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BRIEF REPORT

Red Potato Chips: Segmentation Cues Can Substantially Decrease Food Intake

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Objective: To discover a scalable method of food-packaging presentation, which can help reduce per occasion food consumption by making portions sizes more salient and segmented. ***Methods:*** Two studies of American undergraduates who ate from tubes of potato chips while watching a movie. In each study, participants ate chips that were either identical (the control group) or which had colored chips inserted at regular intervals (the treatment groups). One treatment group had a distinctively different (reddish) chip present at every 7th (Study 1) or 5th (Study 2) chip, and the 2nd treatment group had one present every 14th (Study 1) or 10th (Study 2) chip. Measures were the number of chips consumed and (in Study 1) the participants estimates of how many they believed they consumed. ***Results:*** In both studies, chip consumption was reduced by more than 50%, averaging across the 2 segmentation intervals, with no significant difference between the 2 intervals. Estimates of amount consumed were much more accurate when there was segmentation. ***Conclusion:*** Segmenting a package effectively reduced consumption in the settings we have explored. Segmentation cues may operate by any or all of 3 mechanisms: (a) they call attention to and encourage better monitoring of eating, (b) they suggest smaller consumption (portion size) norms, or (c) they break automated eating sequences by introducing a pause. There is some evidence from the 1st study that provides evidence for the 1st, monitoring account.

Keywords: food, obesity, intake, environment

It is widely acknowledged both that obesity constitutes a major health risk and that dieting is a generally unsuccessful way of dealing with it. Over the last 2 decades, a number of investigators have come to the conclusion that Americans live in an "obesogenic" environment and that environmental changes may be the most promising route to decreasing obesity (Brownell, 2002; Hill & Peters, 1998; Levitsky, 2005; Rolls, Roe, & Meengs, 2007; Rozin, Kabnick, Pete, Fischler, & Shields, 2003; Wansink, 2004). Very modest reductions in intake produced by environmental changes can, when cumulated, lead to a substantial weight loss. Considering the standard conversion of calories to pounds of weight: If over the last 20 years, American adults simply replaced one regular soda with a diet soda once a week—all else equal—the 1.5 lb a year average increase in American weight would have been neutralized (see Swinburn, Sacks, & Ravussin, 2007, for suggestions that many more calories need to be reduced to produce 1 lb of weight loss).

Large portion sizes seem to play a major role in generating obesity; people generally eat what is put in front of them if it is palatable. Why do people finish eating large portions? Consider three answers: (a) they might ineffectively monitor how much they have eaten (Chandon & Wansink, 2007); (b) they may eat what they believe is an appropriate amount (perceived norm defined by the portion; Geier, Rozin, & Doros, 2006); or (c) they may be engaged in a semiautomated habitual activity, which simply continues until interrupted (Wansink & Cheney, 2005). One possible solution to all three of these problems could be segmentation cues, which may serve to interrupt consumption and activate consumption norms.

An increasing amount of research suggests that some people use visual indications—such as a clean plate or bottom of a bowl—to tell them when to stop eating (Wansink, Painter, & North, 2005). To some extent, this is what small-size portions (such as 100 calories packaging) provide.

In this research, we hypothesize that inserting visual markers in a snack food package will reduce total intake within a single sitting. Our participants are undergraduate students. This age range (17–21 years) is appropriate because eating problems, both obesity and anorexia nervosa, are common in this age group, and there is great concern among undergraduates about weight, especially

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among female individuals. We report the results of two similar studies and describe them together. The very robust results we achieved in the first study encouraged a replication under somewhat modified conditions.

Both studies were carried out with one group of participants in a single class session, a convenience sample. Both involved a three-level between-subjects design where respondents were randomly given one of three different tubes of potato chips while watching a movie. The stack of yellow chips was interrupted by a red chip at different intervals in the two studies and at two different intervals within each study in the experimental groups.

