The perceived size of packages of complex vs. simple shape depends upon the number of packages presented

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Abstract: A research gap exists regarding the respective effects of package shape and presentation context on size perception. Some prior research shows that complex packages appear larger than simple packages of equal volume. Other research shows the opposite. We resolve the dilemma by showing that shape and presentation context interact to create size impressions. Subjects estimated the relative volumes of sets of packages whose shapes are simple or complex, presented in package sets whose numbers range from two to 16. When packages are displayed in sets of nine or more, packages of simple shape appear larger than packages of complex shape. When packages are presented in sets of eight or less, complex packages appear larger than simple packages. This reversal suggests that the volume estimation strategies employed by consumers change when the complexity of the visual tableau before them leads to cognitive overload.

Keywords: packaging; package shape; presentation context; shelf clutter; size estimation; size estimation heuristics; size estimation error; volume estimation.

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1   Introduction

Prior research concerning the effect of package shape on volume appearance has produced mixed results. By package shape, we refer primarily to whether a package has either simple or complex visual form. Complex form refers to packages exhibiting distinct contiguous parts such as caps and necks, shoulders, bodies and feet, while simple form refers to packages without such distinct parts. In particular, three key studies from the marketing literature – Folkes and Matta (2004), Garber et al. (2009) and Raghubir and Krishna (1999) – produce conflicting results. Folkes and Matta (2004) and Raghubir and Krishna (1999) find that packages of visually simple form, such as cylinders, appear *smaller* than visually complex packages of equal volume. However, in a more recent study, Garber et al. (2009) find the opposite: packages of simple form appear *larger* than complex packages of equal volume. The purpose of the present study is to provide an explanation for this reversal by specifying the conditions under which these respective results will occur, and thereby close the research gap that exists in the literature regarding this issue.

This issue is important to marketers because in most packaged goods categories, size or volume is an important choice consideration for the consumer. This is so not just for utilitarian reasons, but because size appearance can also hold important meanings for the consumer, in the sense that there can be favourable connotations to projecting a certain

size appearance. Such meanings can be category specific. For example, appearing small can be advantageous when 'small' favourably connotes high quality or elegance, as it does with caviar or perfume. Conversely, appearing large can be advantageous when 'large' favourably connotes economy, value or long-lastingness, as it does with breakfast cereals, family sizes or bonus packs.

Complicating the size issue for marketers and package designers is that actual size is not as robust a predictor of apparent size as many might presume (Teghtsoonian, 1965). Humans have been shown to commonly and systematically err in their size estimations, at times grossly (Hundleby et al., 1992; Raghubir and Krishna, 1999). The source of this error is that consumers look to drastically simplifying heuristics to expedite what would otherwise be a relatively complex calculus (Raghubir and Krishna, 1999). So it is volume perception, rather than actual volume, that primarily affects purchase (Yang and Raghubir, 2005) and consumption (Raghubir and Krishna, 1999; Wansink, 1996; Wansink, 2004; Wansink and Van Ittersum, 2003). Therefore, it is useful for marketers and package designers to realise these effects and utilise them to manipulate size appearance to obtain a favourable consumer response, or for the consumer advocate to better understand how consumer perceptions can be manipulated by such superficial visual cues.

2   Background

Extensive research has been devoted to the topic of size appearance of containers, although only a scant part of it addresses commercial packages as containers. A hundred years of human performance research provides us with information about how some particular visual features of containers may affect size appearance. For example, height has been shown to be a robust predictor of size appearance, if not actual size, in that taller packages appear larger than shorter packages of equal volume (i.e. the height-size illusion; Frayman and Dawson, 1981; Raghubir and Krishna, 1999). Another visual factor that may affect package size estimation is colour and its components (hue, value and luminance), with hotter, more saturated, lighter and brighter containers appearing larger (Claessen and Overbeeke, 1995; Payne, 1964; Sato, 1995). Still other confounding visual elements include texture, container material, weight appearance, label elements (including contrasting colour and value, text, logos, characters and photos), the size appearance of surrounding packages and the viewer's degree of familiarity with any and all of the above. In examining the effects of shape, we control for these visual elements in this research.

