The Interaction of Food-Quantity Differences and Temporal Presentation on the Amount of Food People Consume

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Abstract

Previous research suggests that judgments of food quantity affect the amounts of food people eat. In two experiments, we investigated the interaction of food-quantity differences and temporal presentation on participants' judgments of food quantity and the amounts they ate. In Experiment 1, participants viewed drawings of two portions of mashed potatoes presented either simultaneously or sequentially and later recalled sizes from memory. In Experiment 2, participants viewed two serving bowls of pasta salad presented either simultaneously or sequentially and ate as much or as little as they wished from the smaller bowl. The amounts they ate were inversely related to biases in judgments of food quantity.

Food Quantity Judgments

Judgments of food quantity affect the amounts of food people eat (Wansink, 2004). Specifically, in previous research the amounts participants ate were inversely related to biases in their judgments of food quantity. When participants believed that a quantity was smaller, they ate more; and when they believed that it was larger, they ate less. For example, participants ate more when food was packaged in larger containers (Wansink, 1996), served in larger portions (Edelman, Engell, Bronstein, & Hirsch, 1986; Nisbett, 1968; Rolls, Morris, & Roe, 2002), or on larger plates or bowls (Wansink & Cheney, 2005). Wansink (2004) argued that people eat more in these conditions because these factors cause people to judge quantities smaller than they actually are which, in turn, makes people believe that they ought to eat more or leaves them at liberty to eat more. Several researchers (Raghubir & Krishna, 1999; Wansink & Van Ittersum, 2003) have found that participants consume more from short-wide containers than from tall-thin containers. These researchers argued that their results could be explained because short-wide containers appear smaller than do tall-thin containers.

Wansink, Painter, and North (2005) devised a particularly cleaver demonstration of the principle that people eat more when they are misled to believe that quantities are smaller than they actually are by giving their participants bowls of tomato soup that, unbeknownst to the participants, were refilled through a concealed tube as they were trying to eat the soup. These participants consumed 73% more soup on average than did control participants whose soup bowl was not refilled.

The research presented here investigated the interaction of food-quantity differences and temporal presentation on participants' judgments of food quantity and the amounts they ate. Previously published empirical results (Brigell & Uhlarik, 1979; Jordan & Uhlarik, 1984; Massaro & Anderson, 1971; Schiano, 1986) and proposed theories of attribute evaluation (Anderson, 1965, 1981; Choplin & Hummel, 2002; Parducci, 1965; Wedell, Parducci, & Geiselman, 1987) predict very different patterns of how these two factors are likely to interact to bias food-quantity judgments and the amounts of food people eat. The research presented here thereby represents a preliminary opportunity to pit these seemingly contradictory empirical results and theories of attribute evaluation against each other to see which might best fit food-quantity judgments and the amounts of food people eat.

Range-Frequency and Integration Theories

Wedell, Parducci, and Geiselman (1987) presented pictures of women's faces either simultaneously or sequentially and asked their participants to rate the physical attractiveness of the faces. They found assimilation effects (evaluations of the attractiveness of target faces were biased toward the attractiveness of contextual faces) when faces were presented simultaneously and contrast effects (evaluations of the attractiveness of target faces were biased away from the attractiveness of contextual faces) when faces were presented sequentially. A similar pattern has been observed in the parallel line-length illusion (Jordan & Uhlarik, 1984). Wedell et al. modeled ratings of simultaneously presented faces using Anderson's (1965; 1981) integration theory and ratings of sequentially presented faces using Parducci's (1965) range-frequency theory. These models predict that biases ought to be greater the larger the differences between values: the larger the difference in attractiveness between simultaneously presented values the greater the assimilation effects ought to be and the larger the difference in attractiveness between sequentially presented values the greater the contrast effects ought to be.

Although attractiveness judgments might seem qualitatively different from food-quantity judgments, Wedell et al. (1987) intended their model as a general model of attribute evaluation. If food-quantity judgments follow the same pattern as attractiveness judgments, then when a small target quantity is presented at the same time as a larger quantity the small target quantity would appear larger the larger the difference between it and the larger quantity. By contrast, when a small target quantity is sequentially presented after a larger quantity the target quantity would appear smaller the larger the difference. Experiment 1 tested these hypotheses. If the amount of food people eat is inversely related to biases in judgments of food quantity, then people ought to eat more the greater the difference when quantities are presented sequentially and less the greater the difference when quantities are presented simultaneously. Experiment 2 tested these hypotheses.

