectiveness of the three interventions depends on the age-level of the children. Study 2 was conducted with children enrolled in an after school program to test the role reminders play in making pledge interventions work.

Our research makes several contributions to the literature on marketing healthy eating choices to children. First, it identifies incentives, pledges and competitions as viable mechanisms to motivate school children to make healthy food choices over a relatively long period of time. Since the effects of pledges and competitions as motivators of healthy food choices among children have not been studied, this research also contributes to our knowledge of child behavior. Second, it identifies cognitive development as a crucial factor moderating the effectiveness of incentives, pledges and competitions. Third, in line with the social marketing concept (Kotler and Zaltman 1971), it approaches the problem of motivating healthy eating in school children from the perspective of a school administrator and provides actionable ideas to implement a healthy eating program on a school or district wide basis.

We begin by summarizing some key findings from past research on incentives, pledges, and competitions as interventions. We then present our conceptual framework, report the results of two empirical studies conducted among school children, and conclude by summarizing our results and outlining some implications for school administrators and public policy makers.

Literature Review

Incentives, Pledges, And Competitions As Interventions

Incentives. Incentives as health interventions refer to any positive reward for changing or adhering to healthy behaviors. Thus, incentives can be monetary or non-monetary. Incentives have been widely used to promote a variety of behaviors including seat belt use (Geller, Patterson and Talbot 1982), recycling (Katzev and Pardini 1987), pedestrian cross walk use (Boyce and Geller 2000) and healthy eating among children (e.g. Thomas et al. 2003). The use of incentives as interventions follows from behavior modification theories that find that a reward increases the rate or probability of the behavior on which the incentive is contingent (e.g. Skinner 1953). The preceding review of the literature on incentives suggests that incentives can increase healthy eating choices among children. Thus,

H1: Providing incentives will increase healthy food choices compared to not offering incentives.

Pledges. Consistent with its dictionary meaning, a pledge is defined as “a promise or agreement to do or refrain from doing something.” In a healthy eating context, a pledge can be interpreted as a promise to eat more fruits and vegetables or to avoid eating unhealthy foods such as oils and fats. Research as diverse as increasing blood donation from potential donors (Pittman et al. 1981), use of safety seat belts in automobiles (Kello, Geller, and Rice 1988), eating healthy (Nooijer, de Vet, and Brug 2006), abstaining from premarital sex (Bearman and Bruckner 2001), and communicating intentions of commitment to the relationship (Anderson and Weitz 1992) has documented increased compliance when people pledge to undertake these behaviors compared to when they do not pledge. Typically, a pledge increases the level of commitment that is attached to the behavior. This increased level of commitment provides the internal motivation to behave in a manner consistent with the pledge.

Competitions. A competition is defined as the act of striving for some reward (e.g. profit, prizes, etc.) against some other person or group. In a healthy eating context, having children compete for rewards such as recognition or prizes by challenging them to eat more fruits and vegetables can be considered as the implementation of a competition intervention. Competition between individuals or groups of individuals has been used as an intervention to promote healthy behaviors such as weight loss (Brownell et al. 1984; Klem and Klesges 1988) and smoking modification (Hessol 1986). The underlying reason for the effectiveness of competitions is that people feel motivated to perform better when put in situations that allow them to compare their performance with another individual or group (Hinsz 2005). Research shows that competitions are more effective in eliciting the required behavior when individuals compete in teams than as individuals (Stunkard, Cohen and Felix 1989). This suggests that outcome performance is affected by intrinsic as well as extrinsic (social aspects) motivations.

An important limitation of the literatures on all the three interventions is the paucity of research that explores the effectiveness of these interventions on young children. Most studies have focused on adults (e.g. Chen and Komorita 1994; Stunkard, Cohen and Felix 1989), or on adolescents (e.g. Bearman and Bruckner 2001). Given the lack of prior research on young children, we refer to the literature in child development to make predictions about how these three interventions are likely to influence eating behaviors of young children. Specifically, we refer to the research on stages of cognitive development among children (e.g. Piaget 1970).

Stages Of Cognitive Development

The literature on childhood development suggests that a child's cognitive development is positively correlated with age (Piaget 1952, 1970). These developments involve changes in the cognitive processes that children are capable of, as well as their information processing abilities. According to this literature, children develop from relying on relatively less complex, action-based processes to more complex, mental-based processes as they grow older. Therefore, both the quantity and the quality of the information acquired and processed differ as the child ages. Although four stages (sensorimotor, preoperational, concrete operational, and formal operational) were identified by Piaget, we focus on three of these stages – preoperational, concrete operational and formal operational – which are applicable to our population of interest. We use age, or more specifically grade level, as an indicator for the stage of cognitive development. Although there is some disagreement whether age is the best indicator of developmental stage, it is fair to say that younger children are more likely to have less developed cognitive ability than relatively older children (Bahn 1986).

Children between the ages of four and seven (also referred to as younger children in this research) fall in the preoperational stage. In this stage, children's thought processes are still developing and they rely little on logical thought. They perform perceptual and affective tasks by focusing only on perceptual dimensions (e.g. color). They are capable of forming preferences but do not possess the cognitive complexity required for goal commitment (Piaget 1970). On the other hand, children between the ages of seven and eleven years of age are considered to be in the concrete operational stage These children are capable of logical thinking and have the ability to use more than one dimension, which may be perceptual, functional, or cognitive, in processing information (Ward, Wackman, and Wartella 1977). The formal operational stage begins at age twelve and continues into adulthood. This stage produces a new kind of thinking that is abstract, formal, and logical. Thinking is no longer tied to events that can be observed. A child at this stage can think hypothetically and use logic to solve problems (Piaget 1970). For the purposes of this research, formal operational and concrete operational children are grouped together and referred to as older children.

Effect of interventions across cognitive groups. Research has shown that children in the preoperational stage of cognitive development follow heteronomous thinking while concrete operational and formal operational children follow autonomous thinking (Nobes and Pawson 2003; Piaget 1970; Ruffy 1981). A characteristic of heteronomous thinking is rigidity of the rule; rules are fixed and cannot be changed. However, in autonomous thinking there is a greater realization that a rule is more of a social convention and that it can be changed based on circumstances. This pattern of development in thought underlies the moral responsibility that younger children feel in obeying authority compared to older children. This suggests that interventions initiated by authority figures (teachers, parents, etc.) are more likely to be complied with by younger children than older children, provided they have the cognitive capability to understand what they are being asked to do.

Young children seem to have the necessary cognitive capability to understand incentives and competitions. Past research has shown that children as young as four years of age demonstrate social comparison by rating themselves higher after doing better versus worse than another child (Butler 1989, 1998; Frey and Ruble 1985). Similarly, incentives have been found to be effective even with children as young as four years of age (Tapper, Horne and Lowe 2003). Therefore, incentives and competitions are more likely to be successful with younger than older children. Thus,

H2: Younger children will respond more favorably to incentives than older children.

H3: Younger children will respond more favorably to competitions than older children.

In the case of pledges however, while younger children may be more motivated to comply due to heteronomous thinking, they are less likely to be able to understand the implications of pledges due to their limited cognitive development and hence, may not be able to comply. Child development research has shown that keeping a promise, commitment or a pledge is a cognitively and linguistically difficult concept for children in the preoperational stage of cognitive development to understand (e.g. Astington 1988; Maas and Abbeduto 2001). Since these children do not possess the necessary cognitive capability to form commitments, they are less likely to adhere to the pledges they make. Older children in the concrete operational and formal operational stages possess the cognitive capabilities to form attachments and commitments (e.g. James 2001). Hence, they are more likely to understand the meaning and implication of pledges. Therefore,

H4: Older children will respond more favorably to pledges than younger children.

Effect of interventions within cognitive groups. A second implication of the argument that young children understand incentives and competitions and comply with them better than pledges is that within younger children, incentives and competitions are more likely to be successful than pledges. Thus, H5: Younger children will respond more favorably to incentives and competitions than pledges.

When it comes to older children, it is more difficult to make predictions about the relative efficacy of the three interventions. Although older children are cognitively better developed to understand all three interventions, the relative motivating effects of the three interventions are not clear. Further, past research on incentives, pledges and competitions provides little insight into the issue. However, it is of great practical importance to know which of these interventions is more effective with older children. Therefore, rather than state a formal hypothesis, we seek to empirically test the relative effects of incentives, pledges, and competitions among older children and leave it as an empirical research question.

These hypotheses were tested with school children in grades one through eight using a longitudinal field study (study 1).

STUDY 1

The objective of this study was to understand the moderating effects of cognitive development on the relative effectiveness of incentive, pledge and competition interventions on healthy eating choices among school children. The study consisted of three experimental conditions – "incentive only", "pledge+incentive", and "competition+incentive". Due to constraints imposed by the schools, incentives had to be offered to all the students in the study. That is, the pledge and competition conditions also included an incentive component. Our assumption is that pledges and competitions have an additive effect with incentives. Since an incentive only condition was present, the effects of pledge and competition over and above that of "incentive only" can be measured. For example, comparing the “pledge+incentive” condition to the “incentive alone” condition reveals the effects of the pledge intervention. If the “pledge+incentive” condition results are no different from the “incentive only” condition, it indicates that the pledge component of the intervention did not add anything above and beyond the incentive component. On the other hand, if the “pledge+incentive” condition results are superior to the “incentive only” condition, it indicates that the pledge component of the intervention has an added impact beyond that of the incentive component.

