THE EFFECT OF PACKAGE SHAPE ON APPARENT VOLUME: AN EXPLORATORY STUDY WITH IMPLICATIONS FOR PACKAGE DESIGN

Lawrence L. Garber, Jr., Eva M. Hyatt, and Ünal Ö. Boya

We examine a range of standard package shape types and test their effects on volume perception. Results show that consumers group most existing standard packages into four distinct shape categories, including cylinders, kegs, bottles, and spatulates. Each shape type has characteristic effects on volume appearance. Geometrically complex forms appear smaller than simple forms, suggesting that containers displaying different levels of geometric complexity evoke different consumer estimation strategies. For compound complex forms, composed of the conspicuous joining of two or more simple parts, including necks, shoulders, bodies, and feet, consumers key on the body as a sole indicator of volume.

Although consumers have size preferences for packaged goods, humans commonly and systematically err in their size estimations (Hundleby et al. 1992). This suggests that it is appearance of size and not actual size (Teghtsoonian 1965) that affects purchase (Yang and Raghubir 2005) and consumption (Raghubir and Krishna 1999; Wansink 1996, 2004; Wansink and van Ittersum 2003). The distinction between actual and apparent size is strategically important because marketers may then proceed to manipulate size appearance independently of actual size to meet promotional goals—so long as they understand how to do so.

The subject of this research is how one can manipulate one particular visual element—package shape—to effect a certain size appearance. It is our purpose to investigate the effects of package shape on size appearance by empirically testing a full array of package shapes commonly found on store shelves ranging from the geometrically simple to the complex.

A complicating factor for the designer and the manager seeking an optimal size appearance is that utilitarian aspects place practical limits on how large or how small a package can actually be. For example, a big bottle or box that is attractive on the shelf can pall when it has to be lugged to the car, does not fit in the pantry, pours with difficulty, or spoils before it is used up. Conversely, a tiny box may lose its charm when its contents fail to live up to the quality or refinement that its precious size suggests, or its contents are used up in the blink of an eye (Raghubir and Krishna 1999; Wansink 1996, 2004; Wansink and van Ittersum 2003).

A design solution to these utilitarian constraints may be obtained by creating the illusion of size—that is, taking a package that is sized well for performance purposes and designing it to appear larger or smaller than it actually is for presentation purposes—if one were to know how to do it. A hundred years of human performance research provides us with some information concerning how some particular visual features of containers may affect size appearance, though not all. Those visual features studied include color (for an early review, see Payne 1964) and its components: hue (according to Sato 1955, Tedford, Bergquist, and Flynn 1977, and Wallis 1935, hotter, more saturated colors cause containers to appear larger, whereas colder, less saturated colors cause containers to appear smaller), value (according to Gundlach and Macoubrey 1931, and Warden and Flynn 1926, darker values cause containers to appear smaller, and lighter values cause containers to appear larger), and luminance (according to Claessen and Overbeeke 1995, brighter containers appear larger, duller containers appear smaller).

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Certain aspects of container shape, the focus of this research, have also been studied. These include height (according to Raghubir and Krishna 1999, and Wansink 1996, for example, taller containers appear larger than shorter containers), elongation (according to Frayman and Dawson 1981, and Krider, Raghubir, and Krishna 2001, containers that exhibit a dominant dimension appear larger than those that are more square), and complexity (according to Fisher and Foster 1968, and Martinez and Dawson 1973, two-dimensional shapes of greater geometric complexity appear larger than those of simpler geometric form; Bingham 1993 and Folkes and Matta 2004 found the same for three-dimensional forms).

Of the aforementioned research that examines the effects of shape on size appearance, only Folkes and Matta (2004), Raghubir and Krishna (1999), and Wansink (1996; 2004) examine package containers. Raghubir and Krishna (1999) demonstrate the effects of overall height among cylindrical packages of various proportions (taller cylinders appear larger), and Folkes and Matta (2004) demonstrate the effects of overall shape among bottles exhibiting various degrees of taper (more severely tapering bottles appear larger). Wansink (1996; 2004) and Wansink and van Ittersum (2003) concentrate their studies on the effects of appearance on consumption. All of these studies present package stimuli individually or on a pairwise basis. It is our purpose to replicate and extend this research by considering a fuller range of package shapes, including common package forms rather more complex than those previously studied, presented in view of numbers of packages of varying shapes in a limited range of sizes, a context equivalent to store shelf facings, for purposes of external validity.

The latter is important because other visual research shows that the context in which target package stimuli are presented also affects size appearance (Sigman and Oltman 1977). For example, aspects of context that have been studied include the presence and number of extraneous or distracter objects (Goldstein 1961 found that size appearance is reduced when the target object is presented in the context of more than five extraneous objects), their size (Coren and Miller 1936 showed that objects appear smaller when presented in the context of larger objects, and larger when presented in the context of smaller objects), arrangement (Warden and Flynn 1926 showed that the apparent weights of objects depended in part on the arrangement of differently colored objects, including the degree of contrast with adjacent objects), and relative spatial positions (Goldstein 1961 found that size appearance varied with relative spatial position and viewing angle). We emulate the context of convenience store shelves in our experiments by presenting packages in the context of several other packages (i.e., sets of 20 for Study 1 and 16 for Study 2 presented in the following), and control for the above effects by rotating the order of presentation and masking all visual package elements apart from their shape.

Also shown to affect apparent size, apart from visual cues intrinsic to objects and the contexts in which they are presented, are the cognitive styles that viewers may employ to estimate or infer object size. Specifically, it has been shown in certain contexts that the manner by which viewers infer or estimate size can vary according to the geometric complexity of the object (Folkes and Matta 2004) and its context (Sigman and Oltman 1977). In particular, the roles of memory and attention have been examined. With respect to memory, it has been shown that when objects are familiar to the viewer, information about the object in memory may be accessed and used to infer size, in lieu of the visual sensory information that is immediate (Bingham 1993; Slack 1956). With respect to attention, the chosen size estimation strategy may be a function of the amount of cognitive resources that the viewer chooses to allocate to the task (Masin 1999), as well as the relative amount of attention that is allocated between two or more objects being compared (Folkes and Matta 2004). In particular, it has been shown that processing time increases with the complexity of the object being assessed, suggesting that estimation strategies may be swapped due to the difficulty of the estimation task (Spence 2004).

In summary, the focus of our research is package shape and its effect on the perceived volume of package containers. Specifically, we (1) propose a taxonomy that allows the designer and manager to classify and describe the component parts of complex package shapes, and estimate their respective effects on volume estimation; (2) provide a methodology that allows the designer and manager to classify packages visually by shape, and estimate their relative effects on volume estimation (over and above actual volume); (3) use the above results to infer the heuristics that consumers employ when estimating the volumes of a diverse array of packages; and (4) discuss implications for the designer or the manager faced with the creation or the selection of new packaging.

CONCEPTUAL DEVELOPMENT

The Effect of Height

One class of package volume estimation strategies derives from the geometric notion that in order to *accurately* estimate volume, the linear dimensions of a container must be attended to and estimated first (Krider, Raghubir, and Krishna 2001; Raghubir and Krishna 1999). Volume is calculated as the product of these dimensions (i.e., height, width, and depth). Error is introduced into the process as humans resort to simplifying heuristics to reduce the cognitive load that such a complex calculus imposes. Considerable empirical support has been found in several contexts, including packaging, that height (Raghubir and Krishna 1999) or the elongation of the vertical dimension (Frayman and Dawson 1981; Wansink and van Ittersum 2003) predominates over width and depth as indicators of volume, and is often the only dimension resorted to by humans who abhor covariance (Jenkins, McGahan, and Richard 1994).

