FACULTEIT ECONOMIE
EN BEDRIJFSKUNDE

TWEEKERKENSTRAAT 2
B-9000 GENT
Tel. : 32 - (0)9 – 264.34.61
Fax. : 32 - (0)9 – 264.35.92

WORKING PAPER

How to Make a 29% Increase Look Bigger: Numerosity Effects in Option Comparisons[1]

Pandelaere Mario[2]

Briers Barbara[3]

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[2]Mario Pandelaere is Senior Lecturer at the Department of Marketing, Ghent University, Belgium.
[3] Barbara Briers is an assistant professor, Department of Marketing, HEC Paris, France.

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Abstract

Consumers prefer quantitative to qualitative information, yet the same quantitative information can appear as different numbers (e.g., 7-year warranty = 84-month warranty). The current paper demonstrates that consumers focus more on the number of units (7 versus 84) than on the type of units (year versus month), which implies a unit effect. The same attribute difference expressed as a higher number of units induces a perception of being larger (Study 1). When consumers receive the same information on different scales, the unit effect disappears (Study 2). Because differences in quality for the various options appear inflated due to the use of a scale with more units, consumers may switch away from a lower quality option when the quality ratings employ many units (Study 3). Finally, the unit effect implies that consumers are more sensitive to proportional differences and ratios of attribute levels when the attribute expression relies on many units rather than a few units (Study 4).

HOW TO MAKE A 29% INCREASE LOOK BIGGER: NUMEROSITY EFFECTS IN OPTION COMPARISONS

As a consumer, would you prefer a dishwasher that expresses its warranty levels in months rather than years? Would you be more likely to choose an option that indicates its superior quality in units of 1,000 rather than 10? We argue herein that you would, in both cases. That is, for most consumers, the units in which most attribute information appears affect perceptions of various options. For example, consumers tend to perceive the same attribute differences as larger on scales that have many units than on scales with fewer units, such that the difference between ratings of 7 and 9 on a 1–10 scale appear smaller than the difference between 700 and 900 on a 0–1000 scale. This scale-dependent perception of attribute differences may induce increased preferences for the product with the superior score.

Such quantitative information is common in various situations, including product features and evaluations, service satisfaction, scholastic achievements, and job applicant aptitudes. The unit effect that we find therefore is relevant for any choice setting in which quantitative information appears or is sought by consumers or decision makers. That is, when people engage in quantitative comparisons of options, the number of units used to express the difference may alter preferences and choice confidence.

In particular, consumers tend to associate bigger numbers with bigger quantities, such that prices and budgets seem higher when they are expressed in larger denominations (i.e., face value effect, Raghubir and Srivastava 2002; reverse face value effect, Wertenbroch, Chattopadhyay, and Soman 2007). Similarly, a ratio bias implies that people perceive equivalent odds or probabilities as higher when they employ higher numerators (with, obviously, higher denominators; Kirkpatrick and Epstein 1992). The unit effect we propose herein also is consistent with the idea that consumers associate bigger numbers with bigger quantities, but it differs in two respects from the (reverse) face value effect and the ratio bias: First, it entails a different mechanism, and second, it applies to a different domain. Specifically, the unit effect refers to attribute information, whereas the (reverse) face value effect refers to prices (and budgets), and the ratio bias is constrained solely to chance information.

THEORETICAL FRAMEWORK

Studies of number representation in both animals and humans reveal that the mental magnitude associated with a given number is a logarithmic function of the objective number (Dehaene 1997, 2003; Dehaene, Dehaene-Lambertz and Cohen 1998; Nieder and Miller 2003). Therefore, the same objective difference becomes subjectively smaller when it refers to higher numbers, so the difference between 100 and 101 seems smaller than the difference between 1 and 2. Consistent with this relationship between objective and subjective quantities, consumers pay more attention to proportional attribute differences and attribute ratios.[4] The difference between 1 and 2 seems bigger than the increase from 100 to 101 because the former corresponds to a proportional difference of 100%, whereas the latter corresponds to a proportional difference of just 1%.

Such a preferential focus on ratios and proportional differences renders consumers susceptible to framing effects, because an altered presentation of attribute information and attribute ratios affects consumer preferences (Hsee et al. 2009; Wong and Kwong 2005a, 2005b). For example, when Kwong and Wong (2006) specify the performance of two printers as a percentage of either jobs executed correctly (printer A 99.99%, printer B 99.997%) or jobs executed incorrectly (printer A .01%, printer B .003%), subjects prefer the second printer in the latter context, more so than in the former. The performance ratio is close to 1 when the printing performance specification uses correct jobs, but it increases to greater than 3 when it relies on incorrect jobs.

This study in turn addresses how a change in the units used to express quantitative information might affect consumer perceptions and preferences, even in the absence of changes in the ratios of the attribute values. We focus on expressions of attribute information that employ more units, such as months versus years. A nine-year warranty is 29% longer than a seven-year warranty, as is a 108-month warranty compared with an 84-month warranty. Although people may be particularly attuned to ratios, we propose that changes in absolute attribute differences may affect consumers, even if they leave the ratio of the attribute values unaltered. In particular, we argue that a 24-month warranty length difference appears bigger than a two-year difference.

