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Similarity in Context: Cognitive Representation and Violation of Preference and Perceptual Invariance in Consumer Choice

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A recent stream of research has demonstrated that the relative preference ordering among any two alternatives is influenced by the context or the set of alternatives under consideration. A parallel stream of research has suggested that judgments of similarity or perceived distance also vary with the composition of the stimulus set. In this paper, we suggest that context-induced violations of invariance in preference and in similarity judgments are based on changes in the underlying cognitive representation. Using the case of attraction effect as our example, we demonstrate experimentally that (i) similarity or the distance between two brands changes as a function of new brand introduction and (ii) rather precise predictions can be made as to the pattern of changes in the distance between brands and changes in preference ordering. Furthermore, the effect of context on similarity judgment patterns allows us to identify new effects on preference for previously untested location of new brands, providing additional support for the claim that preference and similarity judgments involve common processes.

Judgments of preference and of perceived similarity are at the core of most theories of consumer behavior. Most traditional formulations of decision making, such as the linear compensatory model, assume that each alternative has a "utility" or subjective value that can be determined independently of the decision context or the set of alternatives under consideration. By contrast, research in the area of context effects suggests that the set of objects under consideration can be an important determinant of preference (Simonson & Tversky, 1992). In particular, the relative preference ordering among any two alternatives may change depending on the presence or absence of additional alternatives in the choice set. An emerging consensus among decision researchers is the notion that preferences are often not well defined but rather, constructed from the specific context in which they are elicited (Payne, Bettman, & Johnson, 1992; Slovic, 1995).

Although it has received less attention in the decision-making literature, the effect of context on similarity judgments is also well established. While early similarity research focused on the notion that subjects converted externally presented stimuli into a subjective (although fixed) "perceptual attribute" scale, studies over the past two decades suggest that judgments of similarity are flexible and context-dependent rather than fixed (Medin, Goldstone, & Gentner, 1993). Citing the body of research associated with Tversky's theory of similarity (1977; Tversky & Gati, 1978), these studies note that there is no unique answer to the question of how similar one object is to another. Rather, changes in similarity structures can be linked to corresponding processing principles that change similarity systematically with the stimulus context.

Our interest in this paper is in the *interaction* between judgments of preference and perceived similarity in consumer decision-making, and, more particularly, in the fact that contextual changes in preference can be linked to the contextual changes in similarity. By way of example, we focus on the case of the "attraction" or the asymmetric dominance effect, which has received a good deal of attention in the recent decision-making and marketing literature. As described by Huber, Payne, and Puto (1982; Huber & Puto, 1983), when a core set of two alternatives (*a b*) is expanded to include a third alternative, *c*, that is dominated either by *a* or by *b*, it increases the probability of choosing the dominating alternative. Since the third alternative

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called the *decoy* is almost never chosen, the resulting attraction effect is a violation of "regularity," the assumption that adding a new option cannot increase the probability of choosing a member of the original set. Since the introduction of the decoy changes the aggregate preference ordering, violation of regularity is also a violation of preference invariance.

Several subsequent studies have replicated the attraction effect (Prelec & Bodner, 1993; Simonson, 1989; Wedell, 1991). Although the early papers focused on demonstrating the phenomenon, more recently, different explanations have been suggested for the attraction effect, most relying on preference-based factors. For instance, Simonson and Tversky (1992; Tversky & Simonson, 1993) account for the attraction effect based on the notion of local contrasts in attribute trade-offs. They posit that context effects can be understood in terms of trade-off contrast, the notion that the preference among alternatives is influenced by the other trade-offs *implied* in the set of options under consideration. Thus, the attractiveness of the trade-off comparison between alternatives *a* and *b* is influenced by other implied trade-offs in the set under consideration. In particular, the tendency to prefer *a* over *b* will be enhanced if the decision maker encounters other trade-off comparisons (i.e., between *a* and the decoy *c*) in which the exchange rate between the two attributes is higher than that implied by *a* and *b*.