Additionally, and to the point of this research, size appearance is affected by shape. Among that broader literature that tests the effects of visual form on perception of area using two-dimensional shapes, results are not conclusive, with "no general agreement on the stimulus characteristics which account for the fact that two figures of the same area but different shape are perceived as different in area" (Martinez and Dawson, 1973, p.763). These inconclusive findings stand to this day, similar to those mixed results found with three-dimensional packages of varying complexity cited above.

2.1 Effects of package shape complexity

Biederman (1987) defines shape complexity according to the number and conspicuousness of concavities that an object exhibits. A bottle of vinegar, for example, with a distinct neck, shoulders, body and foot may exhibit such concavities at the connections of each of these distinct parts and would therefore be deemed more visually complex than, say, a cylindrical can of cola, a convex form exhibiting no concavities whatsoever.

Complex or simple, for practical purposes, package containers largely conform to certain standard shape types. 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 package parts that make up the compound complex forms are stacked, one on top of another, with caps and necks, shoulders, bodies and feet analogous to the human body. The exception is that packages may be absent of one or more of these parts, as is the case with simple forms such as cylinders, which have only one part, which we refer to as the body. We therefore propose and adopt a taxonomy for comparison and reference purposes based on the human form, in which a package may exhibit as many as five or as few as one simple part, as shown in Figure 1. This leads to questions such as the following: is there some particular part that will explain most of the apparent volumes? In other words, does the subject key on some particular shape part to infer the volume of packages that are complex in shape as they use height for simple forms?

Figure 1 Package part taxomomy
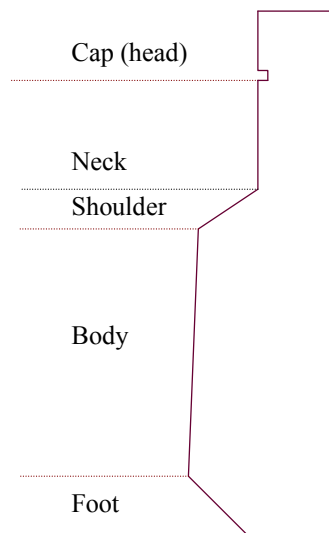
Notes: Since most bottles and jars are symmetrical around the vertical axis (excluding handles), one can think of the distinct parts as stacked one on top of another, and analogous to the human form (though with bottles and jars, one or more of these parts may be missing!). We measured these in terms of height, width, taper, depth, etc.

In line with Biederman's definitions, in a consumer packaging context, Raghubir and Krishna (1999) parsimoniously operationalise shape complexity as the square of the difference between the smallest and the largest diameter that cylindrical packages exhibit. They find that cylindrical packages whose diameters vary more greatly across their length appear larger than those whose diameters vary less, indicating that more complex forms appear larger than simpler forms. Folkes and Matta (2004) define shape complexity for bottles as the degree of taper they exhibit. They find that bottles whose necks exhibit more taper appear larger than bottles whose necks exhibit less taper, also indicating that more complex forms appear larger than simpler forms. On the other hand, Garber et al. (2009) find evidence that packages of simple form, such as cylinders, appear larger than complex packages of equal volume, i.e. those exhibiting distinct contiguous parts such as caps and necks, shoulders, bodies and feet. This result is directly opposite of the results of the two prior studies, perhaps due to the difference in context in which the packages are presented.

2.2   *Effects of presentation context*

Prior research also shows that presentation context affects size appearance (Sigman and Oltman, 1977). 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. The size of the extraneous objects has also been found to affect size appearance. 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. The arrangement of objects is also relevant, with Warden and Flynn (1926) showing that the apparent weights of objects depend in part on the arrangement of differently coloured objects, including the degree of contrast with adjacent objects. Finally, Goldstein (1961) found that size appearance varies with relative spatial position and viewing angle.