Often referred to as the height-size illusion in the human factors literature, it is a specific example of a general behavior in which humans, when confronted with information that is too complex, tend to adopt overly simple hypotheses or strategies for solutions (Shermer 1997, p. 59). In the case of the height-size illusion, that overly simple hypothesis is "if taller, then bigger; if shorter, then smaller."

However, the height-size illusion has been tested on only a limited range of forms. In the human factors literature, it has been demonstrated for irregular forms such as trees (Bingham 1993) and, most commonly, the human figure (Hundleby et al. 1992), and on simple forms such as boxes (Clayton 1994). In the marketing literature, where size estimation research is sparse, the height-size illusion has been demonstrated for cylinders of different proportions (Raghubir and Krishna 1999). Clearly, this list overlooks whole categories of container shapes commonly found on store shelves, most particularly bottles and jars, which come in a vast array of shapes and sizes. We therefore cannot know if the height-size illusion holds for all extant package shapes. Prior research has suggested that as forms become more complex, dimensions become harder to discern and to estimate. Teghtsoonian (1965) reports that judgments of size correspond less to actual physical size when subjects do not judge linear dimensions. Therefore, we ask,

Research Question 1: Is height a robust predictor of apparent package volume for all shape types, however complex, or only simple ones?

The Effect of Shape Complexity

But what happens if height is not salient? Folkes and Matta (2004) argue that for sufficiently complex forms such as tapered bottles, the prior processing of linear dimensions may be discarded altogether as too taxing, and that the direct processing of shape in a holistic manner is simpler. Their argument therefore suggests that in the case of sufficiently complex forms, the consumer switches estimation strategies, opting for a qualitatively different approach that is more heuristic in these instances. This suggests that differing estimation strategies may result in differences in size appearance in addition to the possibility that there are intrinsic differences in the size appearance of forms at varying levels of complexity.

Packages of simple shape may therefore appear systematically larger or smaller than packages of complex shape that are the same size. Prior research shows conflicting results. For example, Raghubir and Krishna (1999) report that cylindrical packages whose circumferences vary more widely across their length appear larger than those whose widths vary less, suggesting that more complex forms appear larger than simpler forms. Folkes and Matta (2004) report that bottles whose necks exhibit more taper appear larger than bottles whose necks exhibit less taper, also suggesting that more complex forms appear larger than simpler forms. On the other hand, Martinez and Dawson (1973) report that for two-dimensional shapes of equal area, those with greater perimeters such as stars and irregular figures appear smaller than those with lesser perimeters, such as triangles and quadrilaterals, suggesting that simpler forms appear larger than more complex forms.

However, all of these studies are limited in some way or another. Raghubir and Krishna (1999) and Folkes and Matta (2004) examine the varying proportions of single forms, cylinders and tapered bottles, respectively, both of which are relatively simple forms, and they present their stimuli on a pairwise basis. Martinez and Dawson (1973) examine a greater range of shapes from the simple to the complex, and have their subjects rank order their forms so that all the shapes are in evidence through the course of their study, a more externally valid context for portraying store shelf contexts; but their stimuli are not packages but two-dimensional forms. We therefore conclude that research treating the effect of object shape on apparent size, particularly objects as package containers, is incomplete (Raghubir and Krishna 1999) and its results mixed. We therefore ask,

Research Question 2: Do simple forms appear larger or smaller than complex forms of the same size?

The Effect of the Simple Parts Comprising Complex Compound Forms

Folkes and Matta (2004) argue that as package forms become sufficiently complex, consumers abandon dimensions as indicators of size and take a more holistic approach to size estimation, looking to overall shape instead. But, Folkes and Matta examined only a limited range of complex forms, bottles exhibiting varying degrees of taper. These are forms that, though more complex than Raghubir and Krishna's (1999) cylinders, are still relatively unified, such that a holistic view of shape would provide a relatively heuristic reference for expedient viewers. But there is another class of forms common to packaging, as yet unstudied, whose shapes are not so unified. Made up of parts we can segment "at regions of deep concavity" (Biederman 1987, p. 117), packaging examples would include salad dressing bottles, composed as they are of a stack of distinct parts, including caps and necks, shoulders, bodies, and feet, each of which has their own volume and exhibits distinctive shapes. How might these forms be evaluated by consumers? What cognitive styles might they evoke? Which parts might expedient consumers look to as a heuristic approach to size estimation?

Biederman (1987), a visual psychologist, does not offer a theory of volume estimation but rather introduces what is now the prevailing theory of object recognition, which gives us clues as to how consumers may go about estimating the volumes of complex compound forms. Called recognition-by-components (RBC) theory, it provides a means by which we may define, measure, and compare volumetric shape complexity. RBC takes a decompositional approach to perceptual object recognition, "representing objects by parts or modules" (Biederman 1987, p. 120). RBC theory suggests that the recognition of objects comes from the prior processing of the simple volumes that comprise a compound complex form, which are subsequently integrated into whole objects by the brain, thereby suggesting that consumers may naturally look to one particular part of compound complex packages to assess their size, just as they look to height for simple forms (Raghubir and Krishna 1999), or to shape in simple packages of increasing complexity (Folkes and Matta 2004). It would therefore stand to reason that for packages composed of several simple parts, consumers may base their volume estimation heuristic on their assessment of some particular one of these parts. We therefore ask,

Research Question 3: Do some simple parts of complex compound forms have a greater effect on the size appearance of the whole package than others?

STIMULUS DEVELOPMENT

For reasons of external validity, we test the effects of shape on size appearance using actual packages. Selecting packages to correctly represent a full range of certain shape types at certain size levels becomes the issue. Prior research examined variations on single shapes and did not attempt to represent a full range of shapes as we are, so there is no precedent for stimulus selection of the sort that we are doing. Herein we propose and execute a two-stage method. In the first stage, we seek to identify the full range of package shapes extant on store shelves, and to know if there is some finite number of standard shape prototypes into which all standard package shapes belong, according to their similarity. If the latter is true, we may then test the effects of these respective prototypes on volume estimation in pursuit of answers to our research questions. In the second stage, we seek to identify and select for experimental purposes a set of packages that discretely represents each particular shape prototype identified from Stage 1, at each of several levels of actual size, for a fully crossed design.

Stage 1 Stimulus Selection

We inspected the store shelves to identify a set of candidate packages to serve as shape/size stimuli. Our perusal yielded the 20 packages listed in Table 1, which represent a wide range of standard package shapes extant on store shelves. We excluded idiosyncratic shapes, such as the anthropomorphic Mrs. Butterworth's bottle, because our focus is on package shapes that are common and recurrent across categories and sizes. For reasons of tractability, in the following, we attempt to reduce these 20 representative packages to smaller, more parsimonious groups sharing shape characteristics.