Perceptual Contrast Effects

In perceptual contrast effects, the judged sizes of items are biased away from the sizes of the items they are placed near. A classic demonstration of a perceptual contrast effect is the Ebbinghaus illusion. In the Ebbinghaus illusion (see Figure 1), a circle is judged larger when it is surrounded by small circles than when it is surrounded by large circles. The center circle in Group 1 appears larger than the center circle in Group 2, for example, because its judged size is biased away from the sizes of the circles that surround it. Unlike the Wedell et al.'s (1987) findings and the parallel line-length illusion wherein simultaneous presentation produced assimilation, and sequential presentation produced contrast (Jordan & Uhlarik, 1984), Ebbinghaus illusion contrast effects are strong when items are presented simultaneously and weaken or disappear when items are presented sequentially (Jaeger & Pollack, 1977).

Of importance to the research reported here, Ebbinghaus illusion contrast effects (unlike line-length illusion biases, Brigell & Uhlarik, 1979; Schiano, 1986) become greater the larger the actual differences (Massaro & Anderson, 1971). In Figure 1, for example, the center circle appears smaller in Group 2 than in Group 3 although it is always smaller than the circles that surround it, because the difference between it and the surrounding circles is greater in Group 2 than in Group 3.

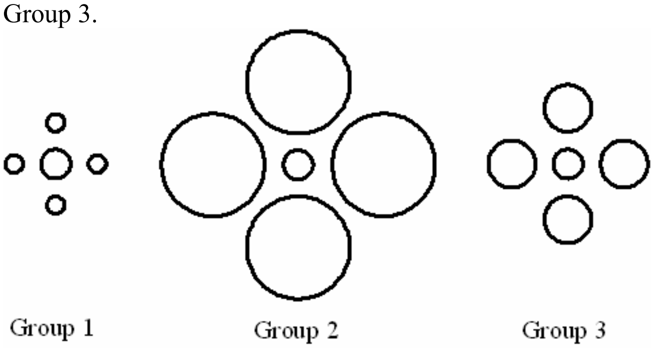

Figure 1. The Ebbinghaus Illusion.

Placing quantities of food near each other so that they are seen simultaneously might produce similar biases. If so, then when a target quantity is surrounded by larger quantities the target quantity would appear smaller the larger the difference between it and the larger quantities that surround it. Experiment 1 tested this hypothesis. If the amount of food people eat is inversely related to biases in judgments of food quantity, then when a quantity of food is surrounded by larger quantities people ought to eat more the greater the difference between that quantity and the larger quantities to which it is perceptually compared. Experiment 2 tested this hypothesis.

Comparison-Induced Distortions

Choplin and Hummel (2002) investigated the effects of verbal, language-based comparisons (e.g., "the triangle is larger than the circle") on size judgments. Consistent with previous research in linguistics (Rusiecki, 1985), Choplin and Hummel argued that verbal comparisons cause people to imagine particular sizes and size differences. When imagining a quantity of food that is "larger" than another quantity, for example, people are unlikely to imagine that the larger quantity is vastly different from the first. They are certainly unlikely to imagine a quantity that fills an entire dining room table. They are also unlikely to imagine a tiny difference. The difference would, at the very least, have to be large enough to be noticeable to the naked eye. Rather people are likely to imagine a quantity that is larger by an intermediate amount.

To illustrate the principle that food quantity comparisons suggest intermediate differences, we used a technique pioneered by Rusiecki (1985). We showed a group of 16 pretest participants a bowl containing 3.00 lbs. of pasta salad and asked them to imagine a larger quantity and then scoop out the quantity they imagined. All 16 participants scooped out intermediate differences. The smallest quantity was 3.92 lbs and the largest quantity was 5.80 lbs (we used these quantities as comparison quantities in Experiment 2). We will call these quantities *comparison-suggested quantities*, because they are the quantities that the comparison suggested to these pretest participants. We will call the differences between the 3.00-lb quantity and the quantities participants scooped out *comparison-suggested differences*, because they are the differences that the comparison suggested to these pretest participants. The smallest difference was 0.92lbs (3.92lbs minus 3.00lbs) and the largest difference was 2.80lbs (5.80lbs minus 3.00lbs).