The number of packages shown, along with the range of package shapes that are represented within the package set, would be a contributor to the clutter of the visual environment that is background to the volume assessment process. The interaction of all those visual elements comprising the package as well as the number of packages presented constitutes the total level of visual information with which the consumer must contend when undertaking the volume assessment process. For the most part, packages on store shelves are displayed in the context of a number of other packages of varying shapes, sizes and heights, what we will in the following call a visually cluttered setting.

However, even though there is not prior research that addresses the issue of the effects of cluttered visual context on size appearance, we find parallels in the literature addressing choice overload, a behavioural phenomenon indicating that consumers faced with large numbers of options may be adversely affected. Specifically, there is prior research indicating that decision makers facing excessive choice cope by applying simplifying choice heuristics (Anderson et al., 1966; Gigerenzer et al., 1999; Hendrick et al., 1968; Scheibehenne et al., 2010). Similarly, we believe that consumers estimating volume who are faced with sufficiently large numbers of packages of various shapes find simplifying heuristics to cope with the complex task.

However, none of these studies directly addresses the problem at hand. What could account for the reversal we find in the aforementioned three studies? We reason that this reversal may be due to the differences in the number of packages presented simultaneously to the consumer at the time of volume assessment in each study.

Resolving the above conflict concerning what shape types appear larger, and when, is the purpose of this research. In seeking this resolution, we observe that the presentation context (in particular the number of packages presented to experimental participants at the time that they assess their volumes) is different across the three key studies. Folkes and Matta (2004) and Raghubir and Krishna (1999), both of whom find that packages of simple shape appear smaller than packages of complex shape, presented their stimulus packages serially in pairs. The participant task was to identify which package of each pair appeared larger to them. Garber et al. (2009), on the other hand, who find that packages of simple shape appear larger than packages of complex shape, presented 16 packages to their participants at once. The participant task was then to rank order the 16 packages by volume. We therefore reason that presentation context could interact with package shape to determine the direction of its effect on volume appearance.

3   Conceptual development

Prior research has shown in certain contexts that the manner in 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 as possible explanations of these effects 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).

Prior research also suggests that there may be two forms of volume estimation heuristic, one dimensions-based (Raghubir and Krishna, 1999) and the other shape-based (Folkes and Matta, 2004). Folkes and Matta (2004) suggest that the shape-based approach may be utilised as shape becomes more complex and the evaluation of linear dimensions becomes more difficult. This may be true for more cluttered visual tableaux of all types, not just those stemming from complex package shapes, but also those due to cluttered presentation contexts.

Could the differences between these volume estimation strategies account for differences across visually cluttered tableaux? We believe so. For example, it would be logical to presume from prior research that the use of linear dimensions to infer size would be expedient for simple packages presented in uncluttered visual contexts. Consider the comparison of two packages of equal height an uncluttered visual tableau.

According to Krider et al. (2001), the consumer may look to another dimension, which for facings would be width. If it is the inclination of most consumers to compare maximum widths to infer greater volume in uncluttered presentation contexts, then the more complex form will more often be chosen as larger in volume relative to the more simple form.

And if we were to extend Folkes and Matta's (2004) suggestion that more complex forms cue a shape-based estimation heuristic in more cluttered presentation tableaux, what does this suggest for the comparison of simple and complex forms? We speculate that in the face of higher visual complexity, consumers could devote fewer cognitive resources to evaluating the visual intricacies posed by each package and would make a broader assessment in that context. For example, we believe that consumers would in the more cluttered context be less likely to compare linear dimensions across packages, choosing, à la Folkes and Matta (2004), to select, assess and compare shapes rather than dimensions. For example, Garber et al. (2009) find that, in cluttered contexts, consumers tend to focus on the bodies of complex package forms as indicators of size: the larger the body within the whole form, the larger its volume appearance. Therefore, since the body of simple forms is in effect the entirety of the package, then in a comparison of simple and complex forms of equal height in a cluttered visual context, bodies become the point of comparison. And since the body of the simple form will comprise a larger part of its whole form, the simpler form will appear to be the larger. Therefore, this switching of volume estimation heuristics from a linear reference to a shape reference could explain the reversal of volume appearance between simple and complex forms under uncluttered vs. cluttered presentation contexts.