Forty-eight subjects, 71 percent female and 29 percent male, all undergraduate students of traditional college age attending a public university in the southeastern United States, were assigned the task of judging the relative (dis)similarity of every pairwise permutation combination of the 20 aforementioned packages.[1]

An important procedural issue is raised by the fact that we are asking respondents to evaluate a relatively large number of stimulus pairs. The pairwise comparison of all permutation combinations of 20 stimuli yields 20 * (20 – 1)/2, or 190 pairs. Survey research orthodoxy would suggest that 190 stimulus pairs is far too many for respondents to be able to evaluate without fatigue, thereby degrading reliability (Wilkie and Pessemier 1973). We sought to address this problem in two ways: first, by reducing the level of data that we required (we solicited association rather than ratings data, as described in the following), thereby simplifying the respondent task; and, second, by creating and providing a set of physical aids to help organize and structure, and thereby facilitate, the respondent task. Specifically, respondents were

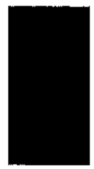
Table 1
Stage 1 Stimuli Ordered By Size

Description	Unmasked	Masked	Height (cm)	Maximum Width (cm)	Minimum Width (cm)	Elongation (height/width)	Net Volume (ml)	Shape Type
1. Heinz Baby Food			6.6	6.2	4.8	1.07	119	Keg
2. Inglehoffer Mustard			6.3	6.1	4.3	1.03	119	Keg
3. Maille Mustard			9.8	6.2	4.7	1.58	222	Keg
4. Hellman's Salad Dressing			18.3	9.0	4.4	2.03	236	Spatulate
5. Gulden's Mustard			9.7	7.3	4.2	1.33	237	Cylinder
6. Ken's Salad Dressing			18.6	9.0	3.9	2.06	237	Spatulate
7. Kraft Salad Dressing			17.0	7.6	3.5	2.24	237	Spatulate
8. Lawry's Salad Dressing			17.3	6.7	3.5	2.00	237	Spatulate

(continues)

Table 1
Continued

Description	Unmasked	Masked	Height (cm)	Maximum Width (cm)	Minimum Width (cm)	Elongation (height/width)	Net Volume (ml)	Shape Type
9. Food Lion Mouthwash			17.3	7.2	3.1	2.40	250	Bottle
10. Listerine Mouthwash			17.2	8.0	2.6	2.16	250	Bottle
11. Bama Jelly			10.4	7.6	5.7	1.37	296	Keg
12. Welch's Jelly			10.3	7.0	5.6	1.47	296	Keg
13. Girard's Salad Dressing			21.1	9.7	3.1	2.19	354	Cylinder
14. Four Monks Vinegar			21.0	7.0	2.9	3.00	355	Bottle

15. Pantene Pro-V Inverted			22.0	7.3	2.9	3.03	384	Cylinder
16. Pantene Pro-V Regular			21.7	5.5	5.0	3.95	384	Cylinder
17. ReaLemon Juice			18.3	8.9	3.7	2.06	443	Spatulate
18. HarrisTeeter Lemon Juice			18.6	7.6	3.0	2.45	473	Bottle
19. Heinz 28 oz. Ketchup			24.0	10.0	3.5	0.24	830	Spatulate
20. Heinz 32 oz. Ketchup			20.8	10.2	3.5	2.04	948	Spatulate

given poker chips and a large board. On the board was a 20×20 matrix. The left-hand column and top row were filled with photos of each of the 20 package shape stimuli, painted gray to mask brand and category identities, and all other visual elements.

Respondents were placed before the board by a test administrator and given a set of poker chips. They were instructed verbally to first consider the package at the top of the left-hand column. They were to then compare the shape of that package to each of the packages in the top row, in turn. For each pair, respondents were to consider whether they felt that the respective shapes of the two packages were relatively more alike than different, or more different than alike. If they felt that the respective shapes were more alike than different, they were to place a poker chip in the empty cell in the first row that corresponded to those two packages. The respondents were told that they could place as many or as few poker chips as they felt were appropriate, that there were no wrong answers, and that we were interested only in their perceptions. Respondents were told to go on to the next row only when the first row was completed, and to go on to fill out all the rows in the matrix. Respondents filled out only the top right-hand matrix, or the bottom left-hand matrix, to avoid duplication and repetition. Four different boards were constructed, to permit rotation of the stimuli in several ways across respondents, so as to eliminate order bias. In addition, respondents performed the (dis)similarities task twice, once placing poker chips on those pairs that were deemed relatively more similar than different, and once on those pairs deemed relatively more different than similar. (Results were consistent.) The order of these two tasks was rotated across subjects, and the boards rotated as well, to once again eliminate order bias.

We performed two reliability checks, one timed and the other self-reported. We timed respondents at the (dis)similarities tasks, finding that respondents took an average of six minutes to evaluate 190 stimulus pairs, suggesting that subjects found no difficulty in evaluating so many pairs, performing the task swiftly and with confidence. We then asked respondents upon completion whether they found the task to be too demanding, and whether they felt confident that their evaluations were "correct." Virtually all respondents reported that they found the task to be undemanding, and that they were confident in their evaluations. We conclude that subjects were able to perform the (dis)similarities tasks comfortably and reliably, using our aids.

The (dis)similarity associations data were analyzed using the SAS MDS procedure (SAS Institute 2004, vol. 4, pp. 2469–2508) as a data reduction tool. The scree test was used to select the four-dimensional solution. Maps with higher dimensionality did not explain substantially more variance. Four separate clusters of packages were distinguished by shape appearance according to their respective positionings in a four-dimensional solution that accounted for 48 percent of explained variance. Separate solutions were run for both similarities and dissimilarties data, and the results for both were identical in terms of the four clusters that were derived, and the packages that comprised each of them. These four package shape types are interpreted as follows, and are shown in Table 1, where the right-hand column designates the shape groups to which each package belongs.

> *Group 1: Kegs.* Includes packages that are *keg-like,* with short, wide necks, broad shoulders, wide, round, barrel-like bodies showing large girth but that tend to also be curvilinear, sculpted or tapered, and definite feet.

> *Group 2: Spatulates.* Includes packages that are *spatulate* in shape, with relatively tall cylindrical necks, wide or narrow shoulders, shallow, tapered bodies, and definite feet. These are shapes commonly found in salad dressing bodies.

> *Group 3: Cylinders.* Includes packages that are relatively *cylindrical* in shape, with no neck, small shoulders, vertical bodies, and unpronounced feet.

> *Group 4: Bottles.* Includes packages that are *bottle-shaped,* with relatively large, cylindrical necks, square shoulders, vertical bodies, and definite feet.

Stage 2 Stimulus Selection

In contrast to selection of the first stimulus set, where the intent was to test as diverse an array of package shapes as possible, the objective for selection of the second stimulus set was to identify the most typical examples of each of the four previously determined package shape types—cylinders, kegs, spatulates, and bottles—at each of four size levels, within a limited range of sizes, in a fully crossed, full factorial design. We again went to the grocery store and selected 16 bottles according to these criteria, and performed the following manipulation check to confirm they properly represent the levels of shape and size dictated by our experimental design.

Manipulation Check

To assure that the 16 package stimuli are calibrated properly—that is, to assure that each of the selected packages correctly represents the respective shape types to which we assigned them—we performed a manipulation check. We asked a separate set of 79 student subjects, 58 percent female and 42 percent male, to group the 16 package stimuli according to similarity of shape appearance, indicating that they could make as many or as few groupings as they wished. Of the 79 subjects, 29 of them, or 36.7 percent, initially grouped the packages exactly according to our four a priori shape types. Of the remaining 50 subjects, one subject formed three groups. All of the other subjects initially formed more than four shape-type groups, ranging from five to as many as 11 groups.

We then asked those subjects who formed more than four shape-type groups to reduce the number of groups by one, and to repeat that exercise until they were down to four shape groups. For example, if a subject initially formed six shape groups out of the 16 packages, we would then ask them to make five groups out of the six, and then repeat to make four groups out of the five. We then compared the final four groupings of the 50 subjects who started with more than four groupings, with our four a priori groupings. Of these, 82.2 percent matched our a priori groupings with their final four. We take these results to be a strong indication that the 16 stimulus packages correctly represent the respective shape types to which we assigned them a priori. Upon completion of this task, subjects were subsequently asked to describe what each of the package shape groups had in common. Their responses generally corroborated the package shape-type descriptions provided earlier in this paper.