All students were told that those who selected two or more fruits and/or vegetables on any given day would be given a small incentive (e.g. pencils, stickers, key chains, etc.) and a chance for a bigger reward by random drawing if they selected two or more fruits and/or vegetables every day of the week (e.g. mountain bike, soccer balls, sneakers, etc.) The ”pledge+incentive” condition participants were told about the incentives and asked to make a personal pledge to eat more fruits and vegetables by signing their name on a special poster prepared for the occasion and placed in the classroom for the duration of the study. The “competition+incentive” condition participants were told about the incentives and were also told that they were in a friendly healthy eating competition with students at the same grade level from other participating schools. Past research has shown that competition with anonymous competitors elicits greater motivation than competition with known competitors (Yu, Han, and Chan 2008); hence, specific details of the other schools and participants were not revealed to the students. The prize was grant money to the top two schools. Since the proceeds of the win accrued to the school, the level of personal reward was maintained to be the same across the conditions, avoiding potential confounding.

Approximately 31,000 public school students in grades one to eight (ages ranging from five to fourteen years) participated in this longitudinal, multi-component field study conducted over a six month period. A local, not-for-profit organization was involved in its implementation. Participating schools were provided an enhanced lunch menu during the study period. While the standard lunch menu offered one fruit and one vegetable, the enhanced menu consisted of two fruits and two vegetables. The new menu and the benefits of healthy eating were also communicated to students through flyers, banners, posters, and regular public announcements over the intercom. Teachers were encouraged to discuss healthy eating in the classroom and a local radio station that was popular with school children was involved in promoting the program over the air.

A stratified random sampling was used to assign the 55 schools to the three study conditions mentioned previously. First, schools were stratified based on their enrollment size, academic performance status, and cafeteria style (the schools in the study offered both traditional cafeteria-styled lunches and pre-packed, bag lunches). After this stratification, schools were randomly assigned to one of three study conditions. Thus, all students in a particular school belonged to the same intervention condition. This precluded the effect of discussing alternative interventions by students in different intervention conditions. The second independent variable was age. Since it was not possible to measure the age of the child directly, grade was used as a proxy measure. Grades one and two represented younger children (preoperational stage) and grades three to eight represented older children (concrete and formal operational stage).

Two fruits and or vegetables were used as the cutoff because informal discussions with the cafeteria staff indicated that students mostly chose only one-either a fruit or vegetable with their lunch. Therefore, ignoring the first fruit and vegetable serving allowed us to control for the default choice that would have happened even without the intervention thereby providing a more conservative test of the hypotheses.

Procedure

Six weeks prior to the start of the main study, two baseline measures were collected. These baseline measures helped to rule out the possibility that any increase in fruit and/or vegetable choice during the intervention periods could be attributed to the increased availability or novelty of fruits and vegetables from the new menu. For a one week period, the same enhanced menu that was used during the main study was provided to students in the participating schools and their daily fruit and vegetable selection was recorded. However, no mention was made about why the new menu was offered. The following week, the enhanced menu was withdrawn and student's fruits and vegetable choice with the regular menu was recorded. A repeated measures ANOVA conducted on the two measures revealed no significant differences indicating that an enhanced menu by itself would not increase fruit and vegetable choice in the absence of other interventions ($M_{enhanced}$ = .44, $M_{regular}$ = .45, F (1, 731) = 2.16, $p > .1$).

The main study was conducted over six consecutive weeks and the daily choice of fruits and vegetables was recorded for each student in each school (W1, W2, W3, W4, W5 and W6). At the end of the sixth week, all students were told that the healthy eating program had ended. The pledge poster board was removed from the "pledge+incentive" condition classrooms and the "competition+incentive" group students were told that the winner would be announced soon (winners were announced after all the data collection was completed.) In the week immediately following the main study, the enhanced menu was again provided and choice recorded to track short-term follow-up behavior (SF). Finally, ten weeks after the completion of the main study, long-term follow-up behavior (LF) was tracked by again offering the enhanced fruit and vegetables menu for a week and recording choice (see Table 1 for the timeline). Therefore, the study was designed as a 3 (intervention: incentive only, pledge+incentive, or competition+incentive) x 2 (age: younger or older children) x 9 (time:

Baseline, W1, W2, W3, W4, W5, W6, SF, LF) mixed factorial design with intervention and age as between-subject variables and time as a within-subject variable.

All data were collected by the cafeteria staff. These staff members, as part of their daily normal activity, routinely record student's lunch choices for billing purposes. In addition to that task, they also kept a record of whether the student took two or more fruits/vegetables for the study. The possibility of errors in data collection was minimized by providing extensive training in recoding data. Random checks by the researchers were also conducted periodically to verify the accuracy of the data.

The primary goal of marketing healthy eating to children is to foster sustained change in food choice. Therefore we focus on the long-term follow-up condition (LF) 10 weeks after completing the intervention for hypothesis testing. For qualitative insights and completeness we report results for all weeks (see Tables 2 and 3 and Figure 1), but do not elaborate on week to week variations.

Insert Table 1 here

Data. Because of privacy concerns, individual choice data was aggregated to the homeroom level by the schools and reported to us as a count of the students who took two or more fruits or vegetables each day in each homeroom. Therefore, the unit of analysis for this study was at the homeroom level. In addition to the count, the total number of students in each homeroom was also reported. Since the number of students in each homeroom differed within and across schools, the counts were converted to proportions to indicate the relative number of students in each homeroom choosing two or more servings of fruit and vegetables for each day of the week. This daily data was then aggregated to form weekly averages for each homeroom to aid computational convenience. When only a small subset of data was missing, an 80% cutoff rule was used to compute weekly averages. That is, if four out of five day's data was available, it was used to calculate the weekly average. However, if two or more day's data was missing, it was considered as missing data.

Data from a total of 1,659 homerooms were available. After considering the missing data, complete data was available for 646 (39%) homerooms. The primary reason for the missing data was a lack of recording of the fruit or vegetable choice by the cafeteria staff. Even though the staff was told of the importance of recording data on all days, some stopped recording data during particularly busy periods, when understaffed, or due to lack of interest in complying with our request. Although data was not recorded, students continued to receive the enhanced menu. An analysis of the homerooms with missing data using the different independent variables (study condition, enrollment size of school, pre-pack, grade, and academic performance) did not show any systematic differences suggesting that the missing data was a random occurrence.

Insert Table 2 here

The top part of Table 2 presents summary statistics for the proportion of students choosing additional fruits and vegetables in the pre-study baseline week with the enhanced menu. In the baseline week, the proportion choosing fruits/vegetables differed between study conditions for both the younger and older students ($F_{younger}(2, 200) = 11.06$, $p <.01$; $F_{older}(2, 442) = 23.35$, $p <.01$). We control for this difference in the statistical modeling of the results and focus our attention on the absolute change over the baseline in each study condition.

Method of Analysis

We used a two level hierarchical linear model (HLM) to analyze the data because homerooms were within the randomly assigned study condition schools and there is a possibility that the different homerooms within each school were correlated with study condition, thus displaying less variance than if a truly random sample was used. To estimate the variance in outcomes due to data nesting, HLM analysis is used to account for homeroom (level 1) and school (level 2) variance separately.

Linear models with fixed and random effects were estimated. The dependent variable in each analysis is the proportion of students choosing an additional fruit/vegetable. We are specifically interested in the effects of the intervention, age, and time. The basic model is represented as:

$$y_{ijt} = \underbrace{\beta_1 + \beta_2 x_{2ijt} + \beta_3 x_{3ijt} + \sum_{l=1}^{8} \lambda_l w_{lijt}}_{fixed\ effects} + \underbrace{\varphi_j + \gamma_{ij} + \varepsilon_{ijt}}_{random\ effects} \tag{1}$$

where y_{ijt} is the dependent variable for homeroom *i*, from school *j*, in week *t*. The variable x_{2ijt} equals one if the homeroom is in the "competition+incentive" condition and zero otherwise, while x_{3ijt} equal to one indicates the "pledge+incentive" condition and zero otherwise. We control for the differences in the baseline week with three intercepts: β_1 is the baseline mean for the "incentive only" condition, $\beta_1 + \beta_2$ is the baseline mean for the "competition+incentive" condition, and $\beta_1 + \beta_3$ is the baseline mean for the "pledge+incentive" condition. Time is captured with the dummy coded w_{lijt} variables where $l = 1 \ldots 6$ indicates week 1 through 6; $l = 7$ is week SF and $l = 8$ is week LF. Random effects are accommodated by $\varphi_j \sim N(0, \sigma^2_{school})$ for school, $\gamma_{ij} \sim N(0, \sigma^2_{hroom})$ for homeroom, and $\varepsilon_{ijt} \sim N(0, \sigma^2_{error})$ for observational error.

