The Presence of Variety Reduces Perceived Quantity

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Against common intuition, we find that variety in an assortment reduces its perceived quantity. Two studies show that people provide larger quantity estimates when shown random patterns of identical colored dots or geometric shapes than when those patterns contain variety. The difference in perceived quantity does not grow as the number of different types increases beyond two, and it disappears if the overall area occupied by the set is made salient through context. We attribute the results to the natural consolidation of identical items into a single Gestalt whole that makes the set seem larger. Two additional studies show that this perceptual influence also causes people to pour more when using varied items to match a sample of food. The article closes with a discussion of the potential implications of these findings for variety research and portion control.

Does having variety in a set affect the perceived quantity of items? Does a bowl with both red and blue candies seem to have more or less than a bowl with only one color of candy? Despite research showing that quantity perceptions influence portion sizes (Wansink and van Ittersum 2003), feelings of satiation (Raghubir and Krishna 1999), and food intake (Wansink, Painter, and North 2005), we know little about how variety affects perceived quantity.

To investigate intuition, we asked 121 students if "a package with a variety of items appears like it has less than a package with just one type." People could respond with Agree, Disagree, or No Effect. The results indicate that most people expected a relationship (overall $\chi^2(2) = 27.68$, $p < .0001$). In particular, more people disagreed ($n = 64$) with this statement than agreed ($n = 40$) or believed there was no effect ($n = 17$). A majority believed that variety makes a set appear to have more rather than less items.

There are several reasons for this belief. First, variety makes it easier to notice each item among other nearby items (Frick 1987). Second, since people use more items as a cue for more variety in an assortment (Broniarczyk, Hoyer, and McAlister 1998), the reverse intuition could also be used. Third, varied sets may attract more attention, and people sometimes misattribute attention to a greater quantity (Folkes and Matta 2004). Although these mechanisms suggest that variety could increase perceived quantity, past research has not tested whether it actually does.

Contrary to popular belief and the above reasoning, we propose that the presence of variety actually makes it seem like there are fewer items. Put another way, items seem more numerous when they are all the same, or homogeneous. A set composed of only identical items makes it easy for people to perceive the items as a single, unified whole. Focusing on this larger, all-encompassing whole makes the set appear to occupy more space. Since people rely on spatial area as a cue for quantity (Krueger 1972; Raghubir and Krishna 1996; Vos et al. 1988), a set appears to have more items when they are all identical.

Our primary objective is to establish this perceptual influence. Four experiments provide this evidence as well as support for a proposed mechanism. We also highlight a role for quantity perception in variety research. In particular, perceived quantity is a potential mediator to consider in future studies of how variety affects consumption. This article concludes with a discussion of the implications of the current findings, especially for portion control and unintended overconsumption.

BACKGROUND

Quantity Perceptions

We use the term "quantity" primarily as it pertains to how much (e.g., grams in a food serving). When the individual items are nearly the same size, as in the subsequent studies,

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the question of how much is essentially the same as how many. Even in the more general case, this distinction may not matter much, as people rely heavily on the number of items when judging quantity (Pelham, Sumarta, and Myaskovsky 1994). Thus, we use quantity to capture a general sense of how much of something there is.

Numerosity research has identified four ways that people quantify items. First, for up to six items, people can accurately and nearly instantaneously quantify the items (Kaufman et al. 1949). This ability, labeled "subitization," is attributed to the recognition of patterns like triangles for three (Mandler and Shebo 1982). Second, people can keep a running count while enumerating each item. Counting can theoretically quantify any number of items but is time consuming with larger sets. Third, people can estimate or count the number of items in a particular region and then extrapolate. This buildup method requires less effort than counting, especially when regions are small and easily identifiable, but still requires attentional focus and nontrivial calculations.

Finally, people often rely on a more primitive approximation system specialized for approximating quantities (Dehaene 1992, 1997; Piazza et al. 2004), directly perceiving numerosity much like other qualities, such as brightness or weight. Approximation takes 100–200 milliseconds (Mandler and Shebo 1982) and is seemingly automatic regardless of the task (Dehaene 1997). With minimal effort people can reliably notice quantity differences of 17% (Piazza et al. 2004). It seems that, in lieu of more effortful methods, people can quickly approximate a total quantity with reasonable accuracy.

One reason people can make these rapid approximations is that they rely on cues. In particular, people use the area occupied by the items as a cue for the total quantity. Young children judge a set to have more items when toy cubes are made larger (Binet 1890) or candies are more spaced out (Piaget 1968). People perceive a pattern to have more dots if the display area is enlarged (Krueger 1972) and a jagged line to have more dots when the endpoints are further apart (Krishna and Raghubir 1997). Empirical models have fit quantity estimates using the filled area of the overall contour of the set (Vos et al. 1988) and the collective area occupied by the items (Allik and Tuulmets 1991). These results all show that a set appears to have more items as it seems to occupy more space.

Perceptual Grouping and Perceived Quantity

We propose that the perceived area occupied by a set depends on how people perceptually group the items in the set. Although people could attempt to combine the areas of the individual items, they may instead process the set in a holistic fashion by envisioning a global figure that encompasses the items (e.g., an outside border). Such a figure may spontaneously appear if the items naturally combine into a perceptual Gestalt (Palmer 1982; Wertheimer 1938). For example, people see a wall rather than just a bunch of individual bricks and so will rely on the area of the wall as a cue for the quantity of bricks.