The resulting 16 bottles and jars are shown in Table 2. They range in size from 236 mls (milliliters) (Hidden Valley Salad Dressing) to 467 mls (B&M Baked Beans), and in height from 2 cms (centimeters) (Harris Teeter Mushrooms) to 24.2 cms (Cardini's Salad Dressing).

A TEST OF PACKAGE SHAPE TYPES ON VOLUME ESTIMATION

In a 4 × 4 within-subjects design, shown in Figure 1, the same 79 subjects employed for the Stage 2 package stimulus selection were assigned the task of judging by purely visual means the relative volumes of the 16 packages derived therein. The first manipulation is package shape type, the second is size. Each of the four packages selected to represent one of four shape types is also selected to represent one of four size levels in a fully crossed design. Subjects performed two estimation tasks. Experimental participants first rank ordered all 16 packages by volume, then, following Raghubir and Krishna (1999), assigned milliliters to each of the packages using a 355 ml soft drink can as reference, obtaining ratio data.

Method of Analysis

Two sets of regression models were fitted to these data using the SAS GLM procedure (SAS Institute 2004, vol. 3, pp. 1731–1906). The dependent variable in the first set is rank-order data. The dependent variable in the second set is estimated volume in milliliters. The predictor variables in both sets are shape type. Actual volume and height are covariates. Following Raghubir and Krishna, a large number of models were run during this phase to "identify the most parsimonious models and counter any alternative explanations for regression results" (1999, p. 317). Results are shown in Table 3.

Results for Height

As shown in Models 1 and 2 of Table 3, controlling for actual volume, there is a significant main effect of height on perception of volume for both the rank-ordering task ($\beta = 0.25$, $t = 16.77$) and the milliliter estimation task ($\beta = 4.02$, $t = 11.57$), confirming the height–size illusion for all shape types. As a conservative test of shape type, all subsequent models were run using overall package height along with actual volume as covariates, such that any results reported for shape type are over and above the effect of actual volume and overall package height. In answer to Research Question 1, height is a robust predictor of package volume for all package shape types.

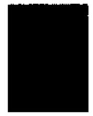
Results for Package Shape Type

Controlling for height and actual volume, we find that shape also significantly affects volume appearance. We find that kegs do not appear to be significantly smaller than cylinders ($\beta = -0.08$, $t = -0.35$; $\beta = -3.61$, $t = 0.66$), and that cylinders appear significantly larger than spatulates ($\beta = -1.75$, $t = -4.20$; $\beta = -60.25$, $t = -6.18$) and bottles ($\beta = -3.33$, $t = -5.83$; $\beta = -93.06$, $t = -6.94$), as shown in Models 3 and 4 of Table 3. These results indicate that differently shaped package containers affect perceived size differently, and further suggest that certain package shape types appear characteristically and systematically larger or smaller than their shape counterparts, such that

Cylinders = Kegs > Spatulates > Bottles.

Table 2
Stage 2 Stimuli Ordered By Size

Description	Unmasked	Height Masked	Maximum (cm)	Minimum Width (cm)	Elongation Width (cm)	Net (height/width)	Shape Volume (ml)	Type
1. Hidden Valley Salad Dressing			17.2	7.6	3.6	2.26	236	Spatulate
2. Harris Teeter Mushrooms			7.0	6.7	6.6	1.04	240	Cylindrical
3. Alessi Vinegar			18.8	5.8	2.5	3.24	250	Bottle
4. Classico Spaghetti Sauce			9.1	7.7	5.7	1.18	270	Keg
5. Mt. Olive Sweet Relish			18.5	7.1	2.1	2.62	295	Spatulate
6. House of Tsang Soy Sauce			21.5	5.9	2.5	3.68	296	Bottle

7. Martinelli's Apple Juice			10.5	8.2	3.5	1.28	296	Keg
8. Old El Paso Taco Seasoning			12.9	6.7	7.3	2.26	236	Cylindrical
9. Consorzio Marinade			21.0	7.8	3.5	2.69	354	Spatulate
10. Mt. Olive Hot Dog Relish			8.8	9.0	5.5	0.98	355	Keg
11. Bunker Hill Gravy Beef			11.2	7.5	7.3	1.49	360	Cylindrical
12. Cardini's Balsamic Vinaigrette			24.2	6.2	2.8	3.90	370	Bottle
13. Jarrito's Limon			23.8	6.7	2.5	3.55	400	Bottle

(continues)

Table 2
Continued

Description	Unmasked	Height Masked	Maximum (cm)	Minimum Width (cm)	Elongation Width (cm)	Net (height/width)	Shape Volume (ml)	Type
14. ReaLemon Juice			17.8	17.8	3.6	1.93	443	Spatulate
15. Harris Teeter Parmesan Cheese			15.4	7.4	6.5	2.08	450	Cylindrical
16. B&M Baked Beans			11.8	11.0	5.9	1.07	467	Keg