Model based effects for each treatment condition and week are obtained by examining the appropriate coefficients. The increase in week 1 is given by λ_1, week 2 by λ_2, etc. An additional model investigating interactions between intervention and time was estimated to determine if there are differences in weekly effects between "competition+incentive" and “pledge+incentive” conditions. As noted below, it is necessary to combine coefficients to get the overall effect of an intervention in a particular week (see coefficients in Table 3). To compare the effect of age, separate models were estimated for younger and older children.

We conducted additional analyses to ensure the robustness of our findings. First, we checked the results by pooling the data and estimating a model where “grade” was entered as a continuous variable with interaction effects. Second, we estimated additional models with the sample stratification variables (enrollment, academic performance status, and cafeteria style) included as covariates. The substantive results were the same under these different models which suggests that the findings detailed below are robust to the assumptions made about the model.

The models are estimated using Markov Chain Monte Carlo (MCMC) simulation methods and a Bayesian approach to inference is adopted (for information on the MCMC estimation algorithm and diagnostics used, please see the Web Appendix.) As noted by Goldstein (1995, p. 23), a Bayesian method has “the advantage, in small samples, that it takes account of the uncertainty associated with the estimates of the random parameters and can provide exact measures of uncertainty.” Although the total number of week by homeroom observations is high, (1,827 for the younger children, 3,987 for older children) as is the number of homerooms (203 for the younger children, 443 for the older), the number of homerooms within condition (ranging from 34 to 206) and the number of schools is relatively low (24 for the younger and 36 for the older children). Bayesian methods also permit calculating exact posterior probabilities for quantities of interest. This will facilitate testing effects which involve combinations of coefficients as well as tests across models e.g. comparing younger and older children.

Results

Table 3 presents the coefficients and model fit statistics for the younger and older students, for models with and without interactions between intervention and time. The log marginal density (LMD) of Newton and Raftery (1994) and the modified Akaike Information Criteria (AICM) of Raftery et al. (2007) are used for model selection. Both measures include an implicit penalty for the number of parameters and favor the model with the highest value; in this case, both measures favor Model 2 with interactions between intervention and time for the younger and older children.

Insert Table 3 here

Simulation based MCMC methods produce “draws” or a “sample” of parameter values from their posterior distribution. These draws are averaged in order to summarize the results. Table 3 shows the average or posterior mean of the model coefficients. Effects which involve adding together parameters (such as $\lambda_1 + \lambda_{1\times comp}$ for the week 1 increase in the “competition+incentive” condition) are calculated by combining the parameters on each draw and then averaging across the draws. Posterior probabilities are used to calculate the “significance” of parameters and effects. In a Bayesian analysis we can directly calculate the probability that ($\theta_i > 0$), ($\theta_i < 0$), or ($\theta_1 > \theta_2$), etc. where θ_i is any parameter or effect of interest. We will indicate this posterior probability by *Pr* in order to distinguish it from the frequentist *p* value (a *Pr* > .95 is analogous to *p* < .05). Similarly, we can calculate the *highest posterior density* (HPD) of a parameter or effect; the HPD is analogous to a frequentist confidence interval. Direct interpretation of the coefficients show that many of the intervention by time interactions are different from zero (Table 3). Since there are interactions and many of the effects require combining coefficients, pertinent results are presented in Table 2 and graphically in Figure 1.

Insert Figure 1 here

Our hypotheses require several comparisons. All the comparisons utilize the model results (Table 3) that are summarized in the lower part of Table 2 and graphically in Figure 1. As explained previously, all hypotheses are tested in the long term follow up week, LF.

For ease of exposition, we hereafter refer to the "incentive only" condition as the "incentive" condition, the "pledge+incentive" condition as the "pledge" condition, and the "competition+incentive" condition as the "competition" condition. We begin our analyses by examining whether the "incentive" condition produced significant results over the baseline (main effect) for both age groups. The results indicate that for both older and younger children, $Pr(incentive_{LF}>0) > .95$. Since younger and older children showed significant increases in the long term follow-up week, we conclude that the "incentive" condition increased the probability of choosing fruits/vegetables over the baseline when no interventions were offered. Thus, H1is supported. In addition, both "pledge" and "competition" conditions were also significantly greater than the baseline in week LF ($Pr(competition_{LF}>0)$ and $Pr(pledge_{LF}>0) > .95$) which can be explained by the fact that they each include the incentives.

Our expectation was that due to the prevalence of heteronomous thinking in younger children, incentives and competitions would be more effective among younger children than older children. In line with these expectations, the "incentive" condition elicited more favorable responses among younger children than older children ($Pr > .95$ in LF). Thus, H2 is supported.

Further, the “competition” condition also showed more favorable responses among younger children than older children (*Pr* > .95 in LF). Thus, H3 is also supported.

We expected that since older children would be sufficiently cognitively developed to understand pledges, they would respond more favorably to pledges than younger children. However, our results indicate that the “pledge” condition is not significantly different between younger and older children in week LF (*Pr* < *.90*). Therefore H4 is not supported. Possible reasons for this result are examined in the discussion section.

Since younger children understand incentives and competitions better than pledges, we expected that incentives and competitions would be more effective than pledges for younger children. As can been seen in Figure 1, “competition” did better than “pledge” and was significant at the *Pr* > .95 level in week LF. Further, there was no difference between the “incentive” and “pledge” conditions. Recall that the “pledge” condition included an incentive component and this lack of difference between the “incentive” and “pledge” conditions suggests that the pledge did not add anything above and beyond what was present with just incentives alone. This provides support for the contention that pledge interventions are not effective for younger children. Therefore, H5 is supported. In addition, for younger children, the “competition” condition showed a significant (*Pr* > .95) increase in the proportion of children choosing additional fruit/vegetables over and above the “incentive” condition in week LF.

Among older children, we found that “competition” was more effective than “pledge” in week LF at Pr > .95. Further, both “competition” and “pledge” resulted in a significant increase over the “incentive” condition in weeks LF (*Pr* > .90 or *Pr* > .95). Possible reasons for this pattern of effects are examined in the discussion section.

Discussion

The results of study 1 indicate that "incentive," "pledge," and "competition" resulted in significant increases in the choice of fruits and vegetables over the baseline period. Even ten weeks after the interventions ended, the proportion of children choosing two or more servings increased between 3 and 24 percentage points, all significantly greater than zero at $Pr > .95$. Importantly, and as predicted, the relative effectiveness of all three interventions depended on the age (and cognitive development) of the child. Within age groups, both younger and older children responded most favorably to "competition." Looking across age groups, younger children responded more favorably to "incentive" and "competition" than older children, but responded no better to "pledge" than older children.

Differences in ages are also apparent when comparing the "pledge" and "competition" interventions to the "incentive" condition. Our findings suggest that while simple incentives can motivate long term changes in healthy eating choices, competitions can add significantly to these changes for young and older children and pledges can add to changes in older children. For younger children, "pledge" did no better than "incentive" suggesting that pledges do not work very well for younger children. While our study did not examine the effect of pledges or competitions independent from incentives, past research does not offer any reason to believe that an interaction between these interventions and incentives is likely. Our results suggest that "competition" and, for older children, "pledge" may be more effective than "incentive" alone in motivating healthy eating choices among school children.

The behavioral changes elicited by "competition" among younger children were significantly higher than the other conditions. Similarly, "incentive" also worked better for younger children compared to older children. Therefore, when the interventions are easily understood, younger children seem to respond more strongly than older children. This suggests that heteronomous thinking acts synergistically with the intervention and underscores the importance of targeting younger children with healthy eating interventions.

The pattern of effects of the three interventions among older children suggests that older children responded more favorably to both “competition” and “pledge” than to “incentive.” This result is consistent with the fact that the older children possess the cognitive capability to understand both competitions and pledges, and hence both interventions add to the effect of incentives alone. We also found that older children respond more favorably to “competition” than to “pledge,” suggesting that pledges may be less motivating than competitions.

Only one of our predictions was not supported by our empirical results. While we expected “pledge” to evoke more favorable responses among older children, we found no difference between the older and younger children. As suggested in the previous paragraph, one explanation for this result could be that the older children lacked the motivation to comply with the “pledge” intervention because of autonomous thinking. Thus, while they understood the concept of making a pledge, they were not sufficiently motivated to comply with it.

We believe that a second reason may better explain why the “pledge” condition was not found to be more effective with older children. We argue that an aspect of the study design may be the cause for this discrepancy. Notice that the effectiveness of “pledge” is consistently and significantly more effective for older children compared to younger children during the intervention weeks (see Table 2- W1 to W6; all $Pr > .95$). However, the effectiveness for older children starts to drop off significantly after the intervention period (from .15 in W6 to .07 in LF; $Pr > .95$). An eight percentage point drop does not occur in any other condition between W6 and LF. It could be that in the “pledge” condition, the pledge board that was prominently displayed in the classroom and removed at the end of the intervention period acted as a visible reminder (cue) of the pledge. Once it was removed the cue was lost. That could account for the steep drop off for older children. For younger children, since the pledge had no effect on them, a drop off was not expected nor found.