Therefore, in this current research, we manipulate both presentation context and package shape complexity to determine the point at which small package sets become large sets. In other words, we set out to determine that set size beyond which simple packages appear larger than complex packages of equal volume. We hypothesise that complex packages will appear larger than simple packages when presented in visually uncluttered presentation contexts and that simple package forms will appear larger than complex forms when presented in visually cluttered presentation contexts, as follows.

Hypothesis 1: Visually complex package shapes appear larger than visually simple shapes when presented in a visually uncluttered presentation context.

Hypothesis 2: Visually simple package shapes appear larger than visually complex shapes when presented in a visually cluttered presentation context.

4   Method

In a series of between- and within-subject experiments, undergraduate business students at two South-eastern US universities were assigned the task of judging by purely visual means the rank ordering of packages by volume. See Table 1 for sample sizes and the number of packages in each experiment. All subjects evaluated packages at each of two levels of shape complexity, the within-subject manipulation. The number of packages evaluated at one time (the between-subject factor) ranged from two- to 16-package sets and were manipulated at nine different levels.

Table 1 Models testing the effect of shape complexity and presentation context on volume appearance

Experiment	Sample size	OLR regression results (dv is rank order by volume appearance)
16 packages rank ordered by volume.	79	Simple > Complex**
16 2D package-like shape silhouettes rank ordered by volume.	50	Simple > Complex**
13 packages rank ordered by volume.	51	Simple > Complex**
9 packages rank ordered by volume.	38	Simple > Complex**
8 packages rank ordered by volume.	37	Complex > Simple***
6 packages rank ordered by volume.	43	Complex > Simple***
5 packages rank ordered by volume.	42	Complex > Simple***
4 packages rank ordered by volume.	23	Complex > Simple*
3 packages rank ordered by volume.	40	Complex > Simple**
2 packages varying in shape complexity are rank ordered by volume.	121	Complex > Simple**
Yang and Raghubir (2005) present beer bottles (complex) with beer cans (simple) serially in pairs.	31	Complex > Simple
Folkes and Matta (2004) report presenting packages serially in pairs.	33	Complex > Simple**
Raghubir and Krishna (1999) report presenting packages serially in pairs.	40	Complex > Simple**

Notes: *$p < .1$; **$p < .05$; ***ns.

4.1   Stimulus selection and creation

For reasons of external validity, we utilise actual packages in our experiment, with one exception that is discussed later, an exception that is made for reasons of convergent validity as well as to test an alternative stimulus type. The packages used are shown in Figure 2. The package selection procedure was to identify candidate packages representing simple and complex shapes in a narrow range of heights and volumes. For experimental control purposes, it might have been ideal to confine ourselves to packages of equal height and volume. However, it happens that there is a paucity of actual packages that exhibit this particular combination of traits. Height and actual volume are used as predictors in the model together with shape so that the incremental effect of shape on size perception can be estimated. It is to be noted that the minor differences in height and volume that the distracter stimuli bring to the display add some additional visual clutter to the presentation context in a manner that is consistent with typical store shelf displays.

Figure 2   The pool of 16 packages from which package stimuli were selected

Classico Spagh. Sauce (270 mls)   HT Mushrooms (270 mls)   Hidden Valley Ranch (236 mls)   Alessi Vinegar (250 mls)

Martinelli's Appl Jce (296 mls)   Old El Paso Taxo Ssng (300 mls)   Mt. Olive Sweet Relish (295 mls)   House of Tsang Soy (296 mls)

Mt. Olive Hot Dog Rlsh (355 mls)   Bunker Hill Gravey Beef (360 mls)   Consorzio Marinade (354 mls)   Cardini's Vinigrette (370 mls)

B&M Baked Beans (467 mls)   HT Parmesan Cheese (450 mls)   ReaLemon Juice (443 mls)   Jarrito's Limon (400 mls)

Simple Shapes   **Complex Shapes**

4.2   2D stimulus creation

For reasons of convergent validity, and also to explore methodology that could be applicable to this research stream, we reserved one condition of the presentation context variable for two-dimensional stimuli. Rendering package silhouettes in two dimensions using imaging software allowed us the freedom to construct package stimuli for the express purpose of portraying those visual aspects we are testing, without the confines of what is available via actual packaging. A particular advantage to this approach is that there are few examples of actual packages of equal height and volume that also represent different levels of shape complexity.