Figure 1
4 x 4 Within-Subjects Design, Stimulus Set 2

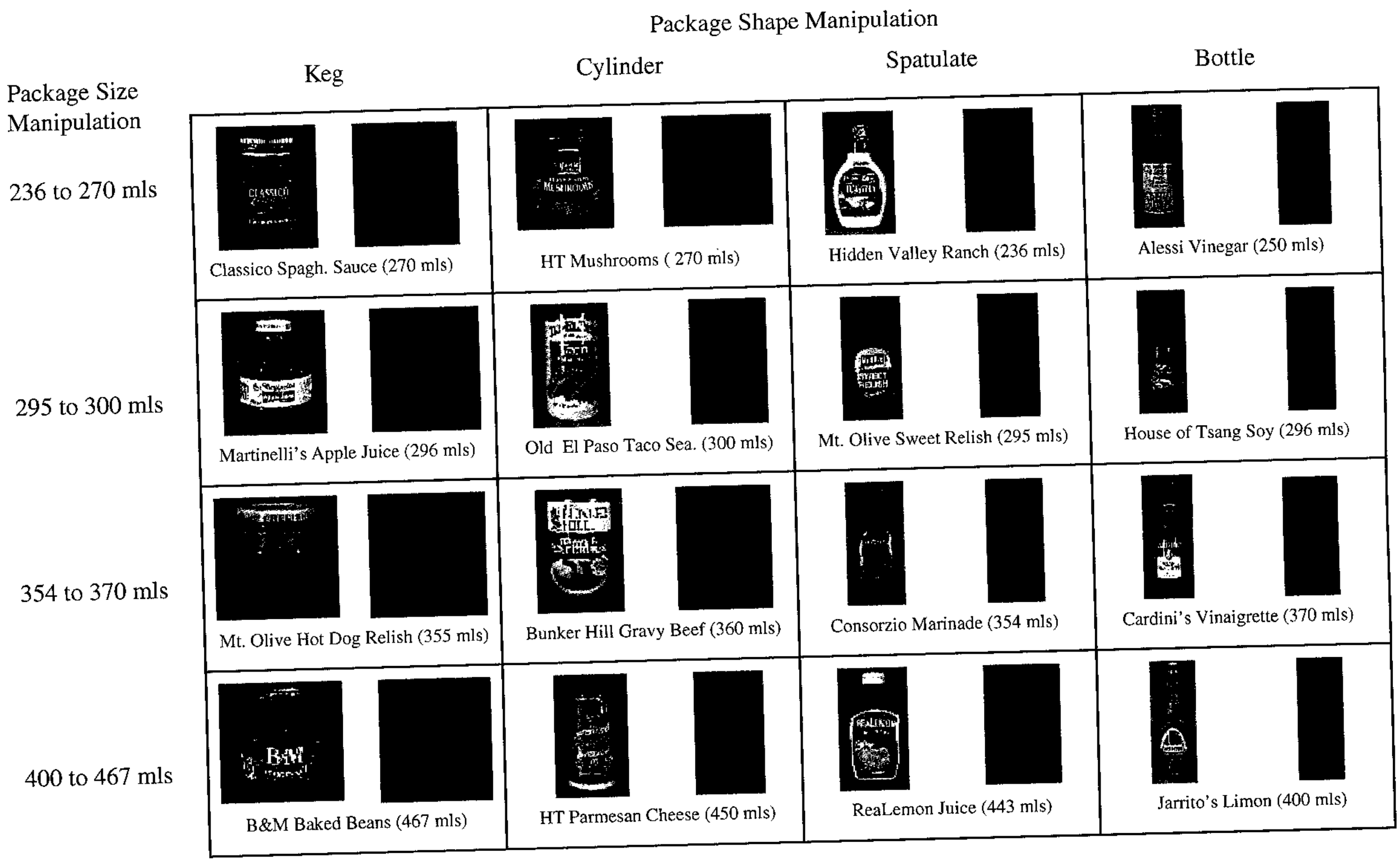


Table 3

Regression Models Testing the Effects of Geometric Shape Complexity, Shape Type, and Shape Parts on Package Volume Perception

Form of Volume Estimation (dv)	Models 1 and 2		Models 3 and 4		Models 5 and 6 Package A of Figure 5		Models 7 and 8 Package B of Figure 5		Models 9 and 10 Package C of Figure 5	
	Rank Order	Milliliters	Rank Order	Milliliters	Rank Order	Milliliters	Rank Order	Milliliters	Rank Order	Milliliters
Net Volume	0.04***	0.78***	0.04***	0.65***	0.05***	0.78***	0.04***	0.76***	0.04***	0.70***
	(41.32)	(30.52)	(27.85)	(19.01)	(37.45)	(27.63)	(24.91)	(18.43)	(21.46)	(15.68)
Overall Height	0.25***	4.02***	0.49***	11.00***	0.09***	0.26***	0.17***	1.43***	0.26***	2.93***
	(16.77)	(11.57)	(9.81)	(9.43)	(2.11)	(0.25)	(5.58)	(2.05)	(7.81)	(3.74)
Keg Shape Dummy			-0.08	-3.61						
			(-0.35)	(-0.66)						
Spatulate Shape Dummy			-1.75***	-60.25***						
			(-4.20)	(-6.18)						
Bottle Shape Dummy			-3.33**	-93.06***						
			(-5.83)	(-6.94)						
Cap and Neck Dummy					-0.11	-9.89	-0.30	-8.30	0.49	12.70
					(-0.28)	(-1.04)	(-0.72)	(-0.86)	(1.71)	(1.89)
Shoulders Dummy					-1.27*	-17.96	0.55**	7.05	-1.21***	-18.50*
					(-2.12)	(-1.28)	(2.40)	(1.32)	(-3.88)	(-2.52)
Body Dummy					1.81***	46.23***	1.52***	44.38***	-0.80*	-33.12***
					(4.35)	(4.74)	(4.16)	(5.18)	(-2.46)	(-4.34)
Foot Dummy					0.88*	18.12*	0.16	8.09	-0.61*	-15.91**
					(2.28)	(2.01)	(0.57)	(1.26)	(-2.47)	(-2.73)
R^2	0.663	0.646	0.675	0.661	0.671	0.657	0.671	0.671	0.673	0.658
Adj. R^2	0.640	0.622	0.652	0.637	0.647	0.633	0.648	0.648	0.650	0.634

Notes: The numbers in the table are β- and *t*-values, respectively. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

In answer to Research Question 2, we find that simple forms such as cylinders and kegs appear larger than more complex forms such as spatulates and bottles.

Results for the Simple Parts Comprising Complex Compound Forms

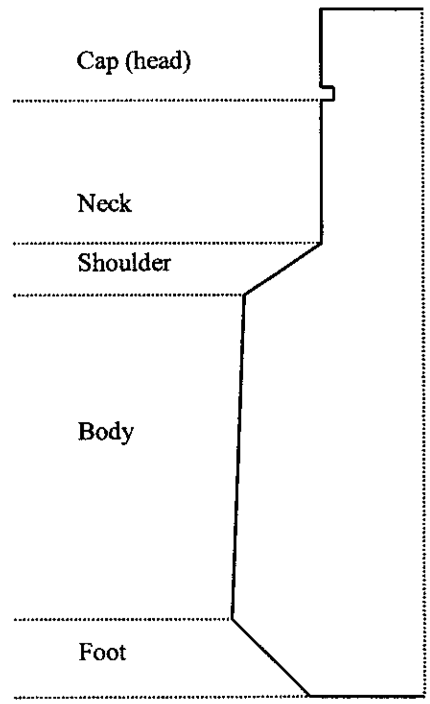
RBC theory suggests that the recognition of compound complex forms proceeds from the prior processing of the simple parts that comprise them. But what are these simple parts? In Biederman's (1987) vernacular, these simple forms are called geons, and he identifies 32 types according to their respective shapes. However, utility requirements constrain the range of shapes that packages may take.

For example, for reasons of stability, stackability, and pourability, most conventional package shapes are upright containers with parallel planar tops and bottoms. They are also either symmetric around the vertical axis (ignoring handles and spouts, as we do in this research) or radially symmetric (i.e., they are round when viewed from above) or bilaterally symmetric on their facing side (i.e., their depth may vary from their facing width). Therefore, the parts that make up those compound complex forms that are bottles and jars are stacked; caps sit on necks, which in turn sit on shoulders that sit on bodies, that sit on feet. This stacked arrangement is analogous to that of the human body, with the exception that, in the case of packages, one or more of these parts may be absent. We therefore propose and adopt a taxonomy for comparison and modeling purposes based on the human form, in which a package may exhibit as many as five or as few as one simple parts, as shown in Figure 2.

We then sought to test for the relative effects on apparent volume of the respective simple shape parts comprising complex compound forms. Is there some particular part that will explain most of apparent volume? In other words, does the subject key on some particular shape part, the neck, for instance, or the body, to infer the volume of packages that are complex in shape? As they use height for simple forms? To answer these questions, we fitted a series of regression models whose independent variables were dummies representing each of the simple shape parts associated with standard package shape types: caps and necks (which tend to be unified by design), shoulders, bodies, and feet.