The theory presented here draws from the literature that demonstrates how similarity or perceptual distance between two objects changes with the introduction of new alternatives. Our paper differs from previous approaches in that, by looking at these context effects in perceptual domain, we wish to understand when the introduction of a new alternative will result in a violation of preference invariance. This in turn may shed some light on the fact that the introduction of a decoy does not always result in the attraction effect. A second difference from the Tversky and Simonson (1993) approach is that the trade-off comparisons operate on the modified perceptual distances among the alternatives. The central point of the theory is that the changes in preference ordering or the attraction effect is obtained when there are corresponding context-induced changes in perceptual distance. This is shown to be true even when the decoy did not result in a favorable trade-off contrasts or asymmetric dominance.

The remainder of the paper is organized as follows. We briefly review the prior research relevant to effect of context on similarity, leading to several hypotheses that were tested in two studies. Study 1 examines the correspondence between contextual changes in similarity judgment and preference and finds that the attraction effect is accompanied with a systematic violation of perceptual invariance. Furthermore, in the absence of systematic changes in similarity judgments, introducing the decoy did not produce shifts in preference. Study 2 demonstrates that, even in the absence of asymmetric dominance and trade-off contrasts, similarity changes are sufficient to explain the shift in preferences. More generally, our findings suggest that the identification of context effects in one domain (similarity) is diagnostic of context effects in the other (preference); and that the consideration of the interaction between both sets of judgments contributes to the development of an integrated framework linking the perceptual and preferential components of context dependent decision-making.

THE THEORY

Within psychology and consumer behavior, perceptual representation is typically assumed to be based on the similarity among the objects in a set. For instance, the subjective judgments of an object is based on the perceived position of that object in the perceptual space. Research over the last two decades suggests that these similarity judgments are flexible rather than fixed (Medin, Goldstone, & Gentner, 1993). For instance, Parducci (1965, 1983) has argued that the distance between two objects changes with the composition of the set in which it is embedded. However, similarity is not randomly flexible since *systematic* changes can be established depending on the particular stimuli that are presented. Building on these findings, the focus of this paper is to show that the changes in similarity can account for the changes in the ordering of preferences.

The changes in similarity can be understood in terms of a spatial representation, in which stimulus similarity is assumed to be some decreasing function of perceptual distance among the objects. Although the typical spatial representation assumes that the perceived distance among objects is fixed across different contexts, different contexts can lead to systematic changes in the perceptual space and in the similarity distance.[1] In geometric terms, the introduction of new alternatives can *stretch* or *shrink* the judged distance along the different attributes (Nosofsky, 1987). To the extent that changes in attribute distances between the two objects are accompanied by corresponding changes in relative preference among them, it provides support for a perceptual-based explanation for the context effects.

[1] This assumption was relaxed by recent models of similarity (DeSarbo & Manrai, 1993), but its implication for understanding violations of preference invariance has not been examined.