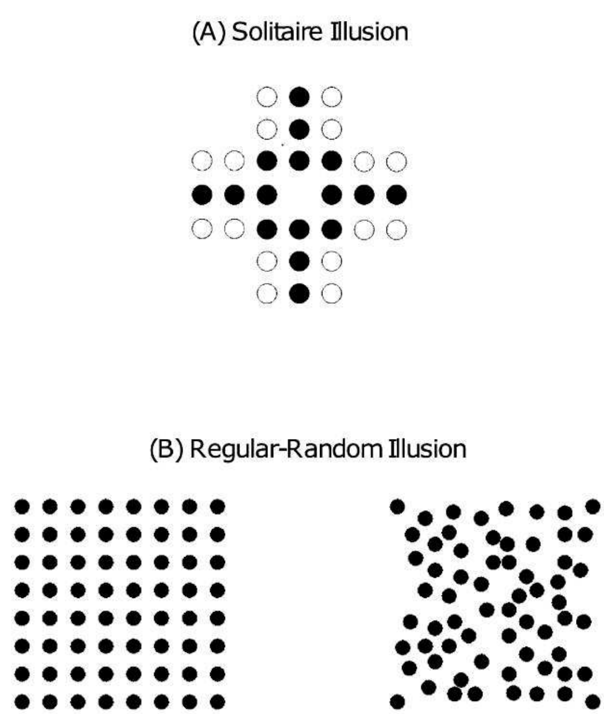
Prior work supports the notion that people use a Gestalt figure to estimate the quantity of items. For example, most people incorrectly perceive that the solitaire illusion in figure 1*A* has more black dots than white dots (Frith and Frith 1972). The black dots presumably create a salient whole with a clear height and width that spans a larger area than the four isolated clusters of white dots (Frith and Frith 1972; Vos et al. 1988). Likewise, as shown in figure 1*B*, people estimate that there are more dots when they are regularly versus randomly arranged (Ginsburg 1978), presumably because the regularly arranged dots appear as a giant square that occupies the entire space. These two illusions both show that rearranging items to make the whole more salient can increase perceived quantity.

Predictions

We explore whether, similar to spatial arrangement, the presence of variety in a set can affect the salience of the whole and in turn the perceived quantity. People group items much faster when they are identical (Enns and Kingstone 1995; Mishra, Mishra, and Nayakankuppam 2006) and naturally see identical items as a single coherent figure (Palmer 1982; Wertheimer 1938). When items differ, people tend to focus on one type or the other and find it difficult to merge the multiple types into a whole. For example, judging the shape of an area is harder when it is two different colors versus just one color (Huang, Pashler, and Treisman 2006).

FIGURE 1

EXAMPLES OF VISUAL ILLUSIONS



Identical items make the whole more salient, focusing attention on the largest possible area occupied by the set. Since area is a cue for quantity, an identical set seems more numerous than a varied one. Conversely, variety makes a set appear to have fewer items.

The prediction that variety reduces perceived quantity is not obvious for several reasons. Variety could make it less likely that people will overlook some items because each item stands out. Variety also may serve as a cue for quantity as sets with more items generally do have more variety (if the items were selected at random). Additionally, varied assortments could attract more attention, which people may misattribute to a greater quantity (Folkes and Matta 2004). People might similarly rely on the ease of perception as a cue for quantity, as they do for many other judgments (Schwarz 2004). However, it is not clear whether greater perceptual fluency should indicate a larger quantity, because bigger sets are easier to notice, or a smaller quantity, because smaller sets have fewer items to process.

Despite any potential effects of variety on these other cues, we predict that all else equal variety reduces perceived quantity because people rely so heavily on the area cue. This proposed mechanism leads to an additional and quite specific prediction as to the nature of this effect. What matters most is whether people perceive the set as a whole or not, that is, it is a special property created by homogeneity. Because the presence of any variety already breaks up the whole, the perceived quantity of items should not change much with further variety. Thus, we predict that although the perceived quantity of a set will decrease as the number of types goes from one to two, it will not decrease when going from two to more than two types. If so, such a result would provide some insight into the underlying process, as a monotonically decreasing relationship would be predicted by several alternative mechanisms (e.g., anchoring on the number of items of one subtype).

The prediction that adding greater variety does not continue to lower the perceived quantity may seem surprising at first. The process we propose might be expected to apply to each part, such that more types of items create smaller Gestalt groupings throughout the set, suggesting a result counter to the previous prediction. However, we do not expect people to simultaneously perceive and build up multiple Gestalts in this way. Top-down processes, like using area as a quantity cue, serve to help avoid the cognitive effort of individually processing many items or groups of items in a set. For example, past work has found that people recall the mean size of an item for the set without recalling the size of any particular item (Ariely 2001; Chong and Treisman 2003). So, given that the notion of the Gestalt applies primarily to a single overall whole, we expect that any effects of variety on the perceived quantity will mostly occur as soon as variety breaks up this whole.

Given that the salience of the whole is central to our proposed mechanism, we can predict two additional boundary conditions. First, as long as the area of the whole remains salient, the presence of variety should have little effect on perceived quantity. This implies that if the context highlights the overall area so people focus on it (e.g., a border), then a varied set should appear to have the same quantity of items as an identical set. Second, although people often rely on the area cue, this reliance will diminish if other quantity cues are salient. Past work has shown that one cue people use is the extent to which the items fill their container (Hsee 1998). If the container is nearly full, people may instead anchor on the quantity cue provided by the size of the container and pay less attention to the Gestalt whole created by identical items. Similarly, if a container is nearly empty, the Gestalt whole created by identical items may seem insignificant relative to the much larger container that holds it. In both cases, we predict that the effect variety has of reducing the perceived quantity will be attenuated because people instead rely somewhat on the container utilization cue.

To summarize, we predict that (1) a set appears to have more items if the items are identical, (2) a set that already has variety does not appear to have even fewer items as more variety is added, (3) variety has no effect on the perceived quantity of items when the context makes the overall area salient, and (4) variety reduces the perceived quantity less so when the container is nearly full or nearly empty.

We should point out that our research is silent on the question of perceived quantity accuracy. That said, if variety reduces perceived quantity, it follows that introducing variety will lead to greater (less) accuracy in settings where people tend to overestimate (underestimate) the quantity. For example, people show an elongation bias whereby they overweight the height dimension (Piaget 1968), and so we would expect that variety would make people less accurate when estimating the quantity for a short, wide bowl and more accurate for a tall, thin bowl. Regardless of any such incidental effects, our focus is on how variety affects the absolute level of perceived quantity, not the accuracy.