By creating our own stimuli, we can generate any number of differently shaped objects of equal height and volume or, in the case of two-dimensional silhouettes, area. The use of silhouettes rather than three-dimensional forms renders the creative process tractable while retaining the ability to relate shape to apparent size. In this case, participants assessed area rather than volume, an analogous process. Further, there is precedent for the use of two-dimensional shapes in this manner (for example, see Martinez and Dawson, 1973). We created and tested 16 package silhouettes, half simple shapes and half complex forms, all of equal height and area, as shown in Figure 3. Number 16 is equal to the largest actual package set tested.

Figure 3 16 invented two-dimensional silhouettes of equal height and area

Simple Shapes   Complex Shapes
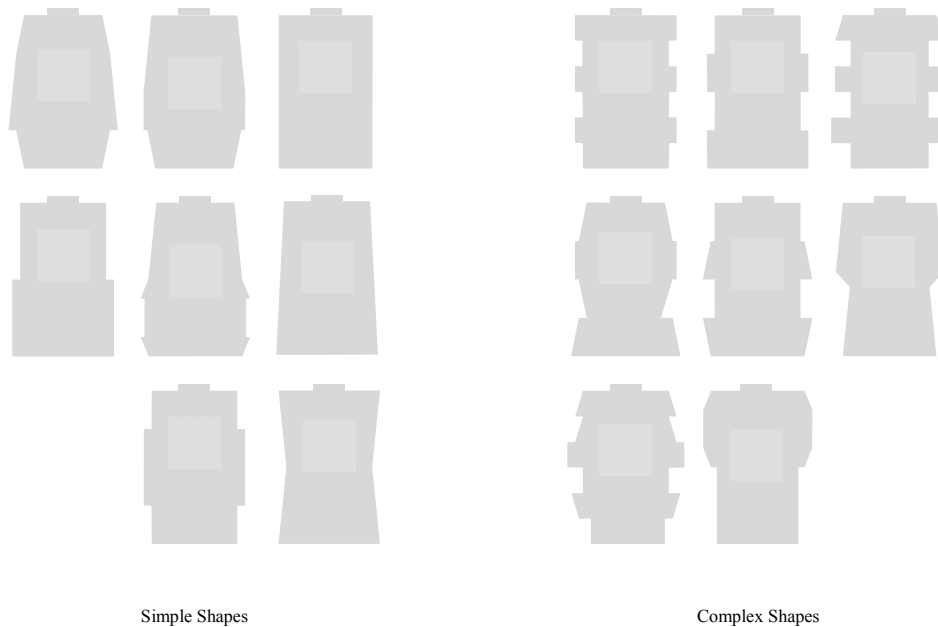
5   Results

We begin by replicating the visually uncluttered, pairwise presentation contexts of
Raghubir and Krishna (1999) and Folkes and Matta (2004) utilising two packages.
Results are shown in Table 1. 121 undergraduate business majors at two South-eastern
US universities were presented the two packages shown in Figure 1 simultaneously, side
by side, and asked to specify which one of the two appeared larger to them. The two
packages were rotated to control for order effects. 74 subjects, or 61.1% of the 121,
found the more complex form, Package B, to appear larger that than Package A, the
simple form. We tested the significance of the difference between this proportion and the
50% proportion to be expected if subjects were selecting randomly using Kanji's "Z-test
for the equality between two proportions (binomial distribution)" (Kanji, 1993, p.25).
This difference is significant (Z_{121} = 2.45, p = .0071, one-tailed test), indicating that
geometrically more complex shapes appear larger than geometrically more simple shapes
of equal height and size when they are presented in pairs without distracters, in
confirmation of Raghubir and Krishna's (1999) and Folkes and Matta's (2004) findings
and in support of Hypothesis 1.