This explanation may also explain in a parsimonious way the earlier described result that "competition" was more effective than "pledge" for older children. Notice that a similar pattern of effects as described in the previous paragraph is also observed during and after the intervention period between "competition" and "pledge" conditions for older children suggesting that the drop off in the "pledge" condition may be the reason for this pattern of results.

The explanation that reminding children about their pledge may be critical for the success of pledge interventions is interesting and has practical implications for implementing such interventions. Therefore, we conducted study 2 to more fully examine this explanation.

STUDY 2

The objective of this study was to test whether a visible reminder about the pledge impacts eating choice. There is some evidence to support the notion that constantly reminding people about their pledge has a significant effect on the outcomes. For example, Hull (1997) conducted a study aimed at encouraging seat belt use. In this study, participants made a commitment by signing a pledge card and hanging it on the rear-view mirror of their car. This was designed to serve as a reminder of their pledge to wear seat belts. As expected, significant improvements were noticed in seat belt use in most of the categories studied. Similarly, Boyce and Geller (2001) provided their pledge participants with a card reminding them about their pledges and found significant compliance with the pledge in their study. However, when not reminded about the pledge, DeLeon and Fuqua (1995) found that pledge respondents did not differ from the control group participants. Thus, reminding participants about their pledge appears to make the pledge more salient and increases compliance. Hence, we posit that visible reminders or cues about pledges will increase their effectiveness.

H6: The effectiveness of pledges on eating choices will be better when a visible reminder of the pledge is present than when it is absent.

We conducted a field experiment with after-school program children to test this hypothesis. Thirty primary school children (M_{age} = 7.20, SD = 1.27) participated in the experiment. The study was a 2 x 3 mixed factorial design with the pledge cue (present or absent) being the between-subjects factor and day of measurement being the repeated measure (baseline, first day, and last day). We expected to find that more fruits would be chosen when a visible pledge cue was present compared to when it was not present.

Procedure

In addition to the regular snack that students received after school, five different cut fruits (melons, grapes, strawberries, etc.) were offered. Children were told that they could take as many or none of the fruits on offer. A record of how many of the five fruits on offer the child chose formed our measure for this study. Therefore, the recorded data took a value of zero to five for each participant. Counting the number of fruits taken rather than just recording whether or not a fruit choice was made resulted in greater variability in the data given the short duration of this study.

To familiarize children to the new snack offering and to control for novelty effects, the first day's data was discarded. The second day's data was used as the baseline measure. The next day, prior to snack time, children were given a talk on healthy eating by their teacher. They were told the importance of eating five fruits servings everyday. To help them eat more fruits, the teacher explained how they could keep it fun by eating fruits from different color groups (e.g. red fruits-strawberries, purple fruits-grapes, etc.) After this talk and associated activities (identifying different fruits, coloring fruit pictures, etc.) the children were invited to make a pledge to eat more fruits everyday. The teacher read out a pledge statement that the children repeated. Each child was then asked to walk up to the front of the classroom and write his/her name on a white board kept there as evidence of their pledge.

A coin toss was used to randomly assign children from one classroom to the pledge cue present condition and children from the other classroom to the pledge cue absent condition. In the pledge cue present condition, the white board on which the children signed their names pledging to eat healthy was placed in the dining room adjacent to the snack serving area. Thus, the board served as a reminder of the pledge they had made. In the pledge cue absent condition, the white board was removed from sight and kept in a cupboard for the duration of the study. The fruits were offered for the next five days during which time choice data was collected on the first and last day of participation for each child.

To summarize, we obtained a baseline measure of fruit choice before the start of the intervention. Subsequently, we measured fruit choice for the first and last day of the intervention period.

Analysis and Results

The data in this experiment represent the number of servings y of fruit chosen by child i at time t where y_{it} is an integer in the range zero to five. For each participant we have three observations, one at the baseline, one on the first day of the intervention, and one on the last day of the intervention resulting in a total of 90 (3x30) observations. To take full advantage of the discreteness of the data and the nesting within subject, a generalized HLM was fit to the data with a Poisson link function. Bayesian methods were used in order to accurately measure the uncertainty in this relatively small sample. The basic model is represented as:

$$y_{it} = f\left(\underbrace{\alpha_1 + \alpha_2 x_{2it} + \delta_1 d_{1it} + \delta_2 d_{2it} + \delta_3 c_{it}}_{\text{fixed effects}} + \underbrace{\kappa_i}_{\substack{\text{random}\\ \text{effect}}} \right) \tag{2}$$

Where x_{2it} is an indicator variable that observation y_{it} is from the cue present condition (for all days including the baseline), d_{1it} indicates that observation y_{it} is from the first day of measurement, d_{2it} indicates the last day of measurement, c_{it} indicates the cue present experimental condition, and the function $f(*)$ is the link to the Poisson model (details given in the Web Appendix). Under this parameterization, α_1 and $\alpha_1 + \alpha_2$ represent the servings of fruit chosen in the baseline prior to the intervention in each experimental condition; by chance, this baseline number differed between the two experimental conditions necessitating the use of two "intercepts." δ_1 captures the increase in fruit servings on day 1, δ_2 captures the increase on the last day of the interventions, and δ_3 captures the incremental increase attributed to the cue being present. Additional models that tested just the main effect of day or cue were also estimated.

Table 4 summarizes the results from selected models. Because the Poisson regression model is non-linear in the coefficients, just the pertinent effects are calculated and presented (see the Web Appendix for details). Model 1 is the "full" model with all main and interaction effects for day and cue. The no cue baseline of 3.09 is different from the cue baseline of 1.98 pieces of fruit and because this difference is not due to the experimental manipulations, it is controlled statistically. The primary reason for the difference in the mean baseline values was the presence of a larger number of children choosing the maximum offerings of fruit in the no cue condition compared to the cue condition. A separate analysis was run after dropping these participants. Without these participants, the baseline values were not significantly different between the two conditions ($p > .10$). More importantly, the effect of the cue was the same with or without these students included.

In the no cue condition, without the cue being visibly present, there was no increase in choice of fruit on either the first day ($Pr(Day\ 1_{no\ cue}) > 0 = .37$) or last day of the intervention ($Pr(Last\ Day_{no\ cue}) > 0 = .53$). However, in the cue condition, with the cue visibly present, there was a significant average increase of .90 pieces of fruit on the last day ($Pr(Last\ Day_{cue}) > 0 = .96$) and an increase on the first day of 0.45 pieces, although it was not statistically significant ($Pr(Day\ 1_{cue}) > 0 = .81$). Therefore, H6 is supported. Model 2 in Table 4 drops the insignificant effects from Model 1 and results in identical substantive conclusions; of all models tested, it was the preferred model on the basis of the LMD and AICM.

Insert Table 4 here

Discussion

This study provides an interesting insight into a moderator for the pledge condition, namely, cue visibility, and demonstrates that the effectiveness of pledges is determined by the presence of visible reminders of the pledge. While past research has identified the public versus private nature of pledges being important (Cialdini 1993), there has been little focus on the visibility of the pledge cue or the use of reminders as a tool to increase pledge compliance. Our results indicate that the use of visible cues or reminders can be critical in implementing an effective pledge intervention.

GENERAL DISCUSSION

Approximately 16% of children (over nine million) in the United States are considered obese and this number has tripled since 1980 (CDC 2009b). Since an important contributor to obesity is unhealthy eating choices, clearly, it is now more important than ever to find ways to help children make healthier eating choices. In this regard, it is specifically important to encourage children to eat more fruits and vegetables. As stated by Dr. William H. Dietz, director of CDC′s Division of Nutrition, Physical Activity, and Obesity, "A diet high in fruits and vegetables is important for optimal child growth, maintaining a healthy weight, and prevention of chronic diseases such as diabetes, heart disease and some cancers, all of which currently contribute to health care costs in the United States." (CDC 2009c)

Further, since school accounts for a major part of the daily life of a child, school administrators are being called upon to play a more active role in motivating children to make healthy food choices within and outside of school. Our research addresses this issue by focusing on school children and examining the effects of three interventions (incentives, pledges and competitions) in promoting healthy eating choices to them. The goal is to provide school administrators (our primary target group) with inexpensive, effective, scalable, and easy to implement ideas that they can apply in schools to get children to eat more fruits and vegetables. Although marketing researchers have examined the motivations that drive healthy food choices among consumers (e.g. Chandon and Wansink 2007; Raghunathan, Naylor and Hoyer 2006; Wansink 2006), their focus has been on adults. This research extends that line of research to children.

The results of study 1 show that incentives, pledges and competitions are all effective at increasing children's choice of fruits and vegetables over the baseline period, but that the age (and cognitive development) of the child determines which intervention is relatively more effective. Our second study finds that a necessary condition for pledges to be effective is that children be constantly reminded about the pledge.

An important contribution of this research is the demonstration of the viability of incentives, pledges and competitions as healthy eating interventions within the school system. As our study reveals, all three interventions are suitable for school wide implementation. Although the incentives provided in the pledge and competition conditions increased the cost of this program, the competition intervention by itself was relatively inexpensive and the pledge intervention had even fewer costs associated with it. These interventions seem to meet the requirements of cost, ease of implementation, and effectiveness that are important to school administrators.