Furthermore, when consumers compare attribute levels, they may not be sure about how to conceive of a given attribute difference (Hsee 1996; Yeung and Soman 2005) and therefore may resort to the numerosity heuristic (Pelham, Sumarta, and Myaskovsky 1994). This heuristic emerges when consumers estimate the total quantity of a set of elements from the number of elements in that set but

[4] Attribute ratios and proportional differences relate linearly. For the remainder of this article, we use these two concepts interchangeably.

do not take the type of elements sufficiently into account (Pelham, Sumarta, and Myaskovsky 1994). When consumers evaluate the difference between two attribute levels, they may pay more attention to the *number* of units rather than the *type* of units, such that they appreciate a 24-month warranty difference more than a two-year warranty difference because they rely on the number of units rather than their type.

Yet numerosity may not be necessary to explain the unit effect. Instead, the effect may be due simply to the logarithmic relation between numbers and their mental representation. We use a simple example from the outset to demonstrate that it is not. The objective proportional difference between a seven-year warranty and a nine-year warranty is (9 – 7)/9 = .22. The objective proportional difference between an 84-month warranty and a 108-month warranty is the same: (108 – 84)/108 = .22. If we log-transform every quantity before calculating the proportional difference, the subjective proportional difference between a seven- and a nine-year warranty is (log(9) – log(7))/log(9) = .11, but that for an 84- versus a 108-month warranty is actually *lower*: (log(108) – log(84))/log(108) = .05.

Numerosity effects appear in several domains; people incorrectly believe cancer is riskier when statistics report that it affects 1,286 of every 10,000 persons than when it causes the death of 24.14 per 100 persons (Yamagishi 1997; see also Raghubir 2008). People also prefer to draw from an urn with 10 winning and 90 non-winning possibilities than from one with 1 winning and 9 non-winning possibilities (Kirkpatrick and Epstein 1992; see also Denes-Raj and Epstein 1994). Such a ratio bias appears to relate to experiential processing, in that people can simulate drawing a winning possibility (or contracting a disease) more easily when the number of possibilities increases. However, if the numbers refer to things other than probabilities, as in our studies, the differences in ease of simulating cannot explain the unit effect. In addition, the ratio bias appears to emerge for small probabilities only (Denes-Raj and Epstein 1994), but the unit effect should be stronger when the objective difference is high.

With regard to the face value effect (Raghubir and Srivastava 2002), prior research shows that consumers often spend less in a foreign country if the value of one unit of the foreign currency is lower than the value of one unit of their own currency, compared with the opposite scenario. When budgets and income also get transformed into the foreign currency though, the opposite phenomenon occurs (Wertenbroch, Soman, and Chattopadhyay 2007), consistent with the hypothesis that consumers anchor their perceptions on posted prices and budgets. Thus, prices seem higher in Mexico than in

Great Britain (e.g., a US$20 blouse costs about MXN268 but about £12), a face value effect, whereas the residual budget after spending seems larger in Mexican Peso than in British pounds, a reverse face value effect.

The (reverse) face value effect also may result from varying evaluation abilities for prices and budgets. A consumer likely knows what a given sum of money can buy in a domestic currency but may not be able to make this evaluation in a foreign currency. That is, reference prices for various objects and services are not as well known in foreign currencies. However, to the extent that a consumer becomes familiar with a foreign currency, this difference disappears (Marques and Dehaene 2004). For example, shortly after the introduction of the Euro, consumers' price perceptions exhibited a face value effect, but it dissipated rather rapidly (Mussweiler and Englich 2003; Wakker, Köbberling, and Schwieren 2007). The (reverse) face effect therefore seems limited to situations in which consumers are unfamiliar (e.g., Jonas et al. 2002; Raghubir and Srivastava 2002).

The unit effect is similar to the (reverse) face value effect but also features some differences. The (reverse) face value effect results from difficult translations of prices and budgets, which demand that consumers estimate, rather than calculate, the domestic prices and budgets. Large denomination prices and budgets likely prompt overestimations, whereas small denominations may lead to underestimations. Furthermore, once the consumer learns the reference prices, the need for translation disappears, which also eliminates the (reverse) face value effect.

In contrast, the unit effect is not due to deficient translation; most people know that a 200-unit difference on a 1000-unit scale is equivalent to a 2-unit difference on a 10-unit scale. Yet no preferential target of translation exists for attribute levels in a given scale, such as exists for foreign currency, for which the preferential target of translation is the domestic currency. A score of 1000 can be translated into a score on a 100-, 10-, or 50-point scale, but there is no particular reason to do so. Therefore, consumers should not routinely translate attribute scores into different scales; rather, they focus on the number of scale units used to express a certain difference. Consequently, the unit effect results directly from numerosity, whereas the (reverse) value effect features numerosity as a form of anchoring effect through inexact translations between scales.

HYPOTHESES

When consumers evaluate the difference between two options, their consideration may be influenced by the number of attribute units in which the difference gets expressed. Consequently, the number of units that describe an attribute should affect perceived attribute differences. Specifically, we hypothesize

> H_1: Consumers perceive an objective attribute difference as bigger when the number of units expressing the difference is greater (unit effect).

If the unit effect occurs because consumers focus on the number of units but insufficiently account for the type of units, it could be minimized if consumers were reminded that the value of a single unit depends on its type. An obvious way to provide such a reminder would be to display the same information on two different scales. Therefore,

> H_2: The unit effect declines when quantitative information appears on another scale as well.

The unit effect likely influences not only perceived differences but also preferences. When differences loom larger on scales with many units, the superior option may look that much better in comparison with an inferior option. As a result,

> H_3: As the number of attribute units increases, the probability of choosing the superior option also increases.