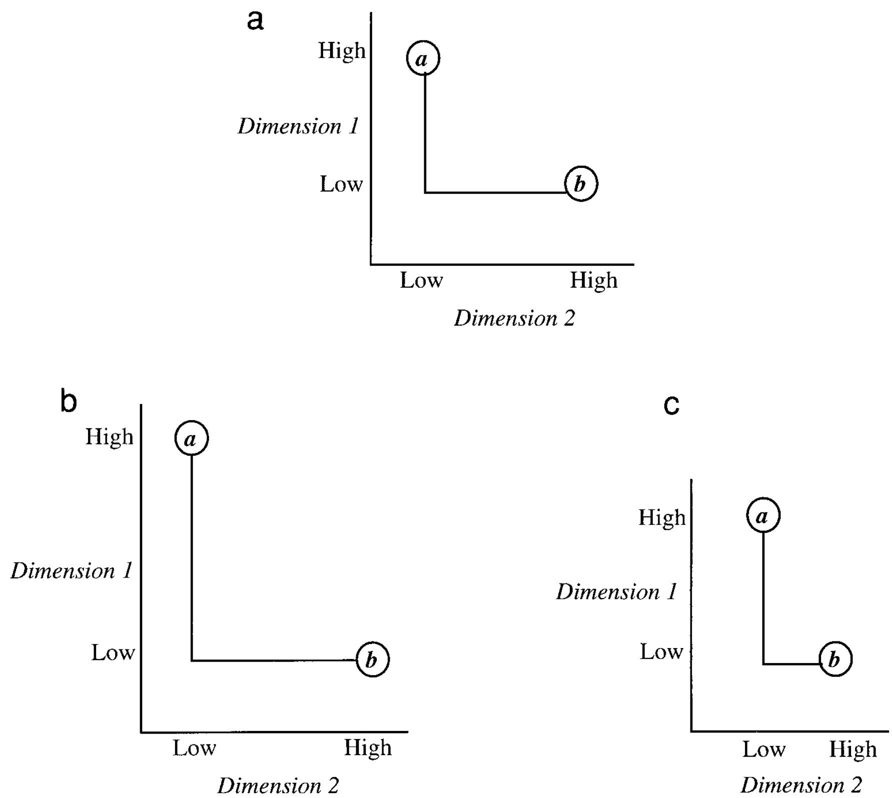

FIG. 1. (a) Multidimensional choice sets. (b) Multidimensional choice sets, dimension 1 stretched. (c) Multidimensional choice sets, dimension 2 shrunk.

To illustrate how changes in stimulus similarity may affect the preference relationship, consider Fig. 1. In Fig. 1a, two stimuli, *a* and *b*, are shown that vary along two dimensions. Figure 1b depicts the situation in which the perceptual distance is stretched along dimension 1, on which *a* is better, whereas Fig. 1c illustrates the situation in which the distance is shrunk along dimension 2, on which *b* is better. Note that these shifts in perceptual distances render the two stimuli less similar to one another in Fig. 1b and more similar in Fig. 1c. Since decision processes are posited to operate on the modified perceptual representation, changes in similarity alter the attribute trade-offs between a given stimuli pair and consequently the relative preference among the objects. Thus, *a* would appear relatively more attractive in relation to *b* in Figs. 1b and 1c than in 1a. Using the framework outlined above and the case of attraction effect as our primary example, we next examine how similarity and preference among the core objects vary with the addition of a third object at different locations.

Similarity and the Attraction Effect

The proposed relationship between changes in judgments of similarity and the attraction effect is examined for choice sets comprising objects that are described by their values on two attributes. Formally, if T = {*a*, *b*, *c* . . .} is a set of multiattribute objects, then we define the preference relation, p(*a*; *b*) as the relative preference of *a* over *b*. Further, we define the similarity relation, s(*ab*), as the similarity between objects *a* and *b*. Furthermore, for subsets of T, {*a*, *b*}, {*a*, *b*, *c*}, etc., let p(*a*; *b* {*a*, *b*}) be the preference for object *a* over *b* from the subset {*a*, *b*}; p(*a*; *b* {*a*, *b*, *c*}), the preference for *a* over *b* from the subset {*a*, *b*, *c*}. Also, let s(*ab*{*a*, *b*}) be the similarity of (*ab*) given the subset {*a*, *b*}; let s(*ab*{*a*, *b*, *c*}) be the similarity of (*ab*) from the subset {*a*, *b*, *c*}, etc.

Using the above notation, an important class of choice behavior has been identified whereby p(*a*; *b*{*a*, *b*}) ≠ p(*a*; *b*{*a*, *b*, *c*})[2]—i.e., the relative preference between objects *a* and *b* depends on which other alternatives are in the choice set. In particular, a number of studies show that when a set of two nondominated alternatives is expanded by adding a new alternative *c*, that is dominated by one (*a*), but not the other (*b*), it

[2] An alternative way of measuring the relative preference of *a* over *b* in the presence of *c* allows *c* to be chosen. In the current formulation, the choice is between *a* and *b* but the context in which it is embedded is either *a*, *b* or *a*, *b*, *c*.

results in a violation of preference invariance—i.e., p(a; $b\{a, b, c\}$) > p(a; $b\{a, b\}$). The focus is on studying the change in similarity as a result of the change in context in order to examine its implications for the change in preference. Formally, if $\{a, b\}$ is the core set to which alternative c is added, we study the link between situations where s($ab\{a, b\}$) ≠ s($ab\{a, b, c\}$) and p(a; $b\{a, b\}$) ≠ p(a; $b\{a, b, c\}$).