Empirical Studies

The first two studies follow the standard method in numerosity research of using simple random patterns. Study 1 shows that variety reduces the perceived quantity of items using both different colored dots and different geometric shapes and that the effect does not change as the number of types increases from two to five. Study 2 provides some insights into the process as the effect disappears when the overall area of the set is outlined by a shaded figure. This suggests that variety affects perceived quantity by making the whole more salient.

After demonstrating the predicted perceptual effect in the standard numerosity setup, two additional studies focus on a more interactive and pragmatic context. The pouring of food is used, since consumers need to do this nearly every day. Study 3 shows that people unintentionally pour more candy in a matching task when the candy has a variety of colors. This occurs even though people knew they could not consume the candy. Study 4 rules out several alternative explanations by manipulating variety in both the sample candy serving and the poured candy. Process measures suggest that variety affects how much people pour through its influence on perceived quantity.

STUDY 1

This study was designed to test whether variety decreases the perceived quantity of items. People estimated the number of items in random geometric patterns, making it easy to quickly gather a large number of estimates with experimental control. The simplicity of the task also reduces the number of possible explanations for any findings. This study was also designed to test the generality of the predicted effect, as items could differ in either color or shape, and the number of different item types could vary from one to five. This design eliminates alternative explanations unique to only colors or only shapes and also tests the prediction that the effect depends on the presence of variety more than the amount of variety.

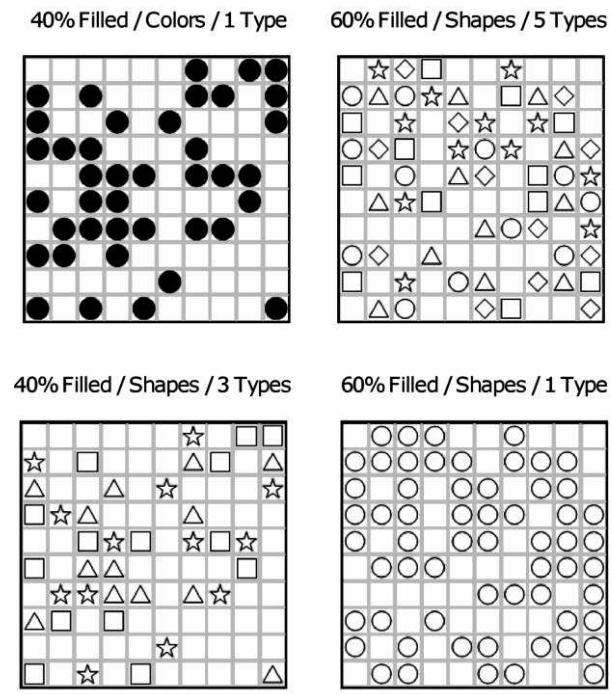
Method

Eighty participants estimated the quantity of items in 50 random patterns of colored dots or common shapes for $5 or undergraduate course credit. Participants saw each pattern on a computer screen for 750 milliseconds and then answered, "What percentage of the box was filled in on the last screen?" Patterns were presented for only a brief time so that people could not count the items. "Percentage filled" was chosen as the response measure since it reduces outlier responses yet still correlates highly with direct estimates of numerosity (Goldstone 1993). Percentage filled also captures the notion that people often judge the quantity of items by how much they fill a container or plate (Wansink 2004).

The pattern stimuli were created using a 5 × 2 × 5 full factorial design on percentage filled (30%, 40%, 50%, 60%, 70%), basis of variety (colored dots, geometrical shapes), and number of different types (1, 2, 3, 4, 5). Figure 2 shows a subset of the stimuli used. A pattern for each level of percentage filled was randomly generated within a 10 × 10 square matrix and used throughout. Because there were 100 total squares in the matrix, the percentage filled equaled the number of items, and the two can be used interchangeably. A wide range of percentage filled levels was used to enhance the ecological validity and generalizability of any findings and to test for any systematic patterns in the estimates. For patterns containing dots, the color of each dot could randomly be red, green, blue, orange, or black. For patterns containing geometric figures, each shape could randomly be an unfilled circle, triangle, square, diamond, or 5-pointed star. The particular colors or shapes used in a pattern were randomly chosen for counterbalancing purposes when the number of different types was less than five. When presented on the computer screen, patterns appeared 5.5 inches tall with a black border around the perimeter and a light gray border dividing each of the 100 individual squares within the matrix. The presentation order of the 50 patterns was randomly determined for each participant.

FIGURE 2

SUBSET OF STIMULI USED IN STUDY 1



NOTE.—Color version available as an online enhancement.

Results

Table 1 reports the mean quantity estimates for each condition. Quantity estimates were analyzed using a repeated-measures ANOVA with the percentage filled, basis of variety, and number of different types as within-subject factors. There were main effects for each of the three factors: percentage filled ($F(4, 76) = 495.31$, $p < .0001$), basis of variety ($F(1, 79) = 5.02$, $p < .03$), and number of types ($F(4, 76) = 31.19$, $p < .0001$). The analysis also found evidence of a percentage filled by number of types interaction ($F(16, 64) = 4.85$, $p < .0001$), a percentage filled by basis of variety interaction ($F(4, 76) = 7.27$, $p < .0001$), and the three-way interaction ($F(16, 64) = 2.15$, $p < .02$). The only factor in the model failing to reach statistical significance was the basis of variety by number of different types interaction ($F(4, 76) = 2.12$, $p > .08$). Given these results, we could proceed with detailed contrasts to understand the nature of the effects and test our predictions.