Method

Study 1 involved 59 undergraduates (38 female students, 21 male students) who were enrolled in a 90-min course at the University of Illinois at Urbana-Champaign. As part of a weekly guest-lecture series, snacks and cookies were often provided during the talk. This facilitated our cover story: that a chip manufacturer was having a new version of packaging tested by the university's food science department, and some of the excess tubes of chips were going to be given as the snack that day. The chips used were Lays Stackables and the "tubes" were the commercial Lays Stackables tubes with the standard Lays Stackables signage. The consumption interrupt or segmentation-framing cue was a pale red-colored potato chip of the same size, composition, and taste as the ordinary pale-yellow chips. The red chips were produced by dipping the regular, pale-yellow chip in a saltwater solution that had been dyed with red food coloring. The newly dyed chips were then dried in a low-temperature oven before being inserted at designated intervals in a stack of regular yellow chips and stacked back into a Lays Stackables tube. Each tube contained 82 chips, weighing about 11 g each, with about 10 calories/chip. In the seven-divider group, every seventh chip (chips 7, 14, 21. . ..) was a red chip. In the 14-group, every fourteenth chip was red (14, 28, 42 . . .). These numbers were chosen because 7 was noted on the package as being approximately 1 serving size.

A student wearing a white lab coat handed out the chips in a randomized order (marking of tube condition was accomplished with an unobtrusive code on the bottom of the tube) along with bottled water (20 oz.). The professor (an author) who introduced the session began eating chips as they were handed out, and made a favorable comment, "Mmmmm . . . tasty," about the chips before commenting that "a few of the chips might have a red color, but they are otherwise identical to the other, yellow chips." He then showed a red chip and then ate it. Respondents were then told that they were going to be shown a 1-hr BBC TV show on shopping behavior ("Buyology–The Science of Shopping").

Following the program, the partially eaten tubes of chips were collected and respondents were handed one-page questionnaires, which included a question asking them to estimate how many chips they ate. Nine of the 68 respondents starting the study were excluded because they ate no potato chips (5) or failed to complete the consent form (4).

Participants were debriefed about the purpose of the study and given full replacement tubes of chips to keep. During a lecture the following week, they were presented with the results.

Study 2 was carried out at the University of Pennsylvania. Participants were 39 undergraduates at a single 1-hr session for credit to meet a course research requirement (gender and age were not recorded). The basic design was comparable except that we used a different brand of commercial chips (Lay's Stax) and a commercially available color–flavor variant of the same brand as a segmentation cure. We also used different segmentation intervals (every fifth or tenth chip), but otherwise, we maintained the same basic three-group design as used in Study 1.

All of the tubes were in a clearly labeled Lay's Stax tube, with the label of the standard (pale yellow) chip. Unlike the first study, we used another flavor (tomato basil) of the same brand as the divider. It had a distinctively red color. Using the procedure of Study 1, tomato-basil chips were inserted every 5th (after the 4th plain yellow chip) or every 10th chip, with control tubes containing no divider chips.

The session included watching a 25-min film excerpted from a commercial movie and answering questions that measured reactions to the movie. The participants were told, before the movie began, that our group frequently does studies with food. We said,

> Today, companies are beginning to market snack products with more than one flavor in the same package. The chips that you will be getting today may contain more than one flavor. After the movie you will be asked to answer various questions, including how much you liked the chips.

At that point, we handed out the Lay's Stax tubes of chips, at random with respect to tube segmentation. Participants had the potato chips for approximately 40 min—about 20 min less than in Study 1.

At the end of the movie, we asked the participants to "please place the caps back on their tubes of chips." They were then given a one-page questionnaire that asked them to rate the taste of the chips they ate on a scale that ranged from −10 (*extremely dislike*) to 10 (*extremely like*). For individuals in the divider groups, separate ratings were obtained for the yellow and red crisps. During a debriefing with nine of the students, none suggested the true purpose of the experiment. Both studies received IRB approval.

Results

As hypothesized, dividers significantly decreased how many chips a person ate (see Figure 1). In Study 1, 19 participants in the 0-divider (control) group ate an average 45.25 chips ($SD = 14.02$), compared with the 20.25 ($SD = 9.26$) eaten by the 21 participants with the 7-chip segments and 23.68 ($SD = 7.79$) eaten by the 19 participants with 14-chip segments, $F(2, 56) = 30.822$, $p < .001$. Combining the two groups with dividers, the effect of dividers is to reduce intake to 48.5% of control levels.