Another major contribution of our work is the finding that there is a difference in the relative effectiveness of interventions and that the age of the children is an important consideration when choosing a promotional campaign. Comparing within age groups, one finds that competitions clearly worked the best for both younger and older children. Pledges had little effect on younger children, but worked better than incentives alone with older children. Incentives worked well in both age groups.

When comparing across age groups, competitions and incentives were more effective with the younger children compared to the older children, consistent with the research on heteronomous thinking that makes these children more complaint to requests by authority figures (Nobes and Pawson 2003). The finding with pledges, however, is not very clear. We expected pledges to do better with older children than younger children. A closer examination of the results shows that this was the case in all the weeks except in the LF. Thus, reminding children of their pledge may be an important contributor to its effectiveness. As seen in study 2, reminding participants about their pledge seemed to improve its effectiveness. We speculate that if we had continued reminding children about the pledge they made even after the study ended, we may have been able to get them to continue making healthier food choices on a longer term basis. However, that raises the question of how administrators can continue to remind children of their pledge. Perhaps, retaining the pledge boards in the classroom may be sufficient. Or, perhaps providing a wrist band or some other personal reminder may help (Boyce and Geller 2001). Future research on ways to remind children of their pledge would be important.

The finding that reminders are critical to pledges may also explain why DeLeon and Fuqua (1995) found that pledges did not work in their study - they did not remind participants of their pledge during the duration of the study. The need for a pledge reminder also raises an interesting issue of whether the initiator of the pledge matters. If the pledge is initiated by someone other than the person himself/herself (externally motivated) as was the case in our study, it may be important to continue to remind the person of the pledge to keep the commitment to the pledge from waning. However, if the pledge is initiated by the person himself/herself (internally motivated), it may not need a reminder. This is an issue that future studies may want to examine.

Implications

Based on our overall experience with this large scale field study and the specific empirical results, we summarize some key implications for school administrators and more broadly for health educators, health marketers, and public policy makers.

Start early. As our results suggest, it is critical to focus on younger children. These children (as early as grade 1) may be more amenable to changing their behaviors in response to interventions than older children (grades 3-8). Not surprisingly, we found the strongest effects with younger children in the competition condition and the drop-off with time was the least with this group.

Be age appropriate. Not all interventions work equally effectively across age groups. Understanding the interventions seems to be an important criterion. For younger children, pledges may not be effective and it may be advisable to use competitions or incentives with these children to get them to make healthier eating choices. However, it is important to note that the cost associated with implementing competitions or incentives is relatively greater than the cost of implementing pledges.

With older children, all three interventions worked. That is, all interventions improved significantly the fruit and vegetable choice compared to the baseline. Therefore, implementing any of these interventions should be effective with older children. However, since competitions worked better than pledges or incentives with these children, if cost is not an important consideration, competitions may be more effective. If cost is a restriction, then pledges may be the appropriate intervention to use.

Involve teachers. Authority figures seem to make a difference, especially with younger children. Involving teachers in implementing the interventions might help children in the heteronomous thinking stage to more faithfully follow the instructions provided. In both of our studies, teachers/care providers were instrumental in communicating the interventions. Apparently, this made younger children respond more strongly than older children. However, if children do not understand the intervention, even authority figures will not help.

Use multiple sources of influence. Rather than restrict to one source of influence, our studies used a variety of influences by involving teachers, a local radio station, peer pressure, etc. This multi component influence approach might help improve the chance of persuading children through one or more of the influencers and might be especially appropriate in a large school setting where individual attention is not possible.

Keep reminding children. There seems to be a general drop-off in choice as the weeks progressed. This decay might be less steep if children are reminded of the interventions on a regular basis. With pledges it is clear that reminders help. Past research has shown that even small environmental changes can have significant effects on food choice and consumption (e.g. Just, Mancino and Wansink 2007; Just et al. 2008). Our results add to this stream of research and indicate that simply making the pledge intervention cue highly salient can significantly increase the effectiveness of pledges.

Use school lunches to motivate healthy eating. Our research demonstrates that school lunches may be an effective and relatively easy context within which eating interventions can be implemented on a school wide basis. While we acknowledge that factors outside the school such as parental influence, food available at home, etc. are important variables that will impact eating behaviors, our results suggest that school level interventions can have sustained effects too (up to 10 weeks after the interventions end).

Enhance school lunch menu offerings. Increased availability of fruits and vegetables on school menus is important as otherwise, students cannot make healthy choices. Either increasing the number of fruits and vegetables or incorporating different fruits and vegetables in school menus can help during and after the interventions by providing an opportunity to sustain changes in their diet. In our studies, the enhanced menu was not offered on a sustained basis. This may have reduced the effectiveness of the interventions as students who wished to eat an additional serving of fruit/vegetable were unable to do so. It is important to remember, however, that even if children start eating the two (fruit and vegetable) options being offered with the regular menu, that itself will be a major improvement to the current situation where many children are not doing so. Changing school menus has significant cost implications that need to be considered by school administrators. Federal agencies, private agencies (e.g. food brand marketers) and parents may be required to bear these additional costs.

Another important implication from our results is that simply enhancing the availability of healthy foods, such as fruits and vegetables, may not be sufficient to enhance healthy eating choices among school children. Thus, in study 1, there was no significant increase in choice of fruits and vegetables in the baseline period when no interventions were run. Hence, increased availability may be a necessary but not sufficient condition to increase fruit/vegetable choice.

Use relatively long interventions. We also suggest that eating interventions be maintained for relatively long durations rather than for short periods of time. The longer durations would allow for an increase in children's familiarity with the healthy foods and this increased familiarity may increase their preference for such foods (e.g. Cooke 2007). Thus, offering an enhanced menu for long periods of time (e.g. more than a month) may be necessary to see sustained changes in eating behaviors.

Limitations and future research

Although care was taken in designing the studies, there are some important limitations to consider. First, since the school system required that incentives be offered to all students, we were unable to measure the effect of competitions and pledges by themselves. Thus, our pledge and competition interventions were not clean conditions, in that both these conditions included an incentive component too. While we make the reasonable assumption that incentives would have an additive effect on pledge and competition interventions, this assumption has not been actually tested in this study. Therefore, care is warranted while interpreting our results.

Second, study 1 has a large percentage of missing data (62%). Although such a large proportion of missing data or non response is common in field studies and we do not find systematic variations in the missing data across the conditions, the absence of this large a proportion of the data warrants caution in interpreting our results.

Third, we measure choice and not the actual consumption of the fruits and vegetables. It is possible, though unlikely given the length of the study, that children might have taken the fruit or vegetable to earn the prize but with no intention of eating the food. We minimize the effects of this problem by limiting our hypotheses testing to the long term follow up period (LF) where no prizes were offered and presumably reflects true choice.

Fourth, we make a case for cognitive ability and thinking style (heteronomous vs. autonomous) as the basis for our hypotheses. While we grouped children into different stages based on grade (as a surrogate for age), in practice, it may be important to administer tests to determine which stage a child belongs to since there is widespread agreement that age may not be the best indicator of cognitive development. Research has also shown that long term behavioral change requires attitudinal change (e.g. Conner, Norman and Bell 2002), but we were not able to measure attitudes towards healthy eating. Nor were we able to measure other individual level constructs such as memory/distraction, motivation, commitment, and/or persistence which may have a bearing on the results. Laboratory studies with a more controlled environment may be more conducive to test such process explanations.

Fifth, data for study 1 was collected with an enhanced menu. It is reasonable to ask the question whether these results would hold when the menu reverts to the regular menu. While we hope that there will be an increase in the proportion of school children choosing fruits and vegetables even when the regular menu (one fruit and one vegetable) is offered on a routine basis, we were unable to test this in the current study.

Finally, our studies focus on relatively short term results, up to 10 weeks after the interventions ended in study 1 and immediately after the interventions ended in study 2. Hence, future research should consider the longer term implications of health interventions, (e.g. a year or longer after the interventions end.) Nonetheless, this research further demonstrates the potential of school administrators and marketing researchers to collaborate in order to design campaigns to improve the food choices of children.

REFERENCES

Action for Healthy Kids (2004), "Criteria for Evaluating School-Based Approaches to Increasing Good Nutrition and Physical Activity," (accessed October 8, 2009), [available at http://www.actionforhealthykids.org/pdf/report_small.pdf]

Action for Healthy Kids (2006), "Helping Students make better food choices in school," (accessed October 5, 2009), [available at http://actionforhealthykids.org/pdf/Final%20Report%20-%20Color.pdf]

Anderson, Erin and Barton Weitz (1992), "The use of pledges to build and sustain commitment in distribution channels," *Journal of Marketing Research*, 29 (Feb), 19-34.

Astington, Janet W. (1988), "Children's understanding of the speech act of promising," *Journal of Child Language*, 15 (Feb), 157-173

Bahn, Kenneth D. (1986), "How and when do brand perceptions and preferences first form? A cognitive developmental investigation," *Journal of Consumer Research*, 13 (Dec), 382-93.

Bearman, Peter S. and Hannah Bruckner (2001), "Promising the future: Virginity pledges and first intercourse," *The American Journal of Sociology*, 106 (Jan), 859-911.