First, a planned contrast compared the mean estimates for patterns with only one item type versus the mean of those with more than one item type. As predicted, people judged a pattern to have more items when it had only one color or shape versus multiple colors or shapes ($M = 56.8$ vs. 53.5; $F(1, 79) = 110.19$, $p < .0001$). The magnitude of this contrast did not differ for colored dots versus geometric shapes ($F(1, 79) = 1.59$, $p > .21$). The results support our core pre-

TABLE 1

MEAN QUANTITY ESTIMATES IN STUDY 1

Actual % filled	Number of different item types									
	1 dot	2 dots	3 dots	4 dots	5 dots	1 shape	2 shapes	3 shapes	4 shapes	5 shapes
30	31.6	27.8	29.4	26.1	27.7	24.8	25.4	27.2	24.4	25.1
40	49.0	44.1	41.1	42.6	42.9	46.1	44.3	41.7	43.2	41.6
50	57.4	55.2	54.0	54.8	54.9	62.7	55.8	53.0	53.7	53.3
60	70.7	67.3	69.6	66.0	69.1	67.6	65.0	64.4	66.8	64.2
70	79.2	78.0	76.8	76.3	77.3	78.0	78.1	77.7	77.9	78.1
Overall	57.6	54.5	54.2	53.1	54.4	55.9	53.7	52.8	53.2	52.4

diction that the presence of variety lowers the perceived quantity.

Second, we tested our prediction that the perceived quantity would decline little with further variety. There was a downward linear trend as a pattern went from having one to five different types as shown in the bottom row of table 1 (1 to 5 linear trend, $F(1, 79) = 63.79$, $p < .0001$). However, this trend disappeared when considering only the effect of adding further variety (2 to 5 linear trend, $F(1, 79) = 2.62$, $p > .10$). Perceived quantity also did not differ ($p > .10$) in five of the six possible pairwise comparisons between patterns with two to five different item types. This pattern of results was also replicated in a follow-up study that manipulated the number of colors in the varied condition from two to five as a between-subjects factor. Variety lowered the perceived quantity in each treatment group (all $p < .01$), but this effect did not show a trend as the number of different colors increased ($F(1, 157) = 0.66$, $p > .41$). It appears that, as predicted, variety has its biggest influence on quantity perceptions when a set goes from having identical items to having some variety.

Third, we tested our prediction that the effect of variety on perceive quantity would attenuate as a container approached being nearly empty or full. A test of the interaction of variety with percentage filled (as a linear trend on the deviation from 50%) found that variety tended to have less effect on the estimated quantity as the pattern became more empty or more full ($F(1, 79) = 17.71$, $p < .0001$). However, this effect was qualified by the three-way interaction ($F(1, 79) = 23.80$, $p < .0001$). In particular, variety and percentage filled interacted for the unfilled shapes ($F(1, 79) = 50.81$, $p < .0001$) but not the colored dots ($F(1, 79) = 0.04$, $p > .84$). Thus, we find only partial support for our prediction that percentage filled moderates the effect of variety on perceived quantity.

Finally, we performed some additional analyses to understand the nature of the other effects found in the ANOVA model. For the main effect of percentage filled, not surprisingly, people gave larger estimates as the percentage filled increased (linear trend, $F(1, 79) = 1{,}952.94$, $p < .01$). For the main effect of basis of variety, people gave larger estimates when the items consisted of colored dots rather than unfilled shapes ($F(1, 79) = 5.02$, $p < .03$). However, since we also found a basis of variety by percentage filled interaction, we performed separate ANOVAs at each level of percentage filled. The dots seemed more numerous than the shapes for 30% filled ($F(1, 79) = 19.56$, $p < .0001$) and 60% filled ($F(1, 79) = 13.55$, $p < .001$) but not at any other level of percentage filled (all $p > .52$). Any effect of dots versus shapes on perceived quantity seems fairly weak and inconsistent. Finally, given the three-way interaction, separate two-way ANOVAs were performed at each level of percentage filled. These analyses still found the contrast supporting the primary prediction that variety lowered the apparent quantity ($p < .05$) at every level of percentage filled except 70% ($F(1, 79) = 3.10$, $p > .08$). It is also notable that the effect remained whether people tended to underestimate the total as they did for the 30% patterns ($M = 26.9$ vs. 30; $F(1, 79) = 64.96$, $p < .0001$) or overestimate the total as they did for the 70% patterns ($M = 77.7$ vs. 70; $F(1, 79) = 405.22$, $p < .0001$). Across the many results in the different analyses, the predictions were consistently supported.

Discussion

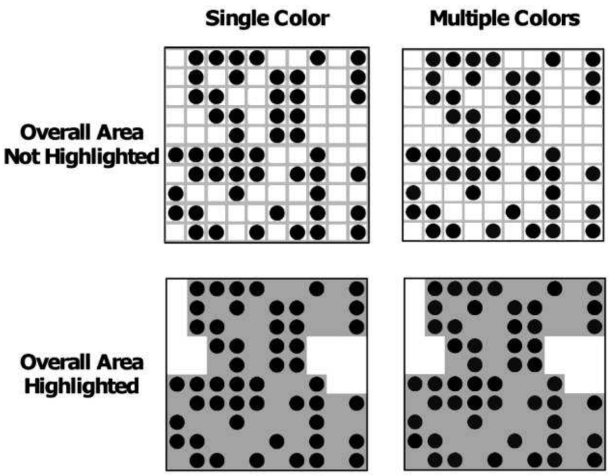
This study asked people to estimate the number of items in a random pattern on a computer screen. As predicted, the presence of variety lowered the perceived quantity of items. This effect appeared whether the items differed in color or shape. This is important because it eliminates any explanations that are unique to differences in a particular feature, such as color contrast. It also suggests that the predicted effect is general in nature and sets may appear to have fewer items whenever the items vary on any easily discriminated feature.

The perceived quantity in a set dropped with the mere introduction of variety, yet changed little with additional variety. Homogeneity among items seems to have a special ability to make a set appear more numerous by making the whole more salient, which leads people to perceive a set to be larger and to have greater quantity. Once variety breaks up the overall form, the addition of more variety cannot further break up the whole. Hence, the effect depends on the absence of variety more than the extent of variety.