A complicating issue with respect to these model specifications was that each of these parts could take different shapes that in themselves could affect the size appearance of the package as a whole. In general, the range of possible shapes these parts can assume is two—taller or wider. Therefore, to be sure that we are comparing apples to apples, we fitted three separate regression models to test the relative effect

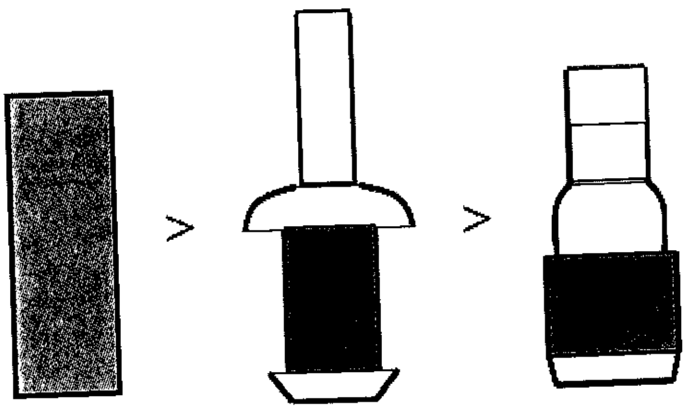
Figure 2
Package Part Taxonomy



Notes: Because most bottles and jars are symmetrical around the vertical axis (excluding handles), one can think of the distinct parts as stacked one on top of another, and analogous to the human form (though with bottles and jars, one or more of these parts may be missing!). We measured these in terms of height, width, taper, depth, and so forth.

of each shape part—one model with all tall parts (wide in the case of shoulders), one model with all short shape parts (narrow in the case of shoulders), and one with no shape parts besides the body. These hypothetical shape parts and the packages that comprise them are shown in Figure 3. Each representation is of equal area. Each representation in Figure 3 is of equal area. Our research indicates their correct rank ordering by appearance by size to be as indicated in the figure. Inspection of Figure 3 may suggest otherwise, but this discrepancy may be reconciled by the contexts in which packages are viewed and evaluated. On store shelves, many forms of disparate shapes are viewed and evaluated simultaneously in an information-laden visual context, evoking a very different, more heuristic, estimation strategy on the part of consumers than that evoked when viewing the simple graphic in Figure 3. In the more visually cognitively demanding store-facing context, our research suggests that visually expedient consumers key on a single simple part of the whole form to infer size—namely, the body. Because, by definition, the body of the simple package is the whole package, as in the left-hand part of Figure 3, it naturally appears

Figure 3
The Relative Appearance of Simple and Two Kinds of Hypothetical Complex Forms



larger when viewers compare it to the bodies of the more complex forms shown to the right, even though all the forms are the same size in terms of surface area, and the middle figure is taller. Because the height-size illusion has been shown by this research to be robust across all forms, and for the simple parts of complex forms, then the taller form of the middle figure causes it to appear larger than the right-hand figure when viewed in a store context. We are testing shape parts separately to determine if one has a disproportionately greater effect on size appearance than the others.

As shown in Models 5 through 10 of Table 3, controlling for actual volume and overall height, in five of six cases, the body is the most important predictor of perceived volume. For example, in Model 5, results show that the body dummy ($\beta_{body} = 1.81$, $t_{body} = 4.35$) is the most strongly significant of the four shape dummies included in that equation, based on the relative sizes of the respective βs and *t*-values of the shape parts. This suggests that, just as shoppers may look to overall height as a sole indicator of size for simple forms, they look to body shape as a sole indicator of size for more complex forms. Therefore, in answer to Research Question 3, some simple parts do have a greater effect than do others on size appearance—namely, the body. This argument may seem to contradict the well-established height-size illusion for simple forms until one remembers that a purely simple form is composed of nothing but body, and that the height of that shape part is therefore also overall height, suggesting that the height-size illusion is a special case of a more general heuristic, applicable to packages of all shapes, including complex compound forms.

SUMMARY OF RESULTS

In this paper, we examine the effect of a full array of standard package shape types on volume appearance. Our results show that (1) package shape has an effect on perceived volume over and above height; (2) there are four standard shape types as they are grouped in the minds of consumers, which we call cylinders, kegs, bottles, and spatulates; (3) each shape type presents a distinct volume appearance; (4) geometrically simple forms appear larger than geometrically complex forms; (5) the bodies of compound complex forms have a disproportionate effect on volume appearance relative to the other simple parts of compound complex packages; and (6) tall bodies contribute to a larger overall package volume appearance than do short bodies.

MANAGERIAL IMPLICATIONS

Although package shape is manipulated by the designer for marketing mix purposes (in particular, complex shape is utilized to gain notice, communicate a unique identity, and convey favorable brand-specific meanings), the primary import of this research to designers and selectors of packages is that their shape decisions will also invest their designs with a size impression that may influence consumer choice.

Complexity

We find that shape complexity, manifested in packaging as the amount of variation in a package's side profile or silhouette, ameliorates the effect of overall height, tending to diminish size appearance. It would appear, then, that the size meanings of complex containers are intrinsically conflicted. They are nested, opposing forces. Height imposes a robust effect on volume appearance, but package shape apart from height also has a significant effect on volume appearance. And the more complex the package shape, the smaller it appears, given its height. This finding indicates that when the designer complicates a form in order to achieve unique identity, he or she may be doing so at the cost of losing size appearance.

Designing Favorable Size Appearance

Making Packages Appear Larger

In order to manipulate package shape so a package appears maximally larger than it actually is, keep its form simple and tall. Examples would be soft drink cans or cereal boxes. If for utility or marketing mix purposes one cannot have a tall package, it is best to keep the form simple and elongate it horizontally to provide shoppers with a clearly superior single dimension. Examples would be cylinders of cookies or crackers.

Of course, for branding purposes, marketers and designers often wish to deviate from such simple forms in order to convey unique identity and meaning by dint of unique package shapes. Such designs by their nature take the package toward more complex forms, to some degree or another. Our research indicates that there are two possible strategies for preserving greater size appearance for complex package forms.

One such strategy is to keep the form as simple as possible. It is often possible to create a unique and memorable form by incorporating distinctive but very small elements that do not break the simplicity of the overall form. These very small elements to which we refer are called interest points. An example would be to place a small notch or some other "break" into what is otherwise a long flowing line. That slight break naturally draws the human eye, thus the name *interest point:* the size of the element does not dictate the notice it creates, in fact a tiny element is often more notable than a larger element. The same principle may be applied to packages to keep their form largely simple yet distinctive. For example, a perfectly cylindrical package may be created by incorporating a cap on one end of the cylinder that is the same diameter as the rest of the package, and fits flush with the sides of the container so the contours of the cylinder are unbroken. However, one may create a more distinctive form by leaving a notch between the cap and the body, where it joins. In effect, the cylindrical package will then have a very short neck of slightly smaller diameter to the rest of the package. This would be an interest point that can make a package distinctive, can lend to brand identity, and yet preserve the simplicity, and therefore the greater size appearance, of the overall form.

Another means of modifying a simple form while maintaining its integrity as a simple form, rather than breaking its lines as in the previous example, is to slightly vary the lines themselves. An example would be to introduce some degree of taper to what is largely a cylindrical form. A curvilinear aspect also softens a form and may lend it a sculptural quality that a strictly cylindrical or rectangular form may not. Such formal qualities may not only lend a unique identity but also favorable meanings to the brand it represents. An example would be the Michelob beer bottle that the maker touts in its television advertising as a carefully crafted work of art, suggesting that the beer that it holds is also a carefully crafted work of art. For all of that, its size appearance is also preserved by the simplicity of form that it retains.

A means of making compound complex forms appear larger is to make their bodies prominent and tall. Our research indicated that, as height is used as a single indicator of size for simple forms, body and body height are used as the single indicator of size for complex, compound forms. Therefore, to preserve size appearance for such forms, the key is to minimize the cap and neck, shoulders, and feet in favor of a proportionately large, tall body. An example of such a complex form that uses this principle is the Mrs. Butterworth's bottle that is in the form of Mrs. Butterworth. If one were to examine the Mrs. Butterworth's bottle carefully, one would see that Mrs. Butterworth's head is quite small in proportion to her (literal) body. Mrs. Butterworth's skirt comprises the bottle's body, and it is evident that it is a rather simple, tall form that serves, among other things, to preserve the size appearance of this complex form. The highly rendered head of Mrs. Butterworth, which comprises the cap and neck of the bottle, is also a highly complex form, incorporating many concavities à la Biederman (1987), yet it does not detract appreciably from size appearance, both because this element is kept small in proportion to the skirt, and because our research shows that shoppers do not key on the cap and neck to estimate size. Therefore, the part of this complex form that serves to convey meaning and brand identity to the package, the head and neck, is kept separate from the part of the form that conveys size—the skirt; and the skirt is kept relatively simple in form, tall, and proportionately large. Mrs. Butterworth's is a good example, therefore, of how different parts of a compound complex package may be used to serve different communications functions in such a manner that they do not compete; in this case, allowing the package to preserve size meaning while using its considerable complexity to also communicate a strong identity and favorable brand meaning.