Boyce, Thomas E. and Scott E. Geller (2000), ", Thomas E. and Scott E. Geller (2001), "Encouraging College Students To Support Pro-Environment Behavior," Environment & Behavior, 33 (Jan), 107-126," *Environment & Behavior*, 32 (Jul), 502-520.

Boyce, Thomas E. and Scott E. Geller (2001), "Encouraging College Students To Support Pro-Environment Behavior," *Environment & Behavior*, 33 (Jan), 107-126.

Brady, Louise M., Christine H. Lindquist, Sara L. Herd, and Michael I. Goran (2000), "Comparison of children's dietary intake patterns with US dietary guidelines," *The British Journal of Nutrition*, 84 (Sep), 361-7.

Brownell, Kelly D., Rita Yopp Cohen, Albert J. Stunkard, Michael R. J. Felix, and Nancy B. Cooley (1984), Weight Loss Competitions at the Work Site: Impact on Weight, Morale and Cost-Effectiveness*,"* *American Journal of Public Health*, 74 (Nov), 1283-85.

Butler, Ruth (1989), "Mastery versus Ability appraisal: a developmental study of children's observations of peers' work," *Child Development*, 60 (Dec), 1350-61.

Butler, Ruth (1998), "Age trends in the use of social and temporal comparison for self-evaluation: Examination of a novel developmental hypothesis," *Child Development*, 69 (Aug), 1054-73.

CDC (2009a), "The State Indicator Report on Fruits and Vegetable, 2009," (accessed October 2, 2009), [available at http://www.fruitsandveggiesmatter.gov/indicatorreport]

CDC (2009b), "OBESITY: Halting the Epidemic by Making Health Easier, At A Glance 2009," (accessed October 3, 2009), [available at www.cdc.gov/NCCDPHP/publications/AAG/obesity.htm]

CDC (2009c), "Majority of Americans not Meeting Recommendations for Fruit and Vegetable Consumption," (accessed October 3, 2009), [available at http://www.cdc.gov/media/pressrel/2009/r090929.htm]

Chandon, Pierre and Brian Wansink (2007), "Is obesity caused by calorie underestimation? A psychophysical model of meal size estimation," *Journal of Marketing Research*, 44 (Feb), 84-99.

Chen, Xiao-Ping and Samuel. S. Komorita (1994), "The effects of communication and commitment in a public goods social dilemma," *Organizational Behavior and Human Decision Processes*, 60 (Dec), 367-386.

Cialdini, Robert B. (1993). *Influence: The psychology of persuasion*. New York: Quill.

Conner, Mark, Paul Norman and Russell Bell (2002), "The theory of planned behavior and healthy eating," *Health Psychology*, 21 (Mar), 194-201.

Cooke, Lucy J (2007), "The importance of exposure for healthy eating in childhood: a review," *Journal of Human Nutrition & Dietetics*, 20 (Aug), 294-301.

DeLeon, Iser G. and Wayne R. Fuqua (1995), "The effects of public commitment and group feedback on curbside recycling," *Environment & Behavior*, 27 (Mar), 233-50.

Frey, Karin S. and Diane N. Ruble (1985), "What children say when the teacher is not around: Conflicting goals in social comparison and performance assessment in the classroom," *Journal of Personality and Social Psychology*, 48 (Mar), 550-62.

Geller, Scott E., Lisa Paterson, and Elizabeth Talbott (1982), "A behavioral analysis of incentive prompts for motivating seat belt use," *Journal of Applied Behavior Analyis*, 15 (Fall), 403-413.

Goldstein, Harvey (1995). Multilevel Statistical Models. New York: John Wiley.

Hessol, Nancy A. (1986), Worksite Smoking Modification Competitions: Long-term vs. Short-term Success," *American Journal of Public Health*, 76 (Jul), 819-20.

Hinsz, Verlin B. (2005), "The Influences of Social Aspects of Competition in Goal-Setting Situations," *Current Psychology: Developmental, Learning, Personality, Social*, 24 (Winter), 258-73.

Hull, Clarence A. (1997) "The efficacy of a one-hour safety belt presentation on students in a first-year college wellness class," doctoral dissertation, Univ. of Southern Mississippi

James, Jeffrey D. (2001) "The role of cognitive development and socialization in the initial development of team loyalty," *Leisure Sciences*, 23 (Oct), 233-261.

Just, David R., Lisa Mancino, and Brian Wansink (2007), "Could Behavioral Economics Help Improve Diet Quality for Nutrition Assistance Program Participants?" Economic Research Report No. 43, U.S. Department of Agriculture, Economic Research Service.

Just, David R., Brian Wansink, Lisa Mancino, and Joanne Guthrie (2008), "Behavioral economic concepts to encourage healthy eating in school cafeterias: Experiments and lessons from college students," Economic Research Report Number 68, U.S. Department of Agriculture, Economic Research Service.

Katzev, Richard A. and A. Pardini (1987), "The impact of commitment and token reinforcement procedures in promoting and maintaining recycling behavior," *Journal of Environmental Systems*, 17, 93-113.

Kello, John E., Scott E. Geller, and Jorgia C. Rice (1988), "Motivating auto safety belt wearing in industrial setting: From awareness to behavior change," *Journal of Organizational Behavior Management*, 9 (Nov), 7-21.

Klein-Hessling, Johannes, Arnold Lohaus, and Juliane Ball (2005), "Psychological predictors of health-related behaviour in children," *Psychology, Health & Medicine*, 10 (Feb), 31-43.

Klem, Mary L. and Robert C. Klesges (1988), "Competition in a Minimal-Contact Weight-Loss Program," *Journal of Consulting and Clinical Psychology*, 56 (Feb), 142-44.

Kotler, Philip and Gerald Zaltman (1971), "Social Marketing: An approach to planned social change," *Journal of Marketing*, 35 (Jul), 3-12.

Lien, Nanna, Leslie Lytle, and Knut-Inge Klepp (2001), "Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21," *Preventive Medicine*, 33 (Sep), 217-26.

Lowe Fergus C., Pauline J. Horne, Katy Tapper, M. Bowdery and C. Egerton (2004), "Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children," *European Journal of Clinical Nutrition*, 58 (Mar), 510-522.

Maas, Fay K. and Leonard Abbeduto (2001), "Children's judgments about intentionally and unintentionally broken promises," *Journal of Child Language*, 28 (Jun), 517-529.

Newton, Michael, and Adrian E. Raftery (1994). "Approximating Bayesian Inference with the Weighted Likelihood Boostrap." *Journal of the Royal Statistical Society (B)*, 56, 3-48.

Nobes, Gavin and Chris Pawson (2003), “Children's understanding of social rules and social status,” *Merrill-Palmer Quarterly*, 49 (Jan), 77-99.

Nooijer, Jascha de, Emely de Vet, and Johannes Brug (2006), “Do implementation intentions help to turn good intentions into higher fruit intakes?” *Journal of Nutrition Education and Behavio*r, 38 (Jan), 25-29.

Perez-Rodrigo, Carmen and Javier Aranceta (2001), “School-based nutrition education: lessons learned and new perspectives,” *Public Health Nutrition*, 4 (Feb), 131-139.

Piaget, Jean (1952), *The origins of intelligence in children*, Oxford: International Universities Press.

Piaget, Jean (1970), *Science of Education and the Psychology of the Child*. New York: The Viking Press.

Pittman, Thane S., Michael S. Pallak, Janet M. Riggs, and Carolyn C. Gotay (1981), “Increasing Blood Donor Pledge Fulfillment,” *Personality and Social Psychology Bulleti*n, 7 (Jun), 195-200.

Raftery, Adrian E., Michael A. Newton, Jaya M. Satagopan, and Pavel N. Krivitsky (2007), "Estimating the Integrated Likelihood via Posterior Simulation Using the Harmonic Mean Identity." *Bayesian Statistics*, (8), 1 - 45.

Raghunathan, Rajagopal, Rebecca W. Naylor, and Wayne D. Hoyer (2006), “The Unhealthy = Tasty Intuition and Its Effects on Taste Inferences, Enjoyment, and Choice of Food Products,” *Journal of Marketing*, 70 (Oct), 170-184.

Ruffy, Michele (1981), “Influence of social factors in the development of the young child's moral judgment”, *European Journal of Social Psychology*, 11 (Jan-Mar), 61-75.

Skinner, Frederic, B. (1953), *Science and Human Behavior*. New York: Macmillan

Stunkard, Albert J., Rita Yopp Cohen, and Michael R. Felix (1989), "Weight loss competitions at the worksite: how they work and how well," *Preventive Medicine*, 18 (Jul), 460-74.

Tapper, Katy, Pauline Horne, and Fergus Lowe (2003), "Food Dudes to the rescue!" *The Psychologist*, 16 (Jan), 18-21.

Thomas, James, Katy Sutcliffe, Angela Harden, Ann Oakley, Sandy Oliver, Rebecca Rees, Ginny Brunton, and Josephine Kavanagh (2003), *Children and Healthy Eating: A systematic review of barriers and facilitators*. London: EPPI Centre.