We focus first on the traditional three object, two-attribute design where a and b are nondominated alternatives, and c is asymmetrically dominated by a,—i.e., a is better than c on at least one attribute and at least as good on the other attribute. With the introduction of c, our analysis examines three potential similarity effects: (i) where the addition of the decoy *decreases* the similarity between the original objects—s(ab, $\{a, b\}$) > s(ab, $\{a, b, c\}$); (ii) where the addition of the decoy *increases* their similarity—s($ab\{a, b\}$) < s($ab\{a, b, c\}$); (iii) where the addition of the decoy leaves the similarity *unchanged*—s($ab\{a, b\}$) = s($ab\{a, b, c\}$). We argue that in order for the attraction effect to occur, the similarity between a and b must shift *differentially* along the two attributes with the introduction of the decoy. In other words, the relative preference for a will increase when adding the decoy stretches the distance along the attribute on which a is superior, or when it shrinks the distance on which b is superior. The different locations of the decoy and their impact on similarity between the two original brands is discussed next.

I. Decreasing the Similarity between the Core Stimuli

Consider the situation where the decoy c_1 is positioned close to the target, a. For example, assume the product category is "stereo cassette recorders" and that the attributes are "sound quality" and "reliability." The target a has a sound quality rating of 65 and a reliability rating of 90, and brand b has a sound quality rating of 85 and a reliability rating of 65. The asymmetrically dominated decoy c_1 is positioned close to a—e.g., a sound quality rating of 60 and a reliability rating of 90 (see location c_1 in Fig. 2). We designate this relationship between a and c_1—i.e., where s(ac_1) is high—as a "tight cluster." Consistent with previous literature, in the typical choice experiment involving these stimuli, p(a; $b\{a, b\}$) < p(a; $b\{a, b, c\}$). The question arises—what is the expected shift, if any, in the similarity (ab) with the introduction of the decoy c_1?

Several different explanations from the similarity literature imply that the introduction of c_1 decreases the perceived similarity between the core set stimuli (ab). For instance, Krumhansl (1978, 1982) proposes a distance–density model of similarity where density is a measure of the concentration of objects in a dimensionally organized metric space. In that framework, changes in stimulus densities produces corresponding changes in judged similarity. Since the addition of the decoy increases the "spatial density" around the region in which the core objects (brands) are located, the model suggests that they will be perceived as less similar. Also, as suggested by Parducci's range-frequency theory (1965, 1983), since finer discriminations are made within denser subregions than within relatively less dense subregions, adding the decoy should increase the perceptual distance between a and b.

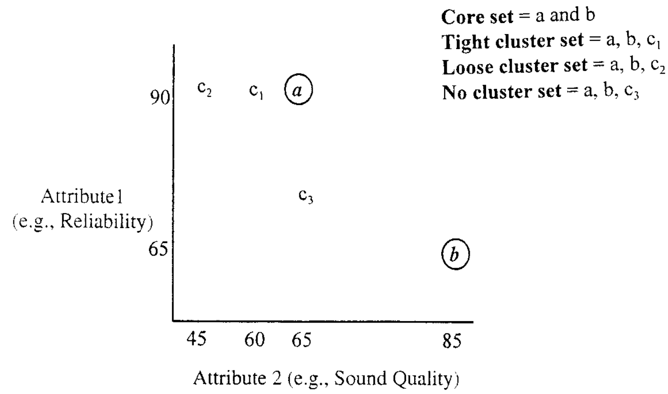

FIG. 2. Choice sets leading to the attraction effect.