Making Packages Appear Smaller

If the aim is to cause packages to appear smaller, the designer needs basically to do the opposite of what one should do in order to make packages appear larger. Packages that appear maximally small are short, square, complex forms.

If the form must be kept simple, then it should be kept square, such as mustard jars. If the package must be tall and slim, then the best way to diminish its size appearance otherwise is to break it into a number of distinct parts. Add a cap, neck, shoulders, and foot to the body, and make them large in proportion to the body. If shoppers estimating size key on the body, then the relatively great extent of its other parts will accentuate the body's relatively diminished size, just as a daddy longlegs may appear small precisely because of the extent of its long legs in proportion to is tiny body. A packaging example is the Log Cabin syrup bottle, whose tall graceful form lends it a certain grace and elegance, befitting a fancy condiment, yet whose tall slim shoulders, cap and neck, and relatively small body lend it a diminutive appearance for all that height, lending its contents a special, premium quality.

Size Appearance and Consumption

Raghubir and Krishna (1999) demonstrate that packages that look larger than they actually are may ultimately disappoint in the consumption experience, because users may be disappointed when they pour out less contents than appearance causes them to expect. However, it is also to be realized that this effect is category specific and most apparent in categories where a high proportion of the contents are poured out on one usage occasion. This would be true for many beverage containers. Therefore, effecting an extreme illusion of size may not be an ideal visual strategy in this instance. However, in other categories, such as steak sauce, contents are poured out in small increments so the contents are used up only after a considerable period, and the package stays in the house for a significant period, thus reducing the sense that the contents are used up quickly. With long-lasting, slow-pouring condiments such as A1 Steak Sauce, there is not penalty for small appearance, which also provides the benefit of elegant appearance. For example, A1 Steak Sauce diminishes its size appearance by topping its small body with an elegant long neck, yielding a distinctive appearance.

LIMITATIONS AND FUTURE DIRECTIONS

Although we show that package shape affects perceived volume across a range of standard forms, it is important to determine boundary conditions for this effect.

We examine extant packages and package shapes only. This provides external validity but also creates limitations. First, there are other potential container shapes not represented by extant packages that could present a different shape appearance from those that current standard package shapes do not exhibit, or could evoke estimation strategies apart from those that these results would seem to suggest. Examples of other shapes to be considered would include some existing packages deemed idiosyncratic for purposes of this research and excluded: the big shoulders and feet of Listerine mouthwash, for instance, or the triangular pyramidal shapes of Girard's salad dressing.

There are some practical difficulties related to examining a full range of package shapes—namely, their acquisition or creation. An expedient approach would be to use two-dimensional representations of the front facings of packages of various shapes, facilitating their creation for experimental purposes. The rationale for this approach is that shoppers are less able to discern the depth dimension of packages sitting side by side on store shelves, and then only in parallax. Prior research has confirmed the insignificance of the depth dimension as an indicator of size (Raghubir and Krishna 1999), as did our own. Frayman and Coll (1981) compared the effects of geometric solids and life-sized, two-dimensional representations on apparent volume to find that geometric solids appeared larger than their two-dimensional counterparts, but also found that, within those respect modes, shape had equivalent effects, thus validating the substitution of two-dimensional representations as stimuli for volume estimation research on containers.

In our current experiments, we fully cross shape type with size (within a limited range of sizes), though not height. Some shape types are characteristically shorter or taller than other shape types of close to the same size. We therefore covaried height within our equations to experimentally control for height's effect, important because prior research has demonstrated a robust height effect. Therefore, it could be helpful to further confirm results here among package stimuli that are the same height. This is difficult to achieve using extant packages because it is hard to find packages of different shapes, particularly exhibiting differing levels of shape complexity, of equal height and close to the same volume. However, a thorough perusal of store shelves may yield a few such examples. Another means of comparison, in keeping with the prior paragraph's discussion, is to create two-dimensional shapes of equal height and similar area. Will a shape-based strategy be adopted when making comparisons in equal height circumstances? Or will estimators look to other linear dimensions? Or will the complexity of the shape mediate such choices of strategy?

Another source of effects that were beyond the scope of this research are context effects. We asked consumers to evaluate sets of 20 and 16 package stimuli with all members in full view. We used this mode of presentation, and a rank-ordering task, to simulate certain key aspects of store displays, for reasons of external validity. This method also allowed us to control for context effects by causing presentation form to be invariant for all package size evaluations. However, it may also be true that consumer choice of estimation strategy, which our prior research indicates may vary with package shape, may also vary with context, and by extension, affect the size appearance of particular shapes. For example, Folkes and Matta (2004) and Ragubir and Krishna (1999) show more complex forms to appear larger than more simple forms when they presented package stimuli on a pairwise basis, the converse of our result. Could it be that the cause of this reversal is context effects? We propose that the complexity of shape effects that we find may hold only for contexts where there is a great deal of visual information on display, thus causing viewers to evaluate individual packages more holistically and superficially than when presented with target stimuli in a less visual information-laden frame. Further research will be needed to disentangle such shape-context effects on apparent volume.

Weight, density, and haptic effects were not treated in this purely visual experiment. Can there be an interaction effect between package shape, apparent weight, or the addition of touch information? Krishna (2006) finds, for example, a reversal of the elongation effect when consumers are able to touch packages of equal weight in visually loaded conditions.

Considerable research outside marketing finds that apparent size apprehended via hefting is inversely proportional to apparent size perceived via viewing. Will such relationships hold for package containers? What would be the apparent size of packages when viewers are also allowed to heft packages? What would be the size appearance of packages in experiments when shape and weight are fully crossed?

In our experiments, we control for all other visual elements by masking the packages. Several of these have been shown to also affect size appearance (see our brief review of research concerning the size effects of color, value, etc., in the introduction section). Would there be interaction effects (Kofka 1935)?

We also control for marketing mix effects by excluding all aspects of store displays such as prices, brand identity, promotional messages, and product information when we mask the packages. Are there interactions between shape and other elements of the marketing mix?

In masking the brand and package identities of products, we also minimized the effect of familiarity, or the ability of consumers to draw on memory to assign size rather than evaluate the package directly. However, there is the possibility in store circumstances where brand name and category are known, that consumers incorporate these meanings into their size assessments. There could be a shape–familiarity interaction that may yield a new estimation strategy altogether.

This research as well as most prior apparent size research has presumed or demonstrated that viewers implement heavily heuristic estimation procedures in order to determine size appearance expediently, with minimal expenditure of cognitive effort. This would be in keeping with how most consumers go about selecting low-involvement items such as package goods. However, there has been some research investigating the mediating role of attention on size estimation, with mixed results. Folkes and Matta (2004), in finding that more complex forms appear larger than simpler forms, attribute this difference to the differential amounts of attention paid to these respective package shape types, arguing that the greater amounts of attention paid to the processing of novel forms (i.e., more complex forms) will cause them to appear larger. Masin (1999), however, finds that greater amounts of attention paid to the estimation of line lengths yields conflicting results across subjects, finding that apparent line length increased for some subjects and decreased for others, a confirmation of prior research. Clearly, more research needs to be done to clarify the role of attention in size appearance.