United States Department of Agriculture (2001), "Changes in Children's Diets: 1989-1991 to 1994-1996," (accessed July 2, 2009) [available at www.fns.usda.gov/oane/MENU/Published/CNP/FILES/Changessum.htm]

Wansink, Brian (2006), *Mindless Eating*. New York: Bantam Dell.

Ward, Scott, Daniel B.Wackman, and Ellen Wartella (1977), *How children learn to buy: The development of consumer information-processing skills*. Oxford: Sage.

Yu, Fu-Yun, Chialing Han and Tak-Wai Chan (2008), "Experimental Comparisons of Face-to-Face and Anonymous Real-Time Team Competition in a Networked Gaming Learning Environment," *CyberPsychology & Behavior*, 11 (Aug), 511-514.

TABLE 1

TIMELINE FOR VARIOUS EVENTS DURING THE STUDY

Weeks prior/post intervention	Duration of data collection	Description	Code
Six weeks prior	One week	Baseline, enhanced menu	-
Five weeks prior	One week	Baseline, regular menu	-
From fourth week (prior) to beginning of intervention	No data collection	Regular menu	-
Intervention	Six weeks	Intervention period, enhanced menu	W1, W2, W3, W4, W5, W6
Week one, post	One week	Short term follow-up, enhanced menu	SF
Weeks two to nine, post	No data collection	Regular menu	-
Week ten, post	One week	Long term follow-up, enhanced menu	LF

TABLE 2

PROPORTION OF CHILDREN CHOOSING FRUITS/VEGETABLES IN STUDY 1

	Younger Children			Older Children		
	Incentive only	Competition +incentives	Pledge +incentives	Incentive only	Competition +incentives	Pledge +incentives
Baseline (enhanced menu)	.64	.44	.51	.50	.46	.36
Modeled change from Baseline						
Intervention weeks						
W1	.16*	.26*	.06*	.06*	.16*	.19*
W2	.11*	.23*	.11*	.07*	.17*	.20*
W3	.08*	.18*	.10*	.07*	.18*	.18*
W4	.05*	.21*	.09*	.06*	.17*	.16*
W5	.06*	.16*	.02	.05*	.14*	.16*
W6	.14*	.23*	.06*	.06*	.13*	.15*
Post-intervention follow-up						
SF	.12*	.18*	-.01	.07*	.14*	.10*
LF	.09*	.24*	.08*	.03*	.11*	.07*

* indicates more than 95% of posterior mass away from 0; * results are significant. The table should be read as follows: For younger children in the incentive only condition, in the baseline week, .64 (proportion) of the children chose an additional serving of fruits/vegetables. In W1, that proportion increased by .16 such that a total of .80 of the students chose an additional serving of fruits/vegetables.

TABLE 3

STUDY 1 - RESULTS OF HLM ANALYSIS

	Model 1		Model 2	
	Posterior Means		Posterior Means	
	Younger children	Older children	Younger children	Older children
Intercept	.609 *	.482 *	.589 *	.538 *
“Competition”	-.042	.023	-.177	-.047
“Pledge”	-.191	-.064	-.110	-.141
W1	.135 *	.147 *	.161 *	.065 *
W2	.131 *	.161 *	.113 *	.072 *
W3	.108 *	.152 *	.083 *	.072 *
W4	.095 *	.135 *	.053 *	.057 *
W5	.061 *	.128 *	.060 *	.052 *
W6	.122 *	.123 *	.135 *	.064 *
SF	.079 *	.106 *	.125 *	.071 *
LF	.114 *	.072 *	.093 *	.034
“Competition” × W1			.095 *	.091 *
“Competition” × W2			.114 *	.101 *
“Competition” × W3			.101 *	.112 *
“Competition” × W4			.157 *	.112 *
“Competition” × W5			.099 *	.087 *
“Competition” × W6			.094 *	.064 *
“Competition” × SF			.055	.071 *
“Competition” × LF			.146 *	.079 *
“Pledge” × W1			-.105 *	.123 *
“Pledge” × W2			-.005	.131 *
“Pledge” × W3			.019	.105 *
“Pledge” × W4			.038	.099 *
“Pledge” × W5			-.040	.110 *
“Pledge” × W6			-.074 *	.087 *
“Pledge” × SF			-.136 *	.032
“Pledge” × LF			-.009	.035
σ^2_{hroom}	.023 *	.016 *	.023 *	.016 *
σ^2_{school}	.075 *	.048 *	.075 *	.048 *
σ^2_{error}	.024 *	.022 *	.024 *	.022 *
LMD	796.0	1919.8	805.5	1950.2
AICM	1318.2	3061.9	1346.1	3084.6

Note: For numbers with *, the 95% highest posterior density does not contain 0 (equivalent to being significant at the .05 level). LMD and AICM favor the model with the larger value. Intercept is proportion choosing fruits and vegetables in baseline week for the control condition. Other variables are "dummy" coded and additive. “Competition” represents “competition+incentive” and “Pledge” represents “pledge+incentive” conditions.

TABLE 4

STUDY 2: EFFECT OF PLEDGE REMINDERS (CUE) ON CHOICE OF FRUITS – POISSON REGRESSION

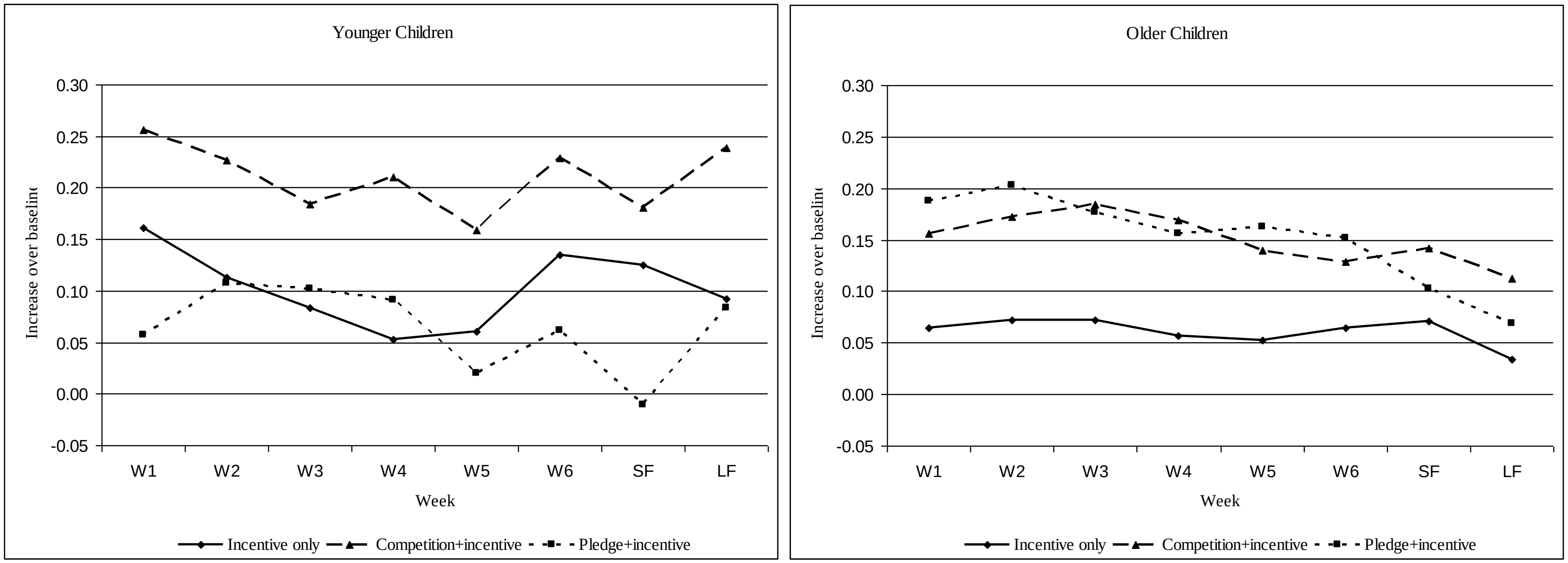
	Posterior Means	
	Model 1	Model 2
No Cue		
Baseline	3.088*	3.026*
First day	-.215	- #
Last day	.058	- #
Cue Present		
Baseline	1.983*	1.987*
First day	.450	.451
Last day	.903*	.905*
$\sigma^2_{student}$	.231*	.231*
LMD	-159.1	-157.7
AICM	-338.0	-333.9

Note: "First Day" and "Last Day" represent increase over "Baseline".
Numbers with * indicate *Pr*(*effect* > 0) > .95.
LMD and AICM favor the model with the largest value.
These effects were dropped from the model.