We found only partial support for our prediction that this effect would become smaller as the pattern became nearly empty or nearly full. For unfilled shapes, the cue provided

FIGURE 3

SAMPLE STIMULI IN STUDY 2



NOTE.—Color version available as an online enhancement.

by the utilization of the container attenuated the effect of variety on perceived quantity. People acted as if they anchored on 0% for nearly empty patterns and 100% for nearly full patterns and simply underadjusted in these cases. In contrast, whether the pattern was nearly empty or full did not matter for the colored dots. It could be that colored dots create a more salient Gestalt than unfilled shapes that easily garner attention even in the presence of other cues for quantity.

If the salience of the whole plays an important role, as we propose, then outlining the set of items such that the overall area is obvious and clearly demarcated should reduce or eliminate the variety effect. The next study tested this prediction by manipulating whether the items in the set were outlined as a salient intact group or not.

STUDY 2

Method

Fifty-seven people completed this study in exchange for an entry into a $50 lottery. People estimated the quantity of items in 20 different patterns of red and blue dots each presented for 750 milliseconds using the procedure from study 1. The pattern stimuli were created using a 5 × 2 × 2 full factorial design on percentage filled (30%, 40%, 50%, 60%, 70%), number of different colors (single, multiple), and salience of the overall area (not highlighted, highlighted by a shaded figure). The pattern of dots for each level of percentage filled was randomly generated within a 10 × 10 matrix and used throughout. The single color condition randomly used either all red or all blue dots. The multiple color condition individually assigned each dot to randomly be either red or blue. The salience of the overall area was manipulated by including a shaded figure that outlined the entire set of items (see samples in fig. 3). The presence of this shaded figure should make the overall area of the set salient even when the set has a variety of different items. We predict that this will diminish the effect of variety on perceived quantity as people will still find it easy to see the whole in spite of variety.

Results

Table 2 reports the mean quantity estimates for each condition. The quantity estimates were analyzed using a repeated-measures ANOVA with the percentage filled, number of colors, and salience of the overall area as within-subject factors. The analysis found statistically significant main effects for the percentage filled ($F(4, 53) = 370.91$, $p < .0001$), number of colors ($F(1, 56) = 15.12$, $p < .001$), and salience of the overall area ($F(1, 56) = 8.50$, $p < .01$). There was also a two-way interaction between the number of colors and the salience of the overall area ($F(1, 56) = 5.86$, $p < .02$). None of the other factors reached statistical significance (all $p > .10$). Detailed contrasts were used to understand the effects and to test our predictions.

Planned contrasts indicated that when the overall area was not highlighted, people estimated that there were more items when they were a single color versus multiple colors ($F(1, 56) = 18.13$, $p < .0001$). This replicates the finding from the previous study. More importantly, this effect of variety on perceived quantity was not present when the shaded figure highlighted the overall area of the set ($F(1, 56) = 1.51$, $p > .22$). In fact, as shown in the bottom row of table 2, the nonhighlighted multiple color group deviated from the other three (all three pairwise contrasts have $p < .0001$). The special status of this condition was predicted since it was the lone condition in which the area Gestalt was broken up by variety and not reestablished with shading.

In contrast, the perceived quantity did not differ among the single color groups (highlighted and unhighlighted) or the highlighted multiple color group (all pairwise contrasts have $p > .22$). This pattern of results suggests that having items of a single color and making the overall area salient contribute in a similar way to quantity perceptions. If the two had completely independent effects, then we would expect an additive relationship. Instead, we find that making the overall area more salient has little effect when all of the

TABLE 2

MEAN QUANTITY ESTIMATES IN STUDY 2

Actual % filled	Overall area not highlighted		Overall area highlighted	
	Single color	Multiple colors	Single color	Multiple colors
30	24.3	20.4	24.4	22.9
40	42.1	38.5	41.5	40.8
50	53.2	48.1	54.0	53.6
60	63.1	59.5	66.8	66.2
70	75.4	73.9	76.9	75.5
Overall	51.6	48.1	52.7	51.8

items are the same color, and vice versa. We propose that this happens because in both cases the critical underlying effect is to make the whole salient.

We also analyzed whether the effect of variety on perceived quantity would diminish for nearly empty and nearly full patterns. After recoding the percentage filled as a linear trend on the deviation from 50%, this factor did not interact with the number of colors ($F < 1$), the salience of the overall area ($F(1, 56) = 1.38$, $p > .24$), or the full three-way interaction ($F < 1$). Thus, as in study 1, the predicted effects seemed robust regardless of how much the dots filled their container.

Discussion

This study replicated the finding from the previous study that variety lowers perceived quantity. It also helped us better understand why this happens by linking this effect to the perception of the whole. When a shaded figure highlighted the area occupied by the set, variety no longer had an effect on perceived quantity. A set with its area highlighted, regardless of whether the items varied, had the same perceived quantity as a set of identical items. This suggests that the area cue plays a critical role in the predicted effects. If the whole has already been made salient by the context, then adding variety has no effect on perceived quantity because it cannot break up the whole.

The next two studies extend the effect of variety on perceived quantity to the pouring of food, a task that is both common and consequential. If variety lowers perceived quantity estimates, then it should result in the pouring of more food. (Note that these two measures are inversely related so the direction of any predicted effects will reverse.) The final two studies did not allow consumption so that the effects of variety on quantity perception could be separated out from any effects that variety might exert on anticipated satiation. However, it is easy to imagine that people would have consumed all of the servings they poured, as they do in other settings (Wansink 2004).

The generalization of the findings in the first two studies to a pouring task should not be taken for granted. Pouring food differs from the previous estimation task in several ways: people are more active in their engagement with quantity, there is more time to deliberate, an explicit quantity estimate is not required, the task is more familiar, and the area cue may not be as obvious. In regards to this last point, we suggest that when people pour food into a container (such as a bowl or plate), they typically judge the size of the serving while standing above the container. From this birds-eye perspective, the cross section of food could appear much like the two-dimensional dot patterns used in the previous two studies. Hence, variety will affect perceived quantity when it breaks up the whole. The final two studies test whether this prediction indeed generalizes to the pouring of food.