Finally, various studies indicate that consumers are sensitive to attribute ratios, though the unit effect suggests that this sensitivity could be moderated by the number of units used to describe the attribute. In other words,

> H_4: Consumers are more sensitive to attribute ratios and proportional differences when the attribute is expressed in many units.

STUDY 1

We first test whether the number of attribute units affects perceptions of attribute differences (H_1). Participants received information about a single attribute for two options, either on a scale with few units or on a scale with many more units. Participants then indicated the size of the difference between the two options.

To test the generality of the presumed unit effect, we use three stimulus variations. First, we varied the focal attributes among probability of success of a medical treatment, television quality ratings, and dishwasher warranty levels. Second, we varied the scales that presented the attribute information, using either a 0–10 scale or a 0–1000 scale for the probability of success of a medical treatment and television quality ratings, as well as years versus in months for the dishwasher warranty levels. Third, we either leave the objective difference the same for both scales (dishwasher) or make it slightly smaller in the scale that contains more units (medical treatment success, television quality).

Method

In return for partial course credit, 210 students (129 men, 81 women) from various majors participated in the study (mean age = 20.28 years, SD = 1.97). The participants were told that they would have to compare two television sets on the basis of an overall quality score, two surgical procedures on the basis of the probability of success, or the warranty of two dishwashers. In the latter condition, the two warranties last for seven versus nine years or 84 versus 108 months. In the other two conditions, the attribute scores for the two options are 7 versus 9 (on the 10-point scale) and 704 versus 903 (on the 1000-point scale). After viewing the two options, participants indicated how large they considered the difference between the two options on a six-point scale without a neutral option (6 = very large; 1 = very small).

Results and Discussion

We conduct separate t-tests for each of the three conditions to determine whether the perceived differences are larger when the attribute information involves many units than when it features fewer units. Irrespective of the variations in design, we find just such perceptions in all three conditions (see Table 1).

Insert Table 1 about here

The first experiment therefore confirms H_1. For all conditions, the perceived difference between two options increases as the scale presenting the information includes more units. In the medical success and television quality scenarios, the objective difference actually is smaller in the

1000-unit condition (199/1000) than in the 10-unit condition (2/10). In addition, in the 1000-unit condition, the difference occurs slightly higher on the scale than in the 10-unit condition. Because of diminishing sensitivity (Kahneman and Tversky 1979), this second finding also implies that the perceived difference should be slightly smaller in the 1000-unit condition than in the 10-unit condition if no unit effect were present. Finally, we note that calculating the difference between 903 and 704 may be harder than calculating the difference between 9 and 7, which in turn could prompt the lower perceived difference in the 1000-unit scale (Thomas and Morwitz 2009). Thus, these two scenarios actually represent somewhat conservative tests of H_1, as their slightly lower effect sizes, compared with the dishwasher scenario, support.

STUDY 2

We undertake Study 2 with two main goals. First, we hope to replicate the unit effect in a less artificial situation than that we used in Study 1, for which we employed a very minimal paradigm. That is, the Study 1 participants received information about a single attribute, whereas for Study 2, we provide information about two attributes. Second, we test the underlying mechanism of the unit effect further. Consumers likely do not routinely translate numbers on one scale to numbers on another scale, so they may not realize that a seemingly big difference would not appear as big on an alternative scale. We attempt to demonstrate whether the unit effect can be reduced, or even eliminated, when a different scale provides the very same quantitative information (H_2).

For this study, participants received quality and price information about two LCD televisions. The price information appears in Euros, whereas the quality information employs either a 10-unit or a 1000-unit scale. Half of the participants received both numeric quality information and a visual representation of that information, namely, a chart with 10 bars, regardless of which scale applied to the quantitative information. When the original quantitative information already appeared on a 10-point scale, the addition of the visual information, which also uses a 10-point scale, should not affect perceived quality differences. However, when the original quantitative information uses a 1000-point scale, the visual representation should have an influence, because it translates the 1000-point attribute information into 10-point attribute information, which may reduce or eliminate the unit effect.

Method

For partial course credit, 194 students (54 men, 135 women, 5 failed to disclose their gender) from various majors participated (mean age = 19.87 years, SD = 1.70). Participants received price and quality information about two LCD televisions, and we manipulated the scale that expressed their quality. Half of the participants considered a score on a 1000-point scale, and the other half reviewed a 10-point scale. The option with the best quality (9/10 or 900/1000) consistently was more expensive (1479 Euro) than the option with somewhat lower quality (7/10 or 700/1000; 1225 Euro).

As noted, half of these participants received a cue, irrespective of the number of scale units, that the quality information really contained only 10 relevant units. The chart therefore presented 7 and 9 of 10 bars in color for the low- and the high-quality options, respectively. The numeric quality information (7 or 9 versus 700 or 900) appeared above the last colored bar (See Appendix A for an overview of the stimuli used in various conditions). All participants then indicated, on six-point scales, the size of the quality difference (1 = no difference; 6 = very large difference).

Results

We subject the perceived quality difference to a 2 (quantitative scale: 10- versus 1000-point) × 2 (visual 10-point scale: present versus absent) between-subjects ANOVA. We obtained an interaction between the quantitative scale and the visual 10-point scale on perceived quality difference $F(1,188) = 6.49$, $p = .01$. We replicate the unit effect when the visual scale is absent ($M_{10} = 3.73$, $M_{1000} = 4.13$; $t(188) = 2.48$, $p = .014$), but not when it is present ($M_{10} = 4.10$, $M_{1000} = 3.96$; $t(188) = 1.13$, $p = .26$), as we show in Figure 1.