Both 7 and 14 dividers significantly reduced intake compared to the no-divider condition ($p < .001$, by Scheffé tests; Cohen's $d = 2.09$), and there was no significant difference between the 7 and 14 dividers. Eight of the 20 participants in the control condition ate more chips than the maximum eaten (49) by anyone in the 7-divider or 14-divider groups.

If there was a concern with the red chip (on account of a less desirable taste or texture, or just a reaction to the color), we would expect many individuals to stop consumption at the first red chip they encountered, either immediately before or after consuming it. No participants, however, stopped at 6–7 or 13–14 chips. In

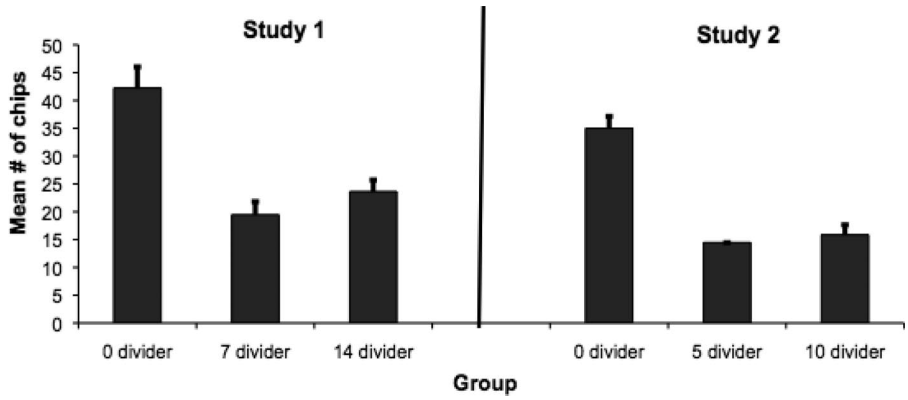

Figure 1. Mean chip intake as a function of presence or absence and frequency of distinctive divider chips across both studies. Standard error of the mean marked by bars. The *y*-axis displays the mean number of potato chips consumed. The *x*-axis displays the three conditions for Study 1 and the three conditions for Study 2. The condition "0 divider" denotes that there were no dividers within the potato chip tubes presented to those participants. In the other conditions, there were dividers placed every 14 or 7 chips in Study 1 and every 10 or 5 chips in Study 2.

combination with two pilot studies that showed similar results, these findings suggest that the red chip was treated as a "regular" potato chip. Furthermore, during the postexperiment debriefing, no participant mentioned that concerns of safety or quality influenced their consumption.

The dividers also led participants to be far more accurate in their estimates of how much they ate. The 0-divider group estimated that they consumed 32.65 chips, when they actually consumed 45.25, amounting to a mean underestimate of consumption of 12.60 (SD = 8.53) chips. In comparison, those in the 7-divider group estimated their intake at only 0.80 (SD = 3.38) greater than their actual intake, whereas participants in the 14-divider group estimated that they consumed 0.05 (SD = 3.03) chips less than their actual intake, The main effect of group on accuracy was highly significant, $F(2, 56) = 31.12$, $p < .001$; the divider groups did not differ significantly, but both were more accurate than the no divider condition ($p < .001$, in both cases, by Scheffé tests).

In Study 2, one participant did not consume any chips and was dropped from the data analysis. All others consumed at least six chips. There were 13 participants in the control group (0-divider group), 14 in the 5-divider group (a tomato-basil chip at every fifth chip), and 12 in the 10-divider group. The range of consumption was from 6 to 51 chips.

The occasional red chip had a major effect in reducing consumption (see Figure 1). Participants who ate from unsegmented tubes (0-divider group) consumed a mean of 35.00 (SD = 7.77) chips compared to 14.45 (SD = 5.90) for the high-segmentation (5-divider) group, and 15.86 (SD = 5.80) for the low-segmentation (10-divider) group. An analysis of variance indicated a highly significant effect of segmentation, $F(2, 35) = 38.831$, $p < .001$; Cohen's $d = 2.98$. Post hoc Scheffé tests indicated a highly significant difference ($p < .001$) between unsegmented tubes and either of the segmented group but no difference between the two segmented conditions ($p = .869$). The combined divider groups consumed only 43.3% of the number consumed by the control group.