Since the decrease in overall similarity can be attributed to an increase in the distance on either or both of the underlying dimensions, an overall perceptual change in itself does not imply an increase in the relative attractiveness of a. In particular, a perceptual mechanism underlying observed shifts in preference suggests that the attraction effect would be observed when the relative increase is greater on the dimension on which a is superior than the one on which b is superior. Consequently, a perceptual mechanism suggests that when the attraction effect is observed, the distance between a and b on "reliability" should increase more than the distance between a and b on "sound quality" with the addition of the decoy c_1.

In summary, we predict an overall decrease in similarity between a and b in the presence of c_1. Further, we predict a greater increase in perceived distance on the attribute on which a is superior when the attraction effect is observed. This is equivalent to a *stretching* of the space so that a and b are now farther apart on "reliability," relative to the distance between a and b on "sound quality." The fact that the two brands are now seen as "farther apart" on the attribute on which a is superior is consistent with the attraction effect. More formally, we have:

H1a. s($ab\{a, b, c_1\}$) < s($ab\{a, b\}$), where s($ab\{a, b, c_1\}$) is the similarity between a and b, in the set $\{a, b, c_1\}$, etc.

H1b. $|s_{att1}(ab\{a, b\}) - s_{att1}(ab\{a, b, c_1\})| > |s_{att2}(ab\{a, b\}) - s_{att2}(ab\{a, b, c_1\})|$ when the attraction effect is observed.

II. Increasing the Similarity between the Core Stimuli

We next consider the case where the decoy is introduced far from the target along each of the two attributes. The evidence for the attraction effect for this decoy location is mixed. Although Huber and Puto (1982) find that the attraction effect does occur in such cases, Heath and Chatterjee (1991) report that the attraction effect occurs only when the distant decoy is located along the attribute on which *a* is inferior. This differential impact of the distant decoy on the attraction effect is consistent with a perceptual-based explanation.

First, consider the situation where c_2 is positioned relatively farther away from the target on the attribute on which *a* is less preferred—e.g., a sound quality rating of 45 and a reliability rating of 85. We designate this relationship between *a* and c_2—i.e., where $s(ac_2)$ is low—as a "loose cluster" (see location c_2 in Fig. 2). Range-frequency theory predicts that the similarity of (*ab*) should increase in the presence of c_2. First, observe that positioning c_2 farther away from the target has the effect of significantly increasing the range of the attribute ("sound quality") on which *a* is inferior to *b*. Thus, adding c_2 increases the subjective value of *a*, but not *b*, along this dimension. As a result, the distance between *a* and *b* on "sound quality" will be seen as smaller in the presence of the decoy c_2. In contrast, the distance between *a* and *b* on the attribute "reliability" should remain relatively unchanged.

An increase in overall similarity between *a* and *b* when c_2 is added is also consistent with density effects (Krumhansl, 1982; Wedell, 1996). Since similarity is proposed to be inversely related to density, the same distance would correspond to greater similarity when the stimuli were located in a sparse rather than dense region. Hence, *a* and *b* are seen as more similar. The combined decrease in overall distance between *a* and *b* as well as a greater decrease in the distance on the dimension on which *a* is inferior increases the relative attractiveness of *a*. In summary, we predict an overall increase in similarity between *a* and *b* in the presence of c_2. Further, we predict a greater decrease in perceived distance on the attribute on which *a* is inferior. This *shrinking* of the space so that *a* and *b* are brought closer together on "sound quality" while *a* and *b* do not move with respect to "reliability" is consistent with the observed increase in the relative preference for *a*. Formally, we have:

H2a. $s(ab\{a, b, c_2\}) > s(ab\{a, b\})$

H2b. $|s_{att1}(ab\{a, b\}) - s_{att1}(ab\{a, b, c_2\})| < |s_{att2}(ab\{a, b\}) - s_{att2}(ab\{a, b, c_2\})|$ when the attraction effect is observed.

III. No Change in the Similarity between the Core Stimuli

Next, we consider the situation where the decoy c_3 is positioned relatively farther along the attribute on which *a* is superior—e.g., a sound quality rating of 65 and a reliability rating of 70 (see the location of c_3 in Fig. 2). For this decoy location, the distance between *a* and c_3 is close to the distance between *a* and *b*. We designate this relationship between *a* and c_3—i.e., where $s(ac_3)$ is close to $s(bc_3)$—as a "no cluster." We argue that since c_3 does not modify the perceptual distance on the two attributes, it is also unlikely to result in the attraction effect.