Insert Figure 1 about here

Discussion

The results corroborate our reasoning regarding the numerosity effect and its declining influence when people consider quantitative information in various scales. When the quality rating appears only numerically, as in Study 1, we find strong evidence of a unit effect, in that the participants perceive quality differences as larger when the quality information appears on a 1000-unit scale compared with a 10-unit scale (H_1). However, when we include a visual representation of quality information on a chart with 0 to 10 bars, the perceived quality difference does not vary significantly as a function of the number of scale units (H_2).

STUDY 3

With Study 3, we investigate whether the effect of the number of units on consumer perception can also change consumer preferences. Therefore, we draw on the attraction effect (e.g., Huber, Payne, and Puto 1982) to create a situation in which consumers find a lower quality option attractive. That is, the participants in Study 3 receive information about the price and quality of three home cinema systems. The attraction option (B) dominates a decoy option (C) because it offers the same quality but at a lower price, which also should make it more attractive than the target option (A) that offers a higher quality but at a higher price. However, when we display the quality ratings in many units, the perceived quality differences should increase, such that participants may indicate they are willing to pay more for the higher quality option (target option) when quality information relies on many units rather than fewer units (H_3).

We divide this investigation into two parts. In Study 3A, we record participants' choices, whereas in Study 3B, we additionally ask participants to indicate their perceptions of quality and price differences. Including these two judgment tasks serves two functions. First, we can test whether the effect of the number of units on choice may be mediated by its effect on perceived quality differences. Second, this addition enables us to consider an alternative account based on magnitude priming (cf. Oppenheimer, LeBoeuf, and Brewer 2008). When quality information gets expressed as many units, respondents may imagine greater quantity, which could then distort any subsequent judgment. In particular, a magnitude priming explanation for our findings would suggest that the number of units used to express quality information should increase perceived differences for not only the quality dimension but also the price dimension. Yet if the unit effect occurs because consumers do not routinely translate information to a different scale—which would lead to numerosity effects—then the unit effect should be restricted to the quality dimension and not occur for the price dimension.

Method

For the combined study, 169 students (70 men, 99 women) from various majors participated and received partial course credit (mean age = 19.53 years, SD = 1.66). Participants considered price and quality information about three fictitious home cinema systems on manipulated scales for the quality information. Half of the participants considered a score on a 1000-point scale, whereas the other half saw expressions on a 10-point scale. The decoy option indicates identical quality as the attraction option but a higher price (quality: 7/10 or 700/1000; price: decoy = 275 Euro, attraction = 250 Euro), and the target option is higher on both (quality: 7.5/10 or 750/1000; price: 300 Euro). In Study 3A, participants indicated the brand they would choose; in Study 3B, they also evaluated the quality and price differences between the attraction option and the target option on a six-point scale (1 = very large; 6 = very small).

Results

Brand choice (both studies). The scale significantly affects the chosen brand in both Study 3A (likelihood $\chi^2(2, N = 73) = 8.10$, $p = .018$) and Study 3B (likelihood $\chi^2(2, N = 96) = 12.86$, $p = .002$). The probability of choosing the target option increases significantly, whereas the probability of choosing the attraction option decreases, though only marginally significantly in Study 3A (see Table 2). Although participants choose the attraction option much more often than the target option in the 10-unit scale condition, which implies an attraction effect, they do not in the 1000-unit scale condition.

Insert Table 2 about here

Rating scales (Study 3B). We use a 2 (number of units for quality: 10 versus 1000) × 2 (dimension: quality versus price) ANOVA with repeated measures on the second factor for perceived quality and price differences. A main effect indicates that price differences ($M = 3.66$) seem greater than quality differences overall ($M = 2.80$; $F(1,94) = 35.25$, $p < .001$). Another main effect reveals higher judgments in the 10-unit condition (M = 3.05) than in the 1000-unit condition (M = 3.42;

$F(1,94) = 7.75$, $p < .01$). The main effects are qualified by a dimension × number of units interaction ($F(1,94) = 13.06$, $p < .001$; see Figure 2). We find a unit effect for perceived quality difference (M_{10} = 2.38, M_{1000} = 3.26; $t(94) = 4.54$, $p < .001$), though not for perceived price difference (M_{10} = 3.72, M_{1000} = 3.59; $t(94) = .68$, $p = .50$.

Insert Figure 2 about here

Mediation analysis (Study 3B). Following the procedure described by MacKinnon (2008) for testing for mediation in categorical data (i.e., brand choice), we find that the observed unit effect on target option choice is fully mediated by the unit effect on perceived quality differences (Sobel test: z = 3.048, $p = .002$).

Discussion

Study 3 indicates that the number of attribute scale units may affect consumer preferences. That is, increasing the number of units used to provide the attribute information shifts consumers' preferences to the option that is superior on that attribute (H_3). In addition, the unit effect on consumer preferences is entirely the result of a unit effect on perceived attribute differences. Finally, expressing an attribute in the form of more units affects the perceptions of that attribute only, a finding that is inconsistent with an alternative account that relies on magnitude priming (cf. Oppenheimer, LeBoeuf, and Brewer 2008).