Choplin and Hummel (2002) found that verbal comparisons bias size judgments towards comparison-suggested quantities and differences. When people see particular quantities and the quantities suggested by verbal comparisons are different from those quantities, people will make judgments by combining (taking a weighted average of) the two sources of information. For example, if the actual difference between two quantities were only 0.92 lbs (i.e., the smallest difference in our pretest and a difference that was smaller than the comparison-suggested difference for 15 out of the 16 pretest participants), then for 15 of our pretest participants averaging the two sources of information would bias judgments of the sizes apart toward their larger comparison-suggested differences (note that comparison-induced biases cannot be described as contrast or assimilation effects, because all biases in this model are assimilation effects toward comparison-suggested differences). The smaller quantity would be judged smaller and the larger quantity would be judged larger than they would have been judged otherwise. Likewise, if the actual difference between two compared quantities were 2.80 lbs (i.e., a difference that is larger than the comparison-suggested difference for 15 out of the 16 pretest participants), then for 15 of our pretest participants averaging the two sources of information would bias judgments of the sizes together toward their smaller comparison-suggested differences. The smaller quantity would be judged larger and the larger quantity size would be judged smaller than they would have been judged otherwise.

By biasing judgments toward comparison-suggested quantities and differences, verbal comparisons produce patterns of bias that are the exact opposite of those found in the Ebbinghaus illusion. If actual differences are smaller than comparison-suggested differences, verbal comparisons will—like the Ebbinghaus illusion—bias values away from each other. However, these biases away from each other become smaller as actual differences become larger until actual differences are equal to comparison-suggested differences at which point there will be no biases. If actual size differences are larger than comparison-suggested differences, verbal comparisons will bias values toward each other and these biases toward each other become greater as actual differences become larger. That is, verbal comparisons produce a pattern of bias wherein the larger the difference between values the less likely values will be biased away from each other and the more likely they will be biased toward each other—the exact opposite pattern from that observed in the Ebbinghaus illusion.

Language-based biases start with perceived values. Low-level perceptual illusions such as the Ebbinghaus and parallel line-length illusions will, therefore, trump language-based biases. Furthermore, although language-based biases also operate when values are presented simultaneously and values are perceptually available (Choplin & Hummel, 2005), they are stronger when values are presented sequentially because once exact size information is no longer perceptually available participants will start to rely upon other sources of information such as verbal comparisons (Choplin & Hummel, 2002) and category membership (Huttenlocher, Hedges, & Vevea, 2000) to evaluate quantities. Participants will then be more likely to rely upon verbal comparisons and be susceptible to the biases produced by verbal comparisons under sequential presentation than under simultaneous presentation.

We tested the interaction of food-quantity differences and temporal presentation on participants' judgments of food quantity and the amounts they ate in two experiments. To investigate this interaction, Experiment 1 used a paradigm in which participants viewed drawings of two portions of mashed potatoes one of which was smaller than the other. The drawings were then taken away and participants redrew sizes from memory. To investigate the effects of perceptual and verbal comparisons on the amounts of food people eat, Experiment 2 used a paradigm in which participants viewed two serving bowls of pasta salad—one of which was filled with a smaller quantity than the other, compared them, and then ate as much of the smaller quantity as they wished.

Experiment 1

Experiment 1 investigated the interaction of food-quantity differences and temporal presentation on participants' judgments of food quantity. Participants saw drawings of two portions of mashed potatoes (a small portion, 2.70cm in diameter, and a large portion, either 4.35cm in diameter or 7.80cm in diameter) and redrew them. The two portions were presented either simultaneously or sequentially.

Method

Participants. Forty people (Half women, half men) volunteered to participate after being approached by the experimenter on the DePaul University campus or in the surrounding community. Half saw portions presented simultaneously and half saw portions presented sequentially.