We predict that the similarity between *a* and *b* will remain unchanged with the introduction of c_3. Observe that positioning c_3 farther away from *a* has no effect on increasing the range of the attribute ("sound quality") on which *a* is inferior. Further, c_3 does not differentially change the density near *a* or *b*. Thus, we predict no shift in the similarity between *a* and *b* when c_3 is introduced. The lack of a differential shift in the perceptual distance between *a* and *b* on either attribute further predicts that the preference for *a* remains unchanged when c_3 is introduced. Note that, although both the perceptual and preference based explanations predict an increase in *a*'s share due to c_1 and c_2, only the perceptual based explanation predicts no effect on preference when the asymmetrically dominated decoy c_3 is introduced. Formally,

H3a. $p(a; b\{a, b\}) = p(a; b\{a, b, c_3\})$.

H3b. $|s_{att1}(ab\{a, b\}) - s_{att1}(ab\{a, b, c_3\})| = |s_{att2}(ab\{a, b\}) - s_{att2}(ab\{a, b, c_3\})|$

Similarity measurement. A concern with perceptual data is whether the observed shift in similarity judgments is indeed due to changes in cognitive representation or merely a "response language" effect that reflects changes in overt ratings but not in the underlying similarity structure. For example, consumers may rate two objects as more similar when a third object that is very different is also provided. Representational, as opposed to response language adjustments, are operative if there is a change in the similarity ordering of stimuli with the change in context (Hutchinson, 1983; Lynch, Chakravarti, & Mitra, 1991). Another method, the one used here, is to measure the *pattern* of shifts in similarity judgments in relation to a third alternative. For instance, a *differential* change in the distance between two brands relative to a third brand cannot be attributed to changes in overt ratings. Thus, the core choice set included an explicit "reference brand"—i.e., a stimulus object i that is a *minimally dominating alternative* relative to a and b. In the example above, i would have a "sound quality" rating of 85 and a "reliability" rating of 90 (Fig. 2). Thus, the core set is $\{a, b, i\}$, to which will be added one of three decoys c_1, c_2, or c_3.

The inclusion of i to the core set serves two other purposes. First, it is essential to have at least three objects to elicit similarity judgments that are conceptually meaningful. Second, by the virtue of its location, the similarity between a and i, and b and i, provide a natural measure of the subjective distance between a and b along each attribute. Thus, an increase (decrease) in the distance between a and i corresponds to a stretching (shrinking) in the distance on *attribute-2* between a and b. Similarly, a change in the distance between b and i provides a measure of the change in distance a-b along *attribute-1*. This enables us to examine the relationship between the attraction effect and the corresponding shift in similarity distance along each attribute. The pattern of effects is summarized in Fig. 3.

The present framework also predicts when the attraction effect will occur for the tight and loose cluster decoys. As noted earlier, the size of the attraction effect has been seen to vary across choice problems. In the current framework, the magnitude of the attraction effect would depend on the change in the cognitive representation. Accordingly, we predict that greater the perceptual shift between the two brands a and b, in the presence of c, the greater the shift in relative choice shares:

H4. The greater the increase in $|s(ab\{a, b, i, c\}) - s(ab\{a, b, i\})|$, the greater the increase in $|p(a; b\{a, b, i\}) - p(a; b\{a, b, i, c\})|$.