STUDY 4

Studies 1–3 indicate that the scale used for attribute information may affect consumer evaluations and decisions, even when these scales do not change the ratios or proportional differences. To reconcile these findings with prior research that indicates consumers are very sensitive to ratios or proportional differences, we consider whether the scale that expresses an attribute may increase or decrease the impact of such ratios and proportional differences (H_4). That is, we ask participants in Study 4 to compare a set of home cinema systems with varying quality levels to a system with perfect quality and then indicate how much more they would be willing to pay for the perfect system than for each other system in the set. We again manipulate the scale used to provide the quality information (10 versus 1000 units). We also propose the following relation between willingness to pay (WTP) and the quality of the systems:

$$WTP = \alpha \left(\frac{Q_P - Q_C}{Q_P}\right), \qquad (1)$$

where Q_P refers to the perfect quality level, and Q_C is to the quality level of the current system. Equation 1 thus describes a linear relationship between WTP and the proportional difference between the quality of the systems. The slope α should relate positively to the number of units used to provide quality information: That is, willingness to pay extra for the perfect system should increase more steeply when the quality information appears on the 1000-unit scale than when it is expressed on the 10-unit scale.

Method

Seventy-one students (28 men, 43 women) with various majors participated for partial course credit (mean age = 22.34 years, SD = 4.12). Participants received quality information about 12 focal home cinema systems, though half considered this information on a 1000-point scale, and the other half saw a score on a 10-point scale. Participants imagined winning one of the systems but also could upgrade to a perfect system in exchange for money. Each participant therefore indicated, for the 12 systems, how much more they would be willing to pay (in Euro) for the perfect home cinema system. The quality of the 12 systems ranged from 4 (400) to 9.5 (950), in steps of 0.5 (50).

Results

To test for outliers, we first regressed each participant's WTP estimates on the quality of the focal system. For two participants, the slope was more than 3 standard deviations above the mean slope; for one participant, the intercept was more than 3 above the mean intercept. We discarded data from these three participants.

We next regressed WTP (in Euro) on the number of units (10 versus 1000) and the quality of the focal system for the remaining participants. To test whether the slope differs across unit conditions, we include the interaction between the number of units and focal quality. A multilevel regression model accounts for the repeated measures nature of the data. The analysis reveals a main effect of focal quality ($F(1,66) = 102.66$, $p < .001$), which is qualified by a significant interaction with the number of units ($F(1,66) = 15.06$, $p < .001$). Therefore, the slope is higher in the 1000-unit condition ($\alpha = 343.42$) than in the 10-unit condition ($\alpha = 153.22$).

The regression model depends on the assumption of linearity, so we undertake an alternative analysis in which we subject the WTP data to a 2 (number of units: 10 versus 1000) × 12 (proportional difference: 5–60%) ANOVA with repeated measures on the second factor. This ANOVA yields significant main effects of both proportional difference ($F(11,66) = 11.83$, $p < .001$) and number of units ($F(1, 66) = 6.56$, $p = .013$). As we hypothesized, we also find a significant interaction between proportional difference and number of units ($F(11,66) = 11.83$, $p < .001$). When the focal quality is very good (9.5/10 or 950/1000) and the proportional difference is 5%, no significant difference in WTP appears between the two scale conditions ($M_{10} = 19.61$, $M_{1000} = 27.29$; $t(66) = 1.06$, $p = .29$). When the focal quality is rather bad though (4/10 or 400/1000), with a proportional difference of 60%, the WTP for the perfect system increases significantly in the 1000-unit condition compared with in the 10-unit condition ($M_{10} = 155.00$, $M_{1000} = 281.71$; $t(66) = 2.96$, $p < .01$).

Finally, follow-up interaction trend tests confirm that the linear relationship differs in the 1000-unit compared with the 10-unit condition ($F(1,66) = 9.72$, $p < .001$). Of the interaction trend tests, only the cubic test is significant ($F(1,66) = 5.48$, $p = .02$). We display, in Figure 3, the mean WTP for each proportional difference, along with a fitted polynomial. In the 10-unit condition, the data can be described adequately by a linear function, whereas in the 1000-unit condition, the relation between proportional difference and WTP slightly departs from linearity at both ends of the displayed curve. The resulting sigmoid curve requires both a linear and a cubic trend to describe it.

Insert Figure 3 about here

Discussion

To reconcile our results with consumers' sensitivity to proportional differences, we posit that the influence of proportional differences depends on the number of units used to express an attribute, such that the proportional difference sensitivity may increase with the number of scale units (H_4). Study 4 supports this line of reasoning. The slope that relates the proportional quality difference to WTP becomes steeper when the quality appears in terms of 1000 units than when it is expressed in terms of 10 units. Therefore, the difference in WTP between the 10- and 1000-unit conditions should be more pronounced for greater objective quality differences than for smaller objective quality differences. Participants indicate they would pay significantly more in the 1000-unit condition than in the 10-unit condition for a perfect system when the focal system offers poor quality, though not when the focal system is nearly perfect.

GENERAL DISCUSSION

Consumers prefer quantitative to qualitative information (Hsee et al. 2009), presumably because they consider it more objective and easier to interpret. But consumption decisions often depend on context, as evidenced by the existence of compromise, attraction, phantom, and range effects (Hedgcock, Rao, and Chen 2009; Huber, Payne, and Puto 1982; Mourali, Böckenholt, and Laroche 2007; Parducci 1965; Pettibone and Wedell 2007; Pocheptsova et al. 2009; Pratkanis and Farquhar 1992; Simonson 1989; Yeung and Soman 2005). The interpretation of quantitative information therefore may not be as straightforward as many consumers believe (Hsee 1996; Yeung and Soman 2005). Even in the absence of context information, consumers' decisions could be influenced by the framing of the information (Janiszewski, Silk and Cooke 2003; Tversky and Kahneman 1991). As we show, the number of units used to describe attribute information acts as one type of frame, which in turn affects consumers' perceptions of attribute differences, as well as their preferences.