STUDY 3

Method

This study examined how variety affects the quantity that people judge is in a food sample. A matching task was used to infer perceptions of quantity. Specifically, people poured candy into a bowl until they thought it had the same amount as a sample bowl of candy. If variety decreases perceived quantity, then people should create larger portions when they pour candy of multiple colors. To control for the expectation that variety makes consumption more enjoyable (Kahn and Wansink 2004), people were told that they would not consume the candy and should only match the quantity of the sample they had been shown.

One hundred five participants completed this study for $5 of compensation or undergraduate course credit. As a cover story, participants were told that this study examined how quickly people pour servings of candy. So that everyone knew how much to pour, participants first were shown a sample (52 grams) of brown M&M's candies in a clear plastic bowl (identical 6-inch-diameter plastic bowls were used throughout the study). Once the participants indicated that they were ready to begin, the lab assistant removed the sample so participants could not use it as a reference in the subsequent matching tasks. Participants were then given a large, 32-ounce plastic cup containing 416 grams of brown M&M's and asked to pour the candy into an empty plastic bowl until it matched the sample they had seen. While they poured the candy, a lab assistant timed them with a stopwatch to support the cover story. This practice task allowed people to get used to pouring from the cup and provided a baseline where the color poured matched the sample color (i.e., both brown).

After completing the practice task, participants were given a new, 32-ounce plastic cup with 416 grams of M&M's to create four more plastic bowls of candy with the same quantity as the sample. The candy in this cup was manipulated between-subjects to be either a single color or an even mixture of three colors (red, green, blue). The particular color given to a person in the single color condition was counterbalanced across the three different colors. The quantity poured did not differ between any of the specific colors used (all $p > .15$), so the results were collapsed for reporting purposes. After participants finished pouring the last bowl, the lab assistant weighed the amount poured in the bowls.

Results

The primary dependent variable was the average amount of candy poured per bowl in grams. Before conducting the analysis, the data were removed for one participant who poured an amount more than four standard deviations from the mean. The results were analyzed using an ANCOVA with the color of the candy (single color vs. mixed) poured as a between-subjects factor and the amount poured in the practice task as a covariate. The practice task covariate explained a decent amount of variance in the second pouring task ($F(1, 99) = 50.95$, $p < .0001$). The results indicate that people poured more when using mixed colors ($M = 59.2$ grams) than a single color ($M = 53.0$ grams). The planned contrast was statistically significant ($F(1, 99) = 4.00$, $p < .05$). This confirms that having variety leads people to pour more candy, presumably because variety lowers the perceived quantity.

We also performed two additional analyses. First, we analyzed the pouring times using an ANCOVA with the treatment group as a between-subjects factor and the time taken in the practice task as a covariate. A planned contrast found no difference between the single color and the multiple color conditions ($F(1, 99) = 0.14$, $p > .70$). Second, we tested whether it was easier to match the sample in one of the conditions to see if this could potentially account for the results. We analyzed the unsigned deviations from the correct amount using an ANCOVA with the treatment group as a between-subjects factor and the deviation in the practice task as a covariate. A planned contrast did not find any difference in accuracy between the single color and the multiple color conditions ($F(1, 99) = 1.42$, $p > .23$). Variety did not affect the time required or the accuracy in pouring the servings in this study.

Discussion

This study extended the findings from the previous studies to pouring food. People poured 12% more into a bowl when the candy was multicolored. This effect occurred even though people knew that they could not consume the candy and everyone had been told to match the quantity with a given sample. Thus, beyond any separate effects variety might have on choosing an amount to consume, variety caused people to pour more candy into a bowl. People did this because variety presumably made them perceive that they had put less in the bowl so far.

Because this study tried to make the pouring task as natural and simple as possible, it had several limitations. First, although people were told to match the sample quantity, some may have ignored this goal. Although it is not clear that ignoring accuracy would lead people to pour more when the items had variety, we still ran a follow-up study that had people pour the candy directly on a weighing scale (with the readout covered) and found the same effects. Second, the current study did not provide any evidence that quantity perceptions contributed to the effect, although it is unclear what else people could be relying on in a matching task. The next study will link explicit quantity estimates to the magnitude of the effects. Third, this study manipulated the variety only in the items being poured and not the sample serving. This allows for the possibility of several alternative explanations, such as variety is more enjoyable to watch while pouring or variety is more difficult because it is a mismatch to the single color of the sample. The next study manipulates the variety of both the sample items and the poured items to rule out these alternative accounts. If greater pleasure of pouring variety causes the effect, then adding variety to the sample should have no effect on the quantity poured. If greater difficulty of mismatched conditions causes the effect, then the effect of pouring less with variety should reverse if the sample has mixed colors instead of a single color (i.e, an interaction). However, if our proposed process underlies the effect, then having variety in the sample should have only a main effect of making people pour less since the quantity to match will seem like less.

STUDY 4

Method

Sixty-four participants completed this study for undergraduate course credit. A matching task paradigm was employed similar to the previous study. Participants first were shown a sample of M&M's candy on a plate (identical 9-inch-diameter plates were used throughout the study). Participants were then given a 32-ounce plastic cup with 400 grams of M&M's and asked to pour the same amount as the sample onto three other plates. The sample was then hidden from view during the pouring task so it could not be used as a reference. While participants created the three plates of candy, a lab assistant timed them as part of the cover story of how quickly people pour servings. Participants repeated this matching task four times such that each person poured a total of 12 plates of candy.

The four matching tasks followed a 2×2 full-factorial design with the number of colors in the sample candy serving (one, four) and the number of colors in the candy poured (one, four) manipulated as within-subject factors. The four different colors used were red, green, blue, and yellow. The particular color used in the single color cases always stayed the same for a given participant, but it varied across participants in a counterbalanced fashion across the four different colors. The order of the tasks was also counterbalanced across participants such that each of the four combinations of the main factors appeared equally often as the first, second, third, and fourth tasks using a Latin square design. Neither of these counterbalancing factors changed the conclusions from the statistical analyses, so they will not be discussed further.