Materials and Procedure. Each participant received a questionnaire. Participants in the simultaneous-presentation condition saw two portions presented on the same page: one small and one large. The small portion was 2.70cm in diameter. To set the sizes of the large portions, we used a group of 16 pretest participants to identify differences that were smaller and larger than comparison-suggested differences (for 15 of the 16 pretest participants and approximately the same proportion of participants in the experiment). Participants saw the 2.70-cm portion and then each imagined a portion that was larger than this portion and drew it. The smallest portion drawn by this group was 4.35 cm in diameter (calculated by averaging the height and width of their drawings at their greatest extent). This difference—1.65cm—was less than the comparison-suggested difference for 15 of the 16 pretest participants so this size was used as the size of the large portion in the small-difference condition. The largest portion drawn was 7.80 cm in diameter so this size was used as the size of the large portion in the large-difference condition. The pictures were taken away and participants were given a page on which to redraw the sizes they had seen from memory. After completing one difference condition, participants completed the other and the order of the conditions was counterbalanced as was the location of each portion (top or bottom of the page). Participants in the sequential-presentation condition saw the same portions presented at the same locations on each page except that the two portions were presented on separate pages and the order of presentation was counterbalanced. The experimenter verbally compared portion sizes noting which one was larger and smaller than the other as participants were viewing them.

Results

A 2(presentation: simultaneous or sequential) x 2(difference: large or small) mixed-factors analysis of variance (ANOVA) on the sizes redrawn by participants found a significant interaction between the type of presentation and the difference between portions, $F(1,38)=78.22$, $p<.01$. Posthoc Tukey analyses found that when portions were presented simultaneously the small portion was recalled significantly larger when there was a small difference between portions than when there was a large difference between portions, but when portions were presented sequentially the small portion was recalled significantly smaller when there was a small difference between portions than when there was a large difference between portions.

The pattern observed under simultaneous presentation was consistent with the pattern observed in the Ebbinghaus illusion (Jaeger & Pollack, 1977; Massaro & Anderson, 1971) and inconsistent with the patterm observed in the parallel line-length illusion (Jordan & Uhlarik, 1984) or the pattern of biases observed by Wedell et al. (1987) for attractiveness judgments. The pattern observed under sequential presentation was consistent with the patterns of bias produced by verbal comparisons (Choplin & Hummel, 2002) and again inconsistent with the patterns of bias observed in the parallel line-length illusion (Jordan & Uhlarik, 1984) or those observed by Wedell et al. (1987) for attractiveness judgments. The results for sequential presentation reported here may have differed from the results for sequential presentation in the Ebbinghaus illusion reported by Jaeger and Pollack (1977), because they presented four comparison sizes rather than one. Also their converging method of limits dependent measure which required participants to verbally compare the center circle to a comparison circle might have discouraged participants from verbally comparing the center circle to the surrounding circles. Although other explanations of this pattern of results might be proposed, no other explanations have been proposed in the literature to date. In fact, this paper is the first to report simultaneous contrast and sequential assimilation effects although we have replicated the results reported in Experiment 1 several times and reported an analogous pattern for judgments of skin color tones elsewhere (Choplin & Wilson, 2006).

Several factors might account for the difference between the results reported here (and Choplin & Wilson, 2006) and the patterns observed in the parallel line-length illusion (Jordan & Uhlarik, 1984) and Wedell et al.'s (1987) attractiveness judgments. One possibility is that different attribute dimensions might have their own idiosyncrasies. Some dimensions such as geometric shapes and color tones might be susceptible to one set of low-level perceptual biases, while other dimensions such as line length might be susceptible to another set of low-level biases, while still other dimensions such as attractiveness might be susceptible to different higher-level cognitive biases.

Alternatively, different dependent measures might produce different patterns of bias (Biernat, Manis, & Kobrynowicz, 1997). In particular, unlike Experiment 1 Wedell et al. used a category-rating measure of attribute evaluation while Jordan and Uhlarik (1984) used a graded-series scale measure which may have some properties of rating scales (but see Choplin & Wilson, 2006). Effects of verbal comparisons are often difficult to gage on category rating measures (see Choplin, 2004). If the results of Experiment 1 could have been different had we used a different dependent measure, one might reasonably question the construct validity of the size reproduction measure we used. Experiment 2 will address this concern by investigating the interaction of food-quantity differences and temporal presentation on real dietary decision making, the amount of food participants eat.