The above experimental procedure conducted for the two-package set was replicated
for each of the other nine levels of presentation context tested (ranging from three to 16
packages), progressively increasing the number of distracter stimuli to be shown along
with the same two target stimuli in each case, so that the total number of packages to be
evaluated kept growing, as shown in Table 1.

5.1   Results for rank ordering

A series for models was run, one for each of the nine levels of presentation context, whose specification follows the same general form, as follows:

$$Rank\ order = \beta_1 * (Actual\ volume) + \beta_2 * (Height)$$
$$+ \beta_3 * (Complexity) + \beta_4 * (Subject_{i=2-n}Dummies)$$

where

Rank order ≡ rank order volume estimation data,

Actual volume ≡ true volume of each stimulus package in mls,

Height ≡ the overall height of each stimulus package in cms,

Complexity ≡ shape complexity dummy, where '1' indicates a relatively geometrically complex package shape, as per Biederman (1987) and a '0' indicates a relatively geometrically simple package shape,

Subject$_{i=2\ to\ n}$ *dummies* ≡ subject dummies for subjects 2 through 79, to account for within-subject variance due to repeated measures design.

We asked subjects to consider not the absolute volume of each package but its relative volume, because consumers are likely to judge size in a store shelf setting by comparison with surrounding packages, judging which package appears less than or more than the others surrounding them, normally not going so far as to estimate them in ounces or millilitres, though this does leave us with ordinal level dependent variables for subsequent regression analyses.

Logistic regression models are appropriate for response variables made of numbers representing successive levels of a construct, such as what we have with subjects assigning rank orders to packages by appearance of size (O'Connell, 2006), and the SAS LOGISTIC procedure was therefore fitted to these data (SAS Institute, Inc., 2004, pp.316–325). The predictor variable is a shape complexity dummy where '1' represents the complex shape condition and '0' represents the simple shape condition. Actual volume and height are covariates. A set of subject dummies are incorporated to control for repeated measures effects.

At the most cluttered level, each experimental participant evaluated 16 package stimuli in a repeated measures design. Each observation is therefore a subject package. There are 79 subjects by 16 packages, for 1264 observations. The result of the model that was run is shown in Table 2. The model is significant, with an R^2 of .659 and a significant shape effect [MLE = 0.79, χ^2 = 9.75, p = .0018, Odds Ratio Estimate (ORE) = 2.204]. The associated ORE of 2.204 [= exp(0.7904)] reveals that the odds for complex packages being at or below some particular size level are more than twice the odds for simple packages, indicating that, controlling for actual volume and height, simple packages appear larger than complex packages when presented in a cluttered presentation context, the converse of what was found for the uncluttered presentation contexts, in support of Hypothesis 2.

Table 2 OLR models testing the effects of geometric shape on volume appearance when presented a succession of contexts represented by the of packages presented simultaneously