After pouring the final plate of candy, participants estimated the quantity in each of the four samples of candy they had been previously shown. With the sample within view, they answered by stating the percentage of the plate covered by the candy. We chose this measure instead of a more direct quantity estimate (e.g., grams) because a pretest showed that people found it difficult to estimate candy quantities in grams. Participants were provided examples of 0%, 50%, and 100% to make sure they understood the task. After participants finished giving these quantity estimates, the lab assistant weighed the amount that had been poured onto each of the 12 plates.

We were concerned that participants might get suspicious about the study's purpose or blindly give the same percentage estimates if the samples were all exactly the same size. Therefore, we varied the size of the sample serving to have either 55 grams or 66 grams of candy. We felt confident that this difference would be large enough that the samples would look different in spite of any predicted effects, given that 22% was nearly twice as large as the size of the effects found in the previous study. The size of the sample was counterbalanced such that each participant had two samples with 55 grams and two samples with 66 grams as part of a fractional design. In particular, everyone had a one-color sample with 55 grams, a four-color sample with 55 grams, a one-color sample with 66 grams, and a four-color sample with 66 grams. Likewise, everyone poured with one color for a 55-gram sample, with four colors for a 55-gram sample, with one color for a 66-gram sample, and with four colors for a 66-gram sample. This counterbalancing design ensured that the total quantity in the samples across all the tasks was equal between the two levels for each of the experimental factors to facilitate direct comparisons.

Results

The dependent variable was the amount of candy poured onto each of the 12 plates. Before conducting the analysis, the data were removed for five poured plates that were more than four standard deviations from the mean. Table 3 reports the means for each condition. A repeated-measures ANOVA was performed with the number of colors in the sample candy, the number of colors in the poured candy, and the size of the sample as within-subject factors. The analysis found a main effect of the number of colors poured ($F(1, 63) = 6.45$, $p < .02$), indicating that people poured more when pouring multiple colors versus a single color. People presumably perceived that they had poured less onto the plate so far when it had a variety of colors, replicating study 3. There was also the predicted main effect for the number of colors in the sample ($F(1, 63) = 6.48$, $p < .02$), whereby people poured less when matching a sample that had multiple colors versus a single color. People did so presumably because a sample appeared to have less quantity when it had a variety of colors. These two main effects were additive, not multiplicative, as indicated by the lack of an interaction between the two variety factors ($F(1, 63) = 1.66$, $p > .20$). The last two results argue against alternative explanations based on enjoyment while pouring that would not predict any effects for variety in the sample or a mismatch between the number of colors in the sample and poured candy that would predict an interaction. The pattern of results is instead consistent with our notion that a variety of colors reduced perceived quantity whether in the sample or the poured items.

The sample size and number of colors in the sample did interact ($F(1, 63) = 6.69$, $p < .02$), such that introducing variety into the sample candy did not decrease the amount poured for the larger sample size of 66 grams. Although we did not explicitly expect this interaction, a post hoc explanation is that the larger sample mostly covered the surface of the plate. People may have used this as a cue for quantity instead of any Gestalt created by a single color, in line with our hypothesis that container cues can attenuate the effect of variety on perceived quantity. There was also an expected main effect of sample size such that people poured more when given the larger sample ($F(1, 63) = 81.94$, $p < .0001$). None of the other factors in the model reached statistical significance (all had $p > .20$).

We also tested to see if the effect changed as people poured more bowls. When the number of bowls poured so far was included in the model, neither the main effect nor any of the interaction terms for this additional factor reached significance (all $p > .35$). Experience with the task did not seem to matter. We also performed the original analysis using other dependent variables. We instead used the unsigned deviation from the correct amount that was in the sample serving as the dependent variable. Neither of the main effects of variety nor their two-way interaction approached statistical significance (all $p > .20$). We finally used the pouring time as the dependent variable. Again, neither of the main effects of variety nor their two-way interaction reached statistical significance (all $p > .06$). The presence of a variety of colors appeared to have little effect on people's accuracy in pouring or the time required for pouring.

We also analyzed people's quantity perceptions of how much each sample filled the plate. Two particular results provide evidence that quantity perceptions underlie the previous pouring findings. First, percentage filled estimates were subjected to a repeated-measures ANOVA with the number of colors in the sample and the size of the sample as within-subject factors. This analysis found a significant main effect of the number of colors in the sample ($F(1, 63) = 5.05$, $p < .03$). This gives us direct evidence that people estimated that a sample appeared to have more when it had a single color of candy ($M = 49\%$) versus multiple colors ($M = 46\%$). Second, we tested whether these percentage filled estimates could help account for the pouring results.

TABLE 3

QUANTITY OF GRAMS POURED IN STUDY 4

	Sample size of 55 grams			Sample size of 66 grams		
	Single color	Multiple colors	Overall	Single color	Multiple colors	Overall
Poured color:						
Single color	58.8	54.1	56.4	66.4	66.6	66.5
Multiple colors	63.3	54.5	58.9	70.3	69.8	70.1
Overall	61.6	54.3	57.7	68.4	68.2	68.3

Because we did not have quantity estimates for the bowls actually poured, for each subject we used their sample perceived quantity estimates as a proxy for quantity perceptions. Specifically, we created an individual difference score that equaled mean percentage filled estimates for the single-colored samples divided by mean percentage filled estimates for all the samples. The latter adjustment accounts for the fact that some people generally had much larger quantity estimates than others. Hence, as a person's quantity estimates show the effects of variety more for the sample, they will have a higher individual difference score, and we would expect variety to have a greater effect on the quantity they pour. We next reran the original model on the quantity poured adding only this individual difference variable as a between-subjects factor. There was a significant colors poured by individual difference score interaction ($F(1, 62) = 4.23$, $p < .05$). This indicates that those people whose perceived quantity judgments were more influenced by variety tended to pour an increased amount when pouring a variety of colors. There was not a similar interaction between the number of colors in the sample candy and the individual difference score ($F(1, 62) = 2.30$, $p > .13$). It is not obvious why we fail to find an effect here as we would expect people with a larger individual difference score to show a greater effect from introducing variety into the sample (though the results were in the expected direction). Regardless, these analyses provide some evidence that the effect of variety on quantity poured is partially attributable to the effect of variety on quantity perceptions.