Experiment 2

In Experiment 2, participants saw two quantities of pasta salad presented either simultaneously or sequentially and ate as much as they wanted of the smaller quantity.

Method

Participants. Eighty undergraduate students (42 women; 38 men) participated in exchange for class credit. Half saw quantities of food presented simultaneously and the other half saw them presented sequentially. Half saw a large difference between quantities and half saw a small difference. We instructed participants not to eat before arriving at the lab. Three women and one man admitted that they had not followed these instructions. Four women reported restricting their diet. Excluding their data did not affect results, so we include their data in the analyses presented below.

Materials and Procedure. Participants arrived at the laboratory individually during lunchtime hours. The experimenter told each participant that a second (fictional) participant was also coming, but that the second participant was apparently running late. The participant sat down at a table. Two serving-bowl sized quantities of pasta salad were prepared—one for the participant and one for the fictional participant who never arrived. Several paper/pencil pretests and previous research (Wansink & Cheney, 2005) suggested the possibility that opaque plates and bowls might provide an alternative perceptual standard of comparison. To control for this possibility, the bowls used in this experiment were transparent. The participants' quantity of pasta salad was 3.00 lbs. They ate directly from the serving bowl rather than scoop out a portion for themselves, because other factors such as the size of the bowl could have affected how much they scooped out. This method also allowed us to avoid ceiling effects should we have served them a reasonably sized portion, the social norm that participants should clean their plates, unit bias (Geier, Rozin, & Doros, 2006), and any feelings on the participants' part that they had been deprived a full portion. The fictional participant's quantity was 3.92 lbs for participants in the small-difference condition and 5.8 lbs for participants in the large difference condition. We used the group of 16 pretest participants described above to set these sizes so that differences would be smaller and larger than comparison-suggested differences (for 15 of the 16 pretest participants and presumably the same proportion of participants in the experiment).

The quantities were presented either simultaneously or sequentially. In the simultaneous-presentation condition, the experimenter set out the bowls, explicitly compared them, and asked participants to eat as much or as little as they wished. Both bowls were left on the table while participants ate. In the sequential-presentation condition, the experimenter placed the fictional participant's bowl in front of the participant but then interrupted and explained she had given them the wrong bowl. She then removed the fictional participant's bowl and gave participants' their bowl, explicitly compared them, and asked participants to eat as much or as little as they wished. These vocal comparisons did not differ across condition and, in most cases, fit naturally into the conversation. Typically, the participant remarked on the quantities of pasta salad which gave the experimenter an opportunity to explain that the participant's quantity was smaller than the fictional participant's and that the fictional participant's quantity was larger than the participant's. The experimenter then left participants alone to eat.

Once participants indicated that they had finished eating, the experimenter weighed and recorded the amount eaten and took several secondary measures. To measure participants' judgments of how much they had eaten, participants estimated the amount they had eaten by scooping that amount from a bucket into a separate bowl. To measure satiety, participants rated how satiated they were on a scale from 1(not full) to 10(very full). As a secondary measure of satiety, participants were given a 100grams of M&M's® Chocolate Candies for dessert and ate as many as they wished.

Results and Discussion

We ran a 2(gender) x 2(presentation: simultaneous or sequential) x 2(difference: large or small) between-subjects ANOVAs on the amount eaten, estimated amount eaten, and our measures of satiety. Of primary interest, the ANOVA testing for amount eaten found a significant interaction between temporal presentation and the difference between quantities, $F(1,72)=18.49$, $p<.01$. Tukey posthoc analyses revealed that in the simultaneous condition, participants ate less if there was a small difference (M=0.23 lbs; 104.33 grams≈231.02 calories) than if there was a large difference (M=0.38 lbs; 172.37 grams≈381.68 calories) between quantities. But in the sequential condition, participants ate more if there was a small difference (M=0.48 lbs; 217.72 grams≈482.09 calories) than if there was a large difference (M=0.33 lbs; 149.69 grams≈331.46 calories) between quantities. These results suggest that the size reproduction measure used in Experiment 1 has construct validity.