# of pcks	# of subjects	Actual volume	Height	Complexity	Model fit statistics	R^2	Max rescaled R^2
16	79	MLE = −.029 χ^2 = 672.07 p = <.0001 ORE = .971	MLE = −.024 χ^2 = 98.11 p = <.0001 ORE = .976	MLE = ,790 χ^2 = 9.747 p = .0018 ORE = 2.204	AIC = 5841 SC = 6335 −2 log L = 5649	.659	.662
16 (2d)	50	MLE = −.435 χ^2 = 267.58 p = <.0001 ORE = .647	MLE = .014 χ^2 = 0.64 p = .4332 ORE = 1.014	MLE = .334 χ^2 = 27.4 p = <.0001 ORE = 1.397	AIC = 4130 SC = 4444 −2 log L = 3996	.423	.425
13		MLE = −.009 χ^2 = 352.48 p = <.0001 ORE = .991	MLE = −.005 χ^2 = 5.066 p = .0244 ORE = .952	MLE = 1.248 χ^2 = 56.67 p = <.0001 ORE = 3.484	AIC = 3127 SC = 3424 −2 log L = 2995	.466	.468
9	38	MLE = .006 χ^2 = 11.17 p = .0008 ORE = 1.006	MLE = −.238 χ^2 = 15.17 p = <.0001 ORE = 1.006	MLE = 1.052 χ^2 = 27.07 p = .<.0001 ORE = 2.862	AIC = 1511 SC = 1694 −2 log L = 1415	.168	.170
8	37	MLE = − .0007 χ^2 = 0.14 p = .7046 ORE = 1.172	MLE = .2111 χ^2 = 4.29 p = .5824 ORE = 1.235	MLE = .1588 χ^2 = 0.58 p = .0383 ORE = .445	AIC = 1317 SC = 1487 −2 log L = 1225	.020	.020
6	43	MLE = −.005 χ^2 = 9.89 p = .0017 ORE = 0.995	MLE = .120 χ^2 = 1.36 p = .2439 ORE = 1.127	MLE = −.164 χ^2 = 0.56 p = .4536 ORE = .848	AIC= 1014 SC= 1191 −2 log L= 914	.041	.042
5	42	MLE = −.005 χ^2 = 7.31 p = .0068 ORE = 0.995	MLE = .0002 χ^2 = .00 p = .9998 ORE = 1.000	MLE = −.219 χ^2 = .72 p = .3961 ORE = .803	AIC = 748 SC = 908 −2 log L= 652	.107	.112
4	23	MLE= −.0009 χ^2 = 0.07 p = .7968 ORE = 0.999	MLE = .26 χ^2 = 0.83 p = .3608 ORE = 1.297	MLE = −.776 χ^2 = 3.01 p = .0783 ORE = .460	AIC = 297 SC = 367 −2 log L = 241	.143	.152
3	40	MLE = −.004 χ^2 = 2.04 p = .1528 ORE = 0.996	MLE = 1.74 χ^2 = 20.80 p < .0001 ORE = 5.695	MLE = −2.25 χ^2 = 21.81 p < .0001 ORE = 0.106	AIC = 311 SC = 434 2LogL = 223	.283	.318

We summarise the results for all of the experiments shown in Table 2 using the bar chart shown in Figure 4, to aid comparison. In Figure 4, we plot the ORE of the complexity variable for each of the nine experiments ranging from three to 16 packages. For the experiments exhibiting fewer numbers of packages, namely those exhibiting eight packages or fewer, the ORE for the complexity variable is less than one, indicating that complex packages appear larger than simple packages when presented in a relatively

uncluttered visual context. For experiments in which nine or more packages are presented, the ORE for complexity is greater than one, indicating that simple packages appear larger than complex packages when presented in relatively cluttered visual context.

Figure 4   Odds ratio estimates by package set size
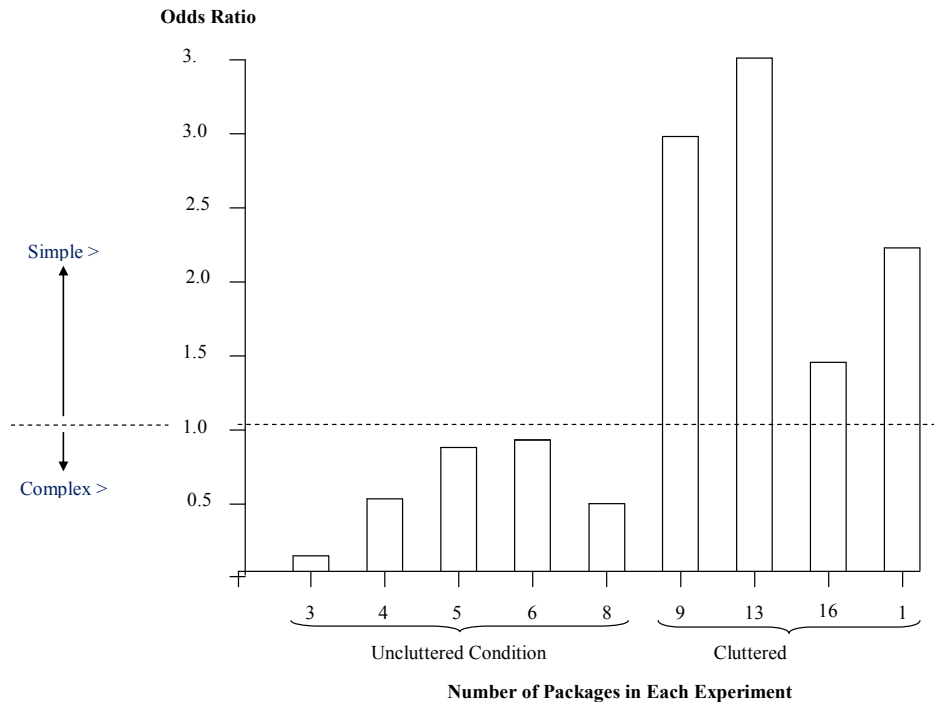
6   Discussion