When the same attribute difference appears in the form of more units, it seems larger and more important (H_1; Study 1). Because quality differences among the various options appear inflated, consumers may avoid the lower quality option that would have been more attractive if the quality ratings had been expressed with fewer units (H_3; Study 3). Finally, we find that the unit effect implies that consumers are more sensitive to proportional differences and ratios of attribute levels that feature many units rather than few units (H_4; Study 4).

Burson, Larrick, and Lynch (in press) reveal that consumers' preferences shift according to the expression of attribute information. Their participants chose between two movie rental plans that allow them to rent a certain number of movies within a given time period; these authors find that participants prefer the cheaper plan when the number of movies available for rent appears on a per week basis. However, they chose the more expensive option when the available movies get presented per year. These changes in preferences may be due to changes in attribute weights in a multi-attribute decision task.

We concur that changes in the attribute information scale may play a role, yet our research points to a different mechanism. In particular, we find that scale changes affect perceived differences. In addition, the results of Study 1 cannot be explained in terms of altered attribute weights as the study involves only one attribute. Further, in Study 3B, altered perceptions of quality differences appear sufficient to explain the effect of scale on choice. We also argue that altered attribute weights cannot explain the results from Study 4.

To explicate the unit effect, we propose that consumers use a numerosity heuristic (Pelham, Sumarta, and Myaskovsky 1995) to evaluate attribute differences. The numerosity heuristic implies that consumers take the number of units into account but do not pay attention to the type of units. Thus, evaluations of an attribute difference depend on the number of units. Consumers appear particularly prone to a numerosity effect when they do not translate attribute information provided on one scale into another scale; as Study 2 indicates, offering the attribute information on two different scales is sufficient to eliminate the unit effect (H_2).

We also consider whether our results might reflect an anchoring mechanism, which occurs when people's numerical judgments gravitate toward a number (the anchor) that became accessible immediately before the judgment (Blankenship et al. 2008; Tversky and Kahneman 1974). Standard anchoring involves an explicit consideration of a certain number as a response to a numeric question (e.g. Janiszewski and Uy 2008), whereas basic anchoring involves the exposure to any number, whether relevant or not, without consideration of that number as a possible response (Critcher and Gilovich 2008; Wilson et al. 1996; Wong and Kwong 2000). Although in both cases, numeric responses move toward the anchor number, the processes involved differ (Blankenship et al. 2008): The standard paradigm increases the accessibility of information consistent with the anchor (Strack and Mussweiler 1997), but basic anchoring involves number priming.

We did not ask our participants to contemplate any number as a potential response, so standard anchoring cannot apply. The number of units that constitute a given difference could offer a basic anchor, but two of our findings are inconsistent with this claim. First, even when we do not request judgments, the number of scale units affects consumer choices (Study 3A). This finding may not exclude an anchoring explanation completely though, because in the absence of explicit judgments, participants might make spontaneous judgments of quality differences, which would affect their subsequent choices. These implicit judgments could have been affected by basic anchoring. Second, we find that only those judgments pertaining to attribute differences exhibit an effect of the number of units. For example, in Study 3B, no unit effect occurs for judgments of price differences. Because basic anchoring does not require relevance (Critcher and Gilovich 2008; Wong and Kwong 2000), the failure to obtain a unit effect on dimensions that relate empirically to the focal dimension strongly argues against an interpretation based on anchoring effects.

Our studies use nonmonetary attributes (e.g., warranty, quality, probability of success), which prompts us to wonder whether similar effects would emerge for monetary attributes (e.g., price, service fee). As we noted previously though, prices and budgets in foreign currencies affect perceptions of both prices (Raghubir and Srivastava 2002) and budgets (Wertenbroch, Soman, and Chattopadhyay 2007). Previous findings regarding how consumers anchor on foreign prices and budgets to estimate equivalent domestic prices and budgets suggest that the numerosity effects would be similar for monetary and non-monetary attributes. However, some recent findings indicate that, when consumers are confronted with different denominations in their domestic currency, a reverse unit effect may be obtained. For example, people appear to value a certain amount of money more when it is specified as a small number of large bills rather than as a large number of small bills (i.e., denomination effect, Raghubir and Srivastava 2009). Furthermore, dollars are much more potent money primes than are dollar cents (Vohs, Meade, and Goode 2006), such that people tend to defect in a prisoner’s dilemma game when then can gain US$2 rather than the equivalent amount of US¢200 (Furlong and Opfer 2009). It appears then that, the occurrence of a unit effect may be limited to situations where the different types of units do not entail differences in intrinsic values (e.g. a large bill is more valuable than a smaller one, just as one dollar is worth more than one cent). In our situations, this was always the case: a unit on a 1000-point is not intrinsically more valuable than a unit on a 10-point scale and neither is a year intrinsically more or less valuable than a month.

Further Research and Implications

People's focus on the number of units, not the type, may be a general tendency that affects sensitivity to certain information. A time window therefore may seem longer when expressed in days rather than weeks, in which case consumers may be willing to pay more for a vacation of 7 days than for a vacation of one week. Furthermore, in time discounting studies, participants could grow less impatient if the wait time appears in weeks rather than days, which in turn could minimize the discounting rate. Time also seems to pass more quickly on a clock that displays tenth of seconds than one that updates only every minute (see also Read et al. 2005). Finally, the rate at which sensitivity to losses and gains diminishes (cf. prospect theory, Kahneman and Tversky 1979) may depend on the scale for expressing the (nonmonetary) attribute. That is, people may be more sensitive to both losses and gains when they appear on a scale that consists of many units. Further research should investigate this speculation.