Participants in the sequential condition (M=0.41 lbs; 185.97 grams≈411.79 calories) ate more than participants in the simultaneous condition (M=0.30 lbs; 136.08 grams≈301.32 calories), $F(1,72)=8.87$, $p<.01$. The typical gender difference wherein men eat more than women failed to reach significance, $F(1,72)=2.58$, $p>.05$.

Despite the fact that temporal presentation and the size of the difference between quantities affected how much participants ate, we found no evidence that participants were aware that they had been affected. We found no analogous interaction for their estimates of how much they had eaten, $F(1,72)=0.04$, $p>.05$, or their ratings of satiety, $F(1,72)=0.36$, $p>.05$. Nevertheless, in some cases these factors might have affected how many M&M's® they subsequently ate, $F(1,72)=6.79$, $p<.05$. Tukey posthoc analyses failed to find differences in M&M's® consumed among participants was saw the pasta salad presented sequentially, but found that among participants who saw the pasta salad presented simultaneously those who saw a large difference ate more than twice as many M&M's® as those who saw a small difference (28.10 grams≈138.25 calories versus 13.40 grams≈65.93 calories). That is, the group that had eaten more pasta salad continued eating more M&M's® afterwards.

General Discussion

We investigated the interaction of food-quantity differences and temporal presentation in two experiments. In Experiment 1, participants viewed drawings of mashed-potato portions that differed by a small or a large amount presented either simultaneously or sequentially. Participants who saw portions presented simultaneously redrew the small portion smaller when the difference was large than when it was small, but participants who saw the two portions presented sequentially redrew the small portion larger when the difference was large than when it was small. In Experiment 2, participants viewed quantities of pasta salad that differed by a small or large amount presented either simultaneously or sequentially. Consistent with previous findings suggesting that the amounts people eat are inversely related to biases in judgments of quantity, the effects of temporal presentation and the difference between quantities were the exact opposite of those found in Experiment 1. Participants who saw the quantities presented simultaneously ate more of the smaller quantity when the difference between the quantities was large than when it was small; but participants who saw the two quantities presented sequentially ate more of the smaller quantity when the difference was small than when it was large.

The pattern observed under simultaneous presentation was consistent with the pattern observed in the Ebbinghaus illusion (Jaeger & Pollack, 1977; Massaro & Anderson, 1971) and the pattern observed under sequential presentation was consistent with the patterns of bias produced by verbal comparisons (Choplin & Hummel, 2002). The results were inconsistent with the patterns of bias observed in the parallel line-length illusion (Jordan & Uhlarik, 1984) or those observed by Wedell et al. (1987) for attractiveness judgments. In fact, this paper is the first to report simultaneous contrast and sequential assimilation effects, and while other potential explanations of this pattern might be proposed, no other potential explanations have been proposed in the literature to date.

Of potential importance to future research, the Ebbinghaus illusion is moderated by factors such as the distances between items, the number of items (Massaro & Anderson, 1971), and similarity (Choplin & Medin, 1999; Coren & Enns, 1993; Coren & Miller, 1974) between items. Likewise, verbal comparison-induced biases are likely to be moderated by such factors as the likelihood that they will verbalize comparisons—whether or not they explicitly vocalize them, and how important comparison are to them (Choplin & Hummel, 2002, 2005). All of these factors may, in turn, affect how much food people eat in real dietary decision making contexts. Furthermore, serving food in opaque plates or bowls (as opposed to the clear plastic bowls used in Experiment 2) may provide alternative standards of comparison and thereby moderate the effects of other comparisons (Wansink & Cheney, 2005).

People typically eat more when they eat in groups than when they eat alone (deCastro & Brewer, 1992). Researchers have proposed several reasons for this social eating effect including the possibility that conversation distracts people and thereby reduces their ability to monitor how much food they eat, that people might model other eaters and only stop eating if other people stop eating as well, and that how much other people have eaten or are eating might serve as a consumption norm suggesting how much they should eat (Wansink, 2004). Food-quantity comparisons and the biases they create (or lack thereof) might be implicated in some of these explanations. For example, distractions might make verbal comparisons less likely. Also comparisons to consumption norms or how much other people eat will likely bias evaluations of how much people are eating and thereby affect how much they subsequently eat.

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