Discussion

This study replicated the finding that people pour more in a matching task when pouring from a varied assortment. It also extended the previous results in three important ways. First, the effect is not limited to just the act of pouring. By showing that the effect can also happen even when variety is in the sample, it rules out several alternative explanations such as enjoyment while pouring, misunderstanding that the food could be consumed, and so forth. Second, this study simultaneously manipulated the variety in both the sample candy and the candy used for pouring. This two-factor design helped rule out any alternative explanation based on a matching account whereby it might be easier for people to recreate a sample when the number of colors in the candy poured matched that in the sample serving. The results did not find any support for the interactive effects predicted by a matching hypothesis. Third, this study linked the predicted effects to quantity perceptions. People judged a sample to have less when it had a variety of colors versus a single color, and those people who showed this influence to a greater extent also tended to pour more candy when pouring with a variety of colors versus a single color. This pattern of results suggests that their quantity perceptions led people to put more candy on a plate when pouring with a variety of colors.

GENERAL DISCUSSION

The effects of variety on enjoyment and decision making have been widely studied. This article complements this research by asking how variety affects people's perception of quantity. Four studies showed that having variety made people perceive that a set had fewer items. This documents a perceptual influence that adds to both the variety and the numerosity literatures. This article also identifies perceived quantity as a potentially important construct for understanding how variety influences how much people consume. Variety seems to make people unknowingly pour larger servings. Given that people typically finish what they serve themselves (Wansink 2004), the current findings have potential implications for how much people consume.

We propose that these effects occur because identical items naturally consolidate into a single whole, making the set seem to occupy a larger area. Because people especially rely on the area cue when making quantity judgments (Krueger 1972; Raghubir and Krishna 1996; Vos et al. 1988), a set of identical items appears to have a greater quantity. The studies provided some evidence to support this explanation. The predicted influence appeared once a set had some items that differed but did not further increase as the set had more variety. This would be expected only if there is something special about complete homogeneity, such as it could make the whole more salient. The predicted influence disappeared if the overall area was highlighted so it remained readily apparent even when a set had variety. This suggests that having variety lowered perceived quantity largely through its influence on the salience of the whole area. This explanation helps us understand not only the current findings but also adds to our theoretical understanding of how people judge the quantity in an assortment. In particular, it shows the importance of Gestalt-type processes and the effect of individual item features on these processes. It also takes a different spin on Gestalt psychology in that the Gestalt has an extra perceptual weight beyond the simple count of items.

The current studies found that having variety reduced perceived quantity from 5% to 12%. The size of this effect typifies those found in other quantity research (Goldstone 1993; Krider, Raghubir, and Krishna 2001; Krishna and Raghubir 1997; Raghubir and Krishna 1999). Although a 10% effect may not seem that large, a person increasing their daily diet of 2,000 calories by 10% could expect to gain 20 pounds after a year (Wansink 2006). Two studies show that variety leads people to unknowingly pour larger servings. Future work should explore whether the same effects spontaneously appear in natural consumption settings. Given the likely automatic and hard-wired nature of quantity perception, we expect that the effects will extend to portion sizes and subsequent consumption.

Researchers could also consider how the current findings might help explain other phenomena. Past work shows that variety increases consumption (Kahn and Wansink 2004; Rolls, van Duijvenvoorde, and Rolls 1984). In addition to any sensory-specific satiety or anticipated enjoyment, variety may increase consumption also because it leads people to estimate smaller quantities and serving portions. People will eat more from a varied assortment if they underestimate how much they have already eaten (Raghubir and Krishna 1999; Wansink et al. 2005). Future work in this area should consider designing studies that can parcel out any effects due to perceived quantity. Likewise, future studies of variety should also gather quantity estimates as a potential explanatory variable. It is important to understand the extent to which quantity misperception might contribute to the overconsumption that can result from having variety.

The current studies focused on establishing the predicted effects and identifying boundary conditions to provide insight into the process. Future work should test how these results depend on the conditions. For example, the effect may increase when people do not explicitly focus on quantity as they were instructed to do in the current experimental setting. Alternatively, variety may not affect perceived quantity when the items vary on a feature that people do not automatically notice (e.g., small letters printed on M&M's candies). There may similarly be no effect if nearly all the items in a set are identical, such as when only a single item differs from hundreds of others. It might also be interesting to see how the effect depends on the extent to which the various items in a set are related (e.g., food items seen as a single meal versus a plate of varied snacks). Future work should also explore when the results could reverse. It could be that variety can increase the perceived quantity when an explicit variety judgment is made before the quantity judgment because people anchor on the number of types and underadjust. Likewise, people may also overrely on the number of types as a cue for quantity when recalling a past amount because the perceptual whole of the Gestalt is not salient compared to recalling the variety in the set.

We found some mixed evidence that the effect can attenuate when the container capacity can serve as a cue. Once a set nearly fills its container, variety may have little effect on perceived quantity because people simply use the container capacity as a cue. The effect may similarly depend on the shape of the container or the arrangement of the items in the set. For example, nicer restaurants often add multiple shapes and colors to create a richer presentation, which our results suggest could create a misperception that they have smaller portions (a seemingly common complaint). However, the effect of variety on the perceived quantity in a set may diminish if the items are arranged along a dimension, especially vertically, given that people tend to focus on the height dimension more when making quantity judgments (Piaget 1968). In fact, the presence of variety might even make the whole more salient if a different type of item is used to create a border around the perimeter of the set. Future work needs to determine how these and other factors influence how people perceive the quantity of varied sets. The findings in this area could potentially lead to clear recommendations for marketers in the areas of product packaging and retail presentation.

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