Additional research also could undertake a comparison of the unit effects for open versus closed scales. Closed scales provide definite endpoints, whereas open scales do not. In both cases, bigger may seem better, but people's appreciation for a particular level may differ according to the state of the scale. For example, a 108-month warranty sounds much better than an 84-month warranty, but it also may be appealing on its own. In contrast, though the quality difference between 700 and 800 on a 1000-unit scale appears rather big, 800 still might not represent a particularly good score. In fact, the appreciation of a particular score may depend on the end point with which it is compared. If consumers compare 800 to the low end of the scale (0), it seems far better than if they compare it against the high end of the scale (1000).

We also suggest several managerial implications based on the unit effect. Brands could increase perceptions of their superiority by expressing their scores on a superior attribute in the form of many units (see also Burson, Larrick, and Lynch, in press), which may be particularly effective in comparative advertising. Loyalty programs that offer points based on the amount consumers spend also should reflect our findings. The difference between rewards A and B may seem greater if consumers must accumulate 500 points for A and 700 for reward B rather than 5 and 7 points. Thus, compared with the alarm clock for 500 points, an MP3 player for 700 points likely will seem more valuable. Consumers can become very focused on their loyalty points (cf. medium maximization, Hsee et al. 2003), and a scale with more units could stimulate them to spend more than would a reward system with fewer points. Finally, when consumers have the choice between a hedonic and a functional reward, greater perceived effort makes them lean toward the hedonic reward (Kivetz and Simons 2002). As the number of points associated with the reward increases—when there are more units—consumers may perceive their greater effort, which should drive them toward more hedonic rewards.

Conclusion

Various studies indicate that people's interpretation of quantitative attribute information depends on the framing of the information and the context in which the information appears. We extend such research by demonstrating that even the scale used to provide the attribute information can affect consumers' preferences. In particular, differences become more pronounced on scales with many units, and this effect may lead to altered preferences. Although the unit effect is relevant for any setting that contains quantitative information, further research is needed to investigate its various implications.

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Table 1: Perceived Differences as a Function of Scale for Three Conditions

Condition	**Scale**	**Attribute scores**	**Perceived difference**	***t***	***p***	$\boldsymbol{\eta^2}$
Dishwasher warranty	Years Months	7 vs. 9 84 vs. 108	3.60 (SD = 1.20) 4.28 (SD = 1.03)	$t(84) = 2.80$	$< .01$	.085
Television quality	10-unit 1000-unit	7 vs. 9 704 vs. 903	4.26 (SD = .82) 4.61 (SD = .76)	$t(60) = 1.77$	.08	.049
Medical success probability	10-unit 1000-unit	7 vs. 9 704 vs. 903	4.90 (SD = .98) 5.32 (SD = .54)	$t(60) = 2.09$	.04	.068

Table 2: Probability of Choosing Attraction, Decoy, and Target Options as a Function of the Number of Scale Units

	Study 3A (*N* = 73)				**Study 3B (*N* = 96)**			
	10 (*n*=36)	1000 (*n*=37)	LR $\chi^2(1)$	*p*	10 (*n*=50)	1000 (*n*=46)	LR $\chi^2(1)$	*p*
Target option	19%	46%	5.95	.02	14%	43%	10.59	.001
Decoy option	6%	0%	2.89	.09	4%	9%	.91	.34
Attraction option	75%	54%	3.53	.06	82%	48%	12.73	< .001

Figure 1: Perceived Quality Difference as a Function of Number of Units and Presence of Visual 10-point Information: Study 2

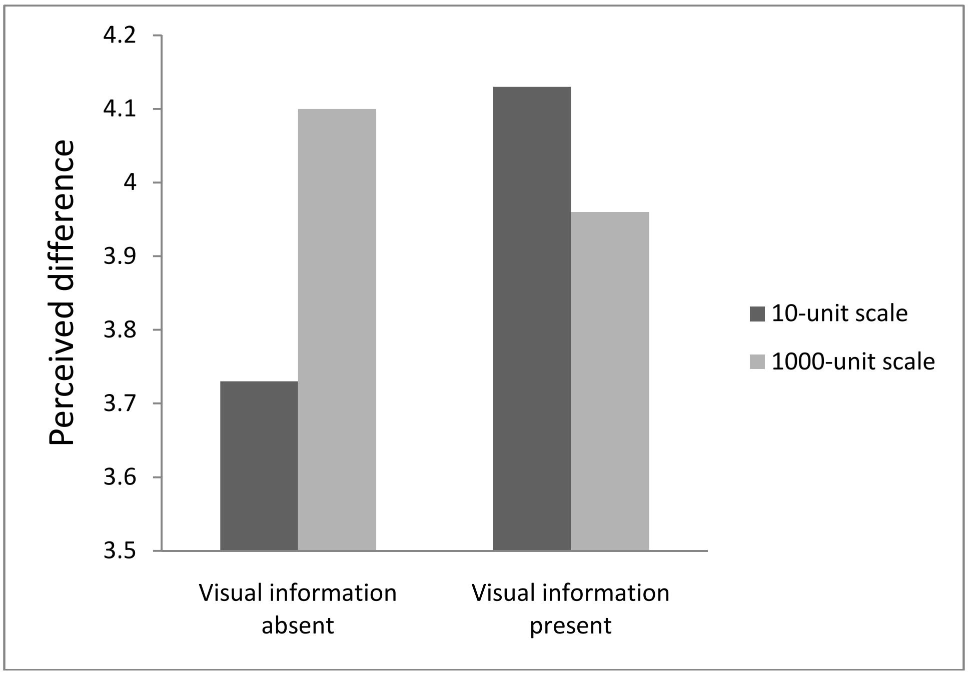


Figure 2: Price and Quality Judgments as Functions of the Number of Units: Study 3