We examine the effects of package shape complexity on volume appearance while manipulating the number of packages presented simultaneously. Overall results indicate that:

- Shape complexity has a significant effect on perceived volume.

- The direction of the effect of shape complexity depends upon the number of packages presented.

- Complex packages (e.g. bottles) tend to appear larger than simple packages (e.g. cylinders) when presented in uncluttered visual contexts.

- Simple packages tend to appear larger than complex packages when presented in cluttered visual contexts.

- Consumers are cued by the body of a complex package when estimating package volume in cluttered presentation contexts.

6.1 Implications

The reversal we find, which is a function of the number of package stimuli being presented at once, would suggest that consumers engage in some sort of swapping of volume estimation heuristics depending upon the levels of visual clutter encountered. The implication of this research for the designer and the manager who select packages is that the size impression of a package is not only a function of intrinsic visual elements such as height and shape, but also a function of the context in which the package is viewed. This means that managers are aided by being cognisant of the size appearance implications of the various circumstances in which their packages are viewed. Any given package may appear larger or smaller in one context than it may in another. For example, consumers may 'read' a certain size appearance when they view a package on the shelf, in the company of many neighbours, yet 'read' an altogether different size appearance when they pick the package up and hold it in their hands. Therefore, the designer and the manager must consider not only the size meaning of given package shapes, but also the context in which the package will be viewed in order to select the proper size signature.

6.2 Study limitations and future directions

Our results are conditional on the specific set of package shape types we tested. By focusing on standard package shape types extant on store shelves, a natural experiment that provides external validity, we overlooked a number of shape part combinations that are not commonly found, but could become a viable option for future research. A full factorial model that considers all possible shape parts and shape type combinations could further refine our basic thinking about how complex container shapes in general are processed and work to achieve their volume meanings. The use of generated two-dimensional stimuli for a single level of the presentation context manipulation in this current research offers evidence of its potential for visual package experimentation, providing the ability to generate an unlimited range of shape types and permitting perfect control of other visual features such as height and size.

Further research is necessary to determine the boundaries between complexity and simplicity, as well as the roles played by the various visual elements that affect complexity vs. simplicity, including the number of visual stimuli present and the range of heights and shapes they exhibit. Also, though some work has been carried out studying the effect of package shape on size perception, little has been done to examine the volume meaning of package shape. By masking all visual elements apart from shape in this research, we in effect controlled out the effects of brand name and all the associations that brand name may confer. But Bingham (1993) has proposed another form of volume estimation heuristic based on such meanings. Called the familiar-size illusion, it states that consumers infer size according to the size meaning those familiar shapes hold. For example, if consumers believe that mustard jars are 4 ounces in size and recognise a jar to hold mustard or to be mustard-like in appearance, they may be disposed to calling that jar 4 ounces in size. Those of us who have studied volume perception in a commercial context have yet to address the familiar-size illusion, which would suggest an altogether different behavioural approach to size assessment than those that have been suggested herein.

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