One interpretation of the segmentation is that the different chip calls attention to the amount eaten or interrupts consumption and, thus, stops a somewhat automated eating sequence. According to this view, segmented groups should tend to stop at the segmenting chip (at multiples of 10 chips for the low-segmentation group, and at multiples of 5 chips for the high-segmentation group). In the low-segmentation group, 6 of 14 (43%) participants stopped at a segment chip (10th or 20th), a value higher (but not significantly) than the randomly predicted 10% stop rate. However, in the high-segmentation group, only 2 of 11 (18%) stopped at a segmenting chip, with a random value of 20%. The participants liked both types of chips. On a rating scale from −10 (*dislike extremely*) to 10 (*like extremely*), for the 23 participants who tasted and rated both types of chips, mean liking was 5.39 (SD = 2.17) for plain chips and 5.65 (SD = 3.08) for the red chips (paired $t[22] = 0.397$). There was no significant difference in palatability of the two types of chips, with the red chips which reduced consumption actually scoring slightly more palatable.

Discussion

Two similar studies, using different student convenience samples at different universities, different types of potato chips, and different segmentation cues, yielded substantial and highly congruent results. In both studies, intake was reduced by more than 50%. In both studies, the large reduction in intake was about the same in the low- or high-segmentation conditions. The effect cannot be the result of surprise or distaste at the initial chip because no one stopped eating the chips at the first segmentation cue, and we presented evidence that the segmenting (red) chip was very similar in palatability to the basic chip.

Our large effect moves in the opposite direction from habituation or sensory specific satiety (Rolls, Rolls, Rowe, & Sweeney, 1981), which would decrease intake on all of the control (unsegmented) conditions. We do not know whether a sensory specific satiety effect was in fact operative in our study, but overwhelmed by the segmentation cues, or whether in the particular conditions of this study, sensory specific satiety was not operative.

In the introductory section, we offered three reasons why segmentation might decrease intake: (a) they call attention to the act of eating and the amount eaten (Chandon & Wansink, 2007); (b) they provide portion-size norms (Geier, Rozin, & Doros, 2006; Wansink, 1996); and (c) they interrupt “mindless” eating episodes (Wansink, 2006). Any or all of these three factors could be involved in producing the effects we have demonstrated. Indeed, any intervention that leads to a large effect size is likely to be overdetermined and to be the result of many overlapping causes.

Our results from Study 1 argue for an effect of intake monitoring because estimates of amount consumed were more accurate for participants who consumed segmented tubes. That participants did not show a striking tendency to stop at a red chip is not consistent with any of the three mechanisms. This may be because participants may have removed and consumed a number of chips at a time, as suggested by one of the reviewers of this article. Finally, it is an open question as to whether a shift in food color is sufficient to indicate a portion norm. Further research would have to evaluate the relative role of the three mechanisms we propose, and perhaps, the operation of other mechanisms.

The potency of segmentation cues is of particular relevance because it is becoming more and more common for food to be presented in portion-size packages or with recommended portion-size markers. Marking modest-sized portion sizes promises to be an effective strategy in the attempt to reduce food intake and obesity. Our study differs from typical packaging to reduce food intake, because these use nonfood entities to mark portion size (e.g., package size itself, or nonfood separators) while we use a different food as a segmenter.

The effect demonstrated and replicated in these studies stands as perhaps the largest practicable procedure to decrease food intake in the literature. It could have major public health significance. Our manipulation reduced caloric intake by about 250 calories. Depending on assumptions about conversion of calories to pounds of body weight, a manipulation of the sort we used could lead to a loss of weight of greater than a pound in a year, a major part of American annual weight gains over recent years. This, of course, assumes that there is no compensation for decreased intake over days or longer periods. We do not yet know if this assumption holds.

Our study illustrates a substantial reduction in intake from a simple segmentation manipulation, a new one, in that it involves food as a segmenting agent. This study used only undergraduate students and only potato chips. Clearly, more work has to be done to both determine in what contexts segmentation cues work, to investigate the precise mechanisms through which segmentation expresses its effects, and to determine whether there is subsequent compensation for any reduction in food intake.

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