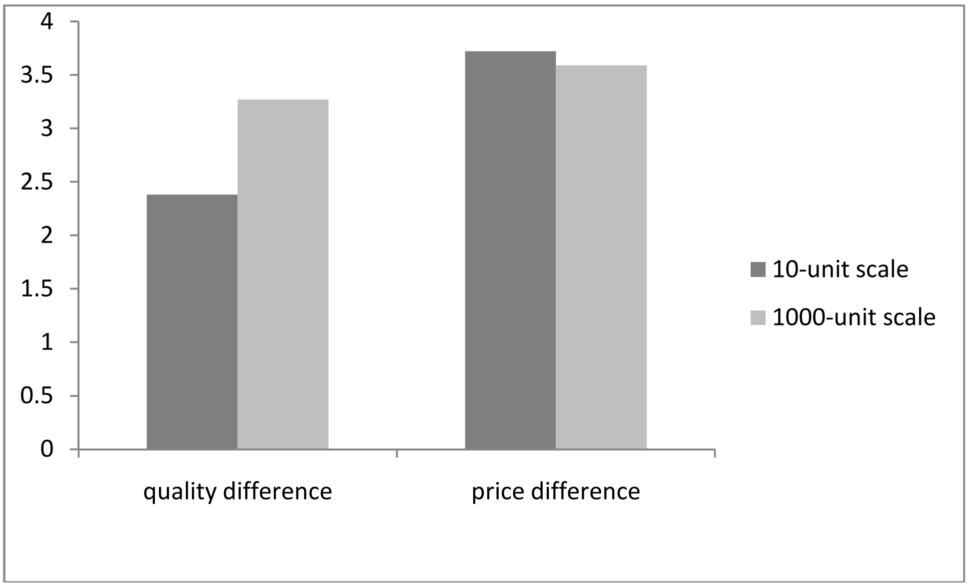
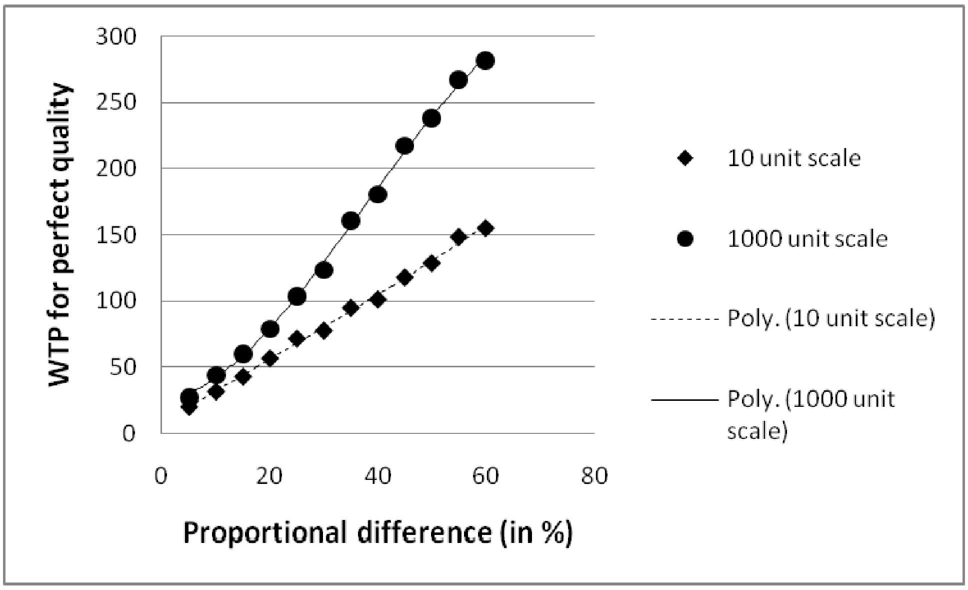


Figure 3: Mean WTP for Perfect Quality as a Function of Current Quality and Scale: Study 4



Notes: The cubic trend line is added.

Appendix A: Stimuli used in Study 2
Condition 1: 10-point quality ratings – no visual information

		Price in $	Quality on 10
			
1	*Brand* LC 46DU4 46 in. HDTV LCD TV	1225	7
2	*Brand* KDL 46XBR4 46 in. HDTV LCD TV	1479	9

Condition 2: 1000-point quality ratings – no visual information

		Price in $	Quality on 1000
			
1	*Brand* LC 46DU4 46 in. HDTV LCD TV	1225	700
2	*Brand* KDL 46XBR4 46 in. HDTV LCD TV	1479	900

Condition 3: 10-point quality ratings –visual 10-point scale

		Price in $	Quality on 10
1	*Brand* LC 46DU4 46 in. HDTV LCD TV	1225	
2	*Brand* KDL 46XBR4 46 in. HDTV LCD TV	1479	

Condition 4: 1000-point quality ratings –visual 10-point scale

		Price in $	Quality on 1000
1	*Brand* LC 46DU4 46 in. HDTV LCD TV	1225	
2	*Brand* KDL 46XBR4 46 in. HDTV LCD TV	1479