Although it is not clear from this research that consumer cognitive styles shift with package shape, as some prior research suggests, it does leave open the possibility that this is what accounts for differences in volume appearance according to shape type. Although the penchant of consumers to heuristically key on a single visual in order to (overly) simplify the size estimation process is supported across shape types, the visual element on which people key may shift. As shape complexity increases, it appears that overall height gives way to the holistic processing of shape, and, as unified shape gives way to compound complex forms, a holistic processing of shape gives way to the processing of the body, or height within the body. If these suppositions are true, it would further appear that the cognitive style applied is not a function of individual differences, but a systematic response to the stimulus that is confronted, making it an evoked behavior.

Many questions are left unanswered following this exploratory investigation, but this research provides a jumping-off point for much-needed future research in the area of package appearance. We also provide research methods to aid future visual researchers in this complex arena, such as demonstrating how physical aids can be used to assist subjects in evaluating large numbers of stimulus combinations. This type of sophisticated visual research in marketing is needed in this era of increasing competition for the attention of consumers of packaged goods.

NOTE

1. We exclude boxes principally because we use cylinders as a base case representing simple geometric forms, following Raghubir and Krishna (1999). Moreover, boxes are perceived typically to hold dry goods, whereas bottles, jars, and cans are typically perceived to hold wet goods. This difference in the nature of the contents poses a potential confound to size estimation, which we choose to control. For research on size estimation and boxes in packaging, see Clayton (1994).

REFERENCES

Anderson, Norman H. (1970), "Averaging Model Applied to the Size-Weight Illusion," *Perception and Psychophysics,* 8 (1), 1–4.

Biederman, Irving (1987), "Recognition-by-Components: A Theory of Human Image Understanding," *Psychological Review,* 94 (April), 115–147.

Bingham, Geoffrey P. (1993), "Perceiving the Size of Trees: Form as Information About Scale," *Journal of Experimental Psychology: Human Perception and Performance,* 16 (6), 1139–1161.

Claessen, J.P., and C.J. Overbeeke (1995), "Puzzling Colours," *Color Research and Application,* 20 (6), 388–396.

Clayton, Dennis E. (1994), "Marketing and Psychographics: Cornflakes and Stevens' Power Function," *Perceptual and Motor Skills,* 78, 593–594.

Coren, Stanley, and Joel Miller (1936), "Size Contrast as a Function of Figural Similarity," *Perception & Psychophysics,* 16 (2), 355–357.

Fisher, Gerald H., and Jeremy J. Foster (1968), "Apparent Sizes of Different Shapes and the Facility with Which They Can Be Identified," *Nature,* 219 (5154), 653-654.

Folkes, Valerie, and Shashi Matta (2004), "The Effect of Package Shape on Consumers' Judgments of Product Volume: Attention as a Mental Contaminant," *Journal of Consumer Research,* 31 (September), 390–401.

Frayman, Bruce J., and Aquinas Coll (1981), "The Effect of Object Shape and Mode of Presentation on Judgments of Apparent Volume," *Perception of Psychophysics,* 29 (1), 56–62.

——, and William E. Dawson (1981), "The Effect of Object Shape and Mode of Presentation on Judgments of Apparent Volume," *Perception and Psychophysics,* 29 (1), 56–62.

Goldstein, A.G. (1961), "The Relation of Extraneous Visual Stimuli to Apparent Size," *Psychological Record,* 11, 257–263.

Gundlach, C., and C. Macoubrey (1931), "The Effect of Color on Apparent Size," *American Journal of Psychology,* 43, 109–111.

Hundleby, John D., Linda Musimi, Janice Van Kampen, and Leo J. Keating (1992), "The Generality of Individual Differences in the Estimation of Size," *Journal of Psychology,* 127 (2), 233–243.

Jenkins, Carolyn A., Joseph A. McGahan, and Frances D. Richard (1994), "Effects of a Common Linguistic Misrepresentation on Judgments About the Relationship Between Height and Weight," *Perceptual and Motor Skills,* 79, 339–347.

Kofka, K. (1935), *Principles of Gestalt Psychology,* New York: Harcourt Brace.

Krider, Robert E., Priya Raghubir, and Aradhna Krishna (2001), "Pizzas: Π or Square? Psychophysical Biases in Area Comparisons," *Marketing Science,* 20 (Fall), 405–425.

Krishna, Aradhna (2006), "Interaction of Senses: The Effect of Vision Versus Touch on the Elongation Bias," *Journal of Consumer Research,* 32 (March), 557–566.

Martinez, Nahum, and William E. Dawson (1973), "Ranking of Apparent Area for Different Shapes of Equal Area," *Perceptual and Motor Skills,* 37 (3), 763–770.

Masin, Sergio C. (1999), "Attention and Estimated Line Length," *Perceptual and Motor Skills,* 88 (3), 831–842.

Payne, M. Carr, Jr. (1964), "Color as an Independent Variable in Perceptual Research," *Psychological Bulletin,* 61 (3), 199–208.

Raghubir, Priya, and Aradhna Krishna (1999), "Vital Dimensions in Volume Perception: Can the Eye Fool the Stomach?" *Journal of Marketing Research,* 36 (August), 313-326.

SAS Institute, Inc. (2004), *SAS/STAT User's Guide, Version 9,* Cary NC: SAS Institute.

Sato, Toshiaki (1955), "The Effect of Color on the Perception of Size," *Tohoku Psychologica Folia,* 14, 115–129.

Shermer, Michael (1997), *Why People Believe Weird Things,* New York: W.H. Freeman.

Sigman, Eric, and Philip K. Oltman (1977), "Field Dependence and the Role of Visual Frameworks in the Perception of Size," *Perception,* 6 (6), 661–666.

Slack, Charles W. (1956), "Familiar Size as a Cue to Size in the Presence of Conflicting Cues," *Journal of Experimental Psychology,* 52 (3), 194–198.

Spence, Ian (2004), "The Apparent and Effective Dimensionality of Representative Objects," *Human Factors,* 46 (4), 738–747

Tedford, W.H., Jr., S.L. Bergquist, and W.E. Flynn (1977), "The Size Color Illusion," *Journal of General Psychology,* 97, 145–149.

Teghtsoonian, Martha (1965), "The Judgment of Size," *American Journal of Psychology,* 78 (3), 392–402.

Wallis, W.A. (1935), "The Influence of Color on Apparent Size," *Journal of General Psychology,* 13, 193–199.

Wansink, Brian (1996), "Can Package Size Accelerate Usage Volume," *Journal of Marketing,* 60 (July), 1–14.

—— (2004), "Environmental Factors That Increase the Food Intake and Consumption Volume of Unknowing Consumers," *Annual Review of Nutrition,* 24, 455–479.

——, and Koert van Ittersum (2003), "Bottoms Up! The Influence of Elongation on Pouring and Consumption Volume," *Journal of Consumer Research,* 30 (December), 455-463.

Warden, Carl J., and Ellen L. Flynn (1926), "The Effect of Color on Apparent Size and Weight," *American Journal of Psychology,* 37, 398–401.

Wilkie, William L., and Edgar A. Pessemier (1973), "Issues in Marketing's Use of Multiattribute Attitude Models," *Journal of Marketing Research,* 10 (November), 428-441.

Yang, Sha, and Priya Raghubir (2005), "Can Bottles Speak Volumes? The Effect of Package Shape on How Much to Buy," *Journal of Retailing,* 81 (4), 269–281.