FIGURE 1

CHANGE IN PROPORTION OF CHILDREN CHOOSING FRUITS/VEGETABLES OVER BASELINE PERIOD IN STUDY 1

HLM ANALYSIS



WEB APPENDIX

Study 1

For estimating equation (1) via Bayesian methods it is convenient to restate the model in a more standard hierarchical framework:

$$y_{ijt} = \beta_{1ij} + \beta' x_{ijt} + \varepsilon_{ijt} \tag{1a}$$

Where:

$$\varepsilon_{ijt} \sim N(0, \sigma^2_{error})$$

$$\beta_{1ij} \sim N(\bar{\beta}_{1j}, \sigma^2_{hroom})$$

$$\bar{\beta}_{1j} \sim N(\bar{\bar{\beta}}_1, \sigma^2_{school})$$

and $\bar{\beta}_j$ is the mean for school *j* and $\bar{\bar{\beta}}_1$ is the grand mean. In (1a) x_{ijt} is the vector of dummy coded explanatory variables and β is the vector of fixed effects. The model hierarchy is finalized by specifying the following prior distributions:

$$\bar{\bar{\beta}}_1 \sim N(0,100)$$

$$\beta \sim N_p(0,100I_p)$$

$$each\ \sigma^2_{.} \sim IG(\frac{a}{2},\frac{b}{2})$$

Here $N_p(0, 100I_p)$ is the multivariate normal distribution with *p* corresponding to the dimension of β, I_p is a $(p \times p)$ identity matrix, and $IG(\frac{a}{2},\frac{b}{2})$ is the inverse gamma distribution where *a* and *b* are chosen such that $E(\sigma^2) = 2.0$ and $Var(\sigma^2) = 14.0$. Thus the priors are conjugate but diffuse. Listed below are the draws from the conditional posterior distribution; since each is a standard conjugate set-up, the details are not provided. See standard references such as Gelman, Carlin, Stern, and Rubin (2004) or Rossi, Allenby, and McCulloch (2005) for necessary details.

1. $\beta_{ij} \mid \bar{\beta}_j, \sigma^2_{hroom}, \sigma^2_{error}, rest$ for each i and j

   Form $y_{ijt} - \beta' x_{ijt} = z_{ijt}$. Now $z_{ijt} \sim N(\beta_{1ij}, \sigma^2_{error})$ and given the prior on β_{1ij}, this is a standard Normal-Normal model.

2. $\beta \mid \{\beta_{1ij}\}, \sigma^2_{error}, rest$

   Form $y_{ijt} - \beta_{1ij} = z_{ijt}$. Now $z \sim N(X\beta, \sigma^2_{error} I_n)$ where n is the total number of stacked observations. Given the prior on β, this is a standard Normal-Normal regression model with conditionally conjugate priors.

3. $\bar{\beta}_{1j} \mid \{\beta_{1ij}\}, \sigma^2_{hroom}, \sigma^2_{school}$ for each j

4. $\bar{\bar{\beta}}_1 \mid \{\bar{\beta}_{1j}\}, \sigma^2_{school}, rest$

   Both these are standard Normal-Normal models.

5. $\sigma^2_{error} \mid \{\beta_{1ij}\}, \beta, rest$

6. $\sigma^2_{school} \mid \{\bar{\beta}_{1j}\}, \bar{\bar{\beta}}_1, rest$

7. $\sigma^2_{hroom} \mid \{\beta_{1ij}\}, \bar{\beta}_{1j}, rest$

   These three are standard, conjugate inverse gamma models.

The MCMC chain was quick to converge but draws were highly autocorrelated. Convergence was assessed following the method of Gelman et al. (2004, pp. 296 – 297): Five chains with different random starting points were run and $\hat{R}$ was less than 1.1 for all coefficients after 2,000 iterations. Autocorrelation was assessed by examining the "relative numeric efficiency" or $\hat{f}_R$ as suggested by Rossi et al. (2005, pp. 92-93). With an MCMC chain thinned to retain only every 10th draw, the maximum $\hat{f}_R$ for the coefficients was approximately 29; this implies that the sample from the MCMC chain is only 1/29th as efficient as a true iid sample. The value of $\hat{f}_R$ for the log-likelihood was approximately 1 ensuring the calculation of the AICM is accurate. The final MCMC sampler was run for 301,000 iterations for all models; the first 2,000 iterations were discarded and a sample of every 10th from the remainder was used for estimating posterior moments and probabilities. The actual sample from the posterior was 29,900 while the effective sample is closer to 29,900/29 ~ 1,000 iid draws

Study 2

A Poisson regression model was fit to the number of fruits selected by each child in the baseline period prior to the intervention, on the first day of the intervention, and on the last day of the intervention.

The Poisson likelihood for child *i* picking *y* servings of fruit on day *t* is given by:

$$\ell_{it} = \frac{e^{-\lambda_{it}} \lambda_{it}^{\;y_{it}}}{y_{it}\,!}$$

$$\lambda_{it} = e^{\alpha_{1i} + \alpha' x_{it}} \qquad (2a)$$

Where x_{it} is the vector of dummy coded explanatory variables, α_{1i} is an individual level effect, and α is the vector of fixed effects. In the Poisson model, y_{it} can take on the value {0, 1, 2, 3, …}, the $E(y_{it}) = \lambda_{it}$ with $\lambda > 0$ and $Var(y_{it}) = \lambda_{it}$. The model is completed with the following priors:

$$\alpha_{1i} \sim N(\bar{\alpha}_1, \sigma^2_{student})$$

$$\alpha \sim N_p(0, 100 I_p)$$

$$\bar{\alpha} \sim N(0, 100)$$

$$\sigma^2_{student} \sim IG(\frac{a}{2}, \frac{b}{2})$$

Where the notation follows that defined earlier for experiment 1. Listed below are draws from the conditional posterior distributions.

1. $\alpha_{1i} \mid \bar{\alpha}_1, \sigma^2_{student}, rest$ for each i

A random-walk Metropolis-Hastings step is used to draw the scalar α_{1i}. Let $\alpha_{1i}^{(o)}$ represent the current, or old value of α_{1i} and form $\alpha_{1i}^{(n)} = \alpha_{1i}^{(o)} + \nu$ where $\nu \sim N(0, s^2 \times \sigma^{2(r)}_{student})$ where s^2 is chosen to minimize the autocorrelation in the posterior sample (here s^2 = 0.75) and $\sigma^{2(r)}_{student}$ is the current draw of $\sigma^2_{student}$. Accept $\alpha_{1i}^{(n)}$ with probability:

$$\text{minimum:} \left(\frac{\prod_{t=1}^{3} \ell_{it}(\alpha_{1i}^{(n)}) \times \exp\left(-\frac{1}{2\sigma^2_{student}} \left(\bar{\alpha}_1 - \alpha_{1i}^{(n)}\right)^2 \right)}{\prod_{t=1}^{3} \ell_{it}(\alpha_{1i}^{(o)}) \times \exp\left(-\frac{1}{2\sigma^2_{student}} \left(\bar{\alpha}_1 - \alpha_{1i}^{(o)}\right)^2 \right)}, 1 \right)$$

2. $\alpha \mid rest$

A random-walk Metropolis-Hastings step is used to draw the vector α. Let $\alpha^{(o)}$ represent the current, or old value of α and form $\alpha^{(n)} = \alpha^{(o)} + \nu$ where $\nu \sim N(0, s^2 \times H^{-1})$ where s is the "automatic" scale $s = 2.93 / \sqrt{p}$, p is the dimension of α, and H is the *Hessian* from the maximum likelihood estimate of the Poisson model (with no random effects). Accept $\alpha^{(n)}$ with probability:

$$\text{minimum:}\left(\frac{\prod_{i=1}^{30}\prod_{t=1}^{3}\ell_{it}(\alpha^{(n)})\times\exp\left(-\frac{1}{2}\left(0-\alpha^{(n)}\right)'(100I_p)^{-1}\left(0-\alpha^{(n)}\right)\right)}{\prod_{i=1}^{30}\prod_{t=1}^{3}\ell_{it}(\alpha^{(o)})\times\exp\left(-\frac{1}{2}\left(0-\alpha^{(o)}\right)'(100I_p)^{-1}\left(0-\alpha^{(o)}\right)\right)},1\right)$$

3. $\bar{\alpha}_1 \mid \{\alpha_{1i}\}, \sigma^2_{student}$

   This is a standard Normal-Normal model.

4. $\sigma^2_{student} \mid \{\alpha_{1i}\}, \bar{\alpha}_1$

   This is a standard, conjugate Inverse Gamma model.

Convergence and the required length of the MCMC chain were determined following the same procedures as in experiment 1. In this case, a burn-in period of 5,000 iterations was determined to be adequate. The MCMC chain was thinned to every 20th to make draws of the log-likelihood nearly iid and the chain was run for 200,000 iterations. The maximum $\hat{f}_R$ for the effects was approximately 6; thus retaining every 20th iteration from the last 195,000 iterations results in an approximate iid sample size of (9,750/6) ~ 1,625. All chains were started using the MLE estimates. Equation (2a) is non-linear in the coefficients α_{1i} and α. Thus to obtain estimates of an experimental effect (cue present/not present, day, and interactions), the following approximation was used:

$$\lambda_{effect} = \lambda_{w/effect} - \lambda_{w/o\ effect}$$

Where the appropriate values of x are used to form $\lambda = e^{\bar{\alpha}_1 + \alpha' x}$. Alternative calculations using the individual level values of α_{1i} yielded identical substantive conclusions. The value of λ_{effect} was calculated on each iteration of the MCMC sampler and simulation based methods were used for hypothesis testing. Full numerical results for all coefficients and effects are available from the authors.