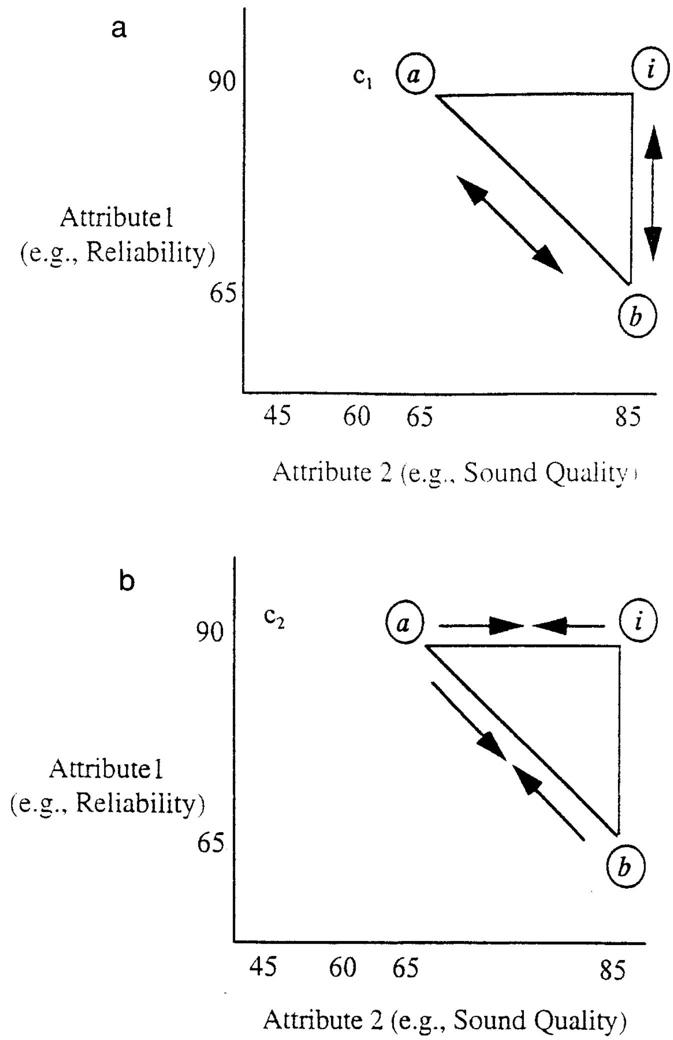

FIG. 3. Shifts in similarity judgments induced by introduction of decoy to core set.

STUDY 1

Method

Stimuli material. Five different types of products were used: automobile, stereo, apartment, manager, and applicant to graduate school. For each of these product categories, each alternative was described on two attributes and subjects were told to assume that they were identical on other attributes. The core set or the control condition consisted of three alternatives. Two of the brands a and b were constructed so that neither dominated the other—i.e., each was superior on one of the two attributes. As described earlier, a third option i was positioned on the higher value on both attributes.

In the three experimental conditions, a new brand dominated by a, but not b, was added to the core set to create the tight cluster, loose cluster, and no cluster settings in the following manner. In the location c_1, the decoy was identical to brand a on the first attribute and very close to it on the second. In location c_2, it was identical to a on the first attribute, but relatively farther away on the second. In location c_3, it was identical to a on the second attribute and relatively farther away on the first. The precise values for the decoy were based on a pilot study described next.

Pilot test. Recall that the hypotheses make specific predictions as to the patterns in perceptual shifts arising due to different locations for the decoy. *Ex post*, therefore, the extent to which the introduction of a decoy satisfies one of the predicted patterns provides a precise way to categorize a decoy to one of the three treatment conditions. Thus, we require an *ex ante*

EXHIBIT A
Stimuli Descriptions for the Core Choice Set and the Three Cluster Conditions

Product category	Brand *A*	Brand *B*	Brand *I*	Decoy C_1	Decoy C_2	Decoy C_3
Automobile						
Comfort rating[a]	65	80	80	60	45	65
Gas mileage	24	16	24	24	24	17
Stereo						
Sound rating[a]	65	85	85	60	45	65
Reliability[a]	90	65	90	90	90	70
Apartment						
Distance (miles)	6	3	3	5	10	6
Condition rating*	88	66	88	88	88	70
Manager						
Technical rating[a]	75	85	85	72	58	75
Human skill rating[a]	85	75	85	85	85	72
MBA Applicants						
GMAT (max = 800)	690	740	740	670	590	690
GPA (max = 4.0)	3.5	3.1	3.5	3.5	3.5	3.2

[a] The attribute was rated on a 100-point scale with max = 100.

method of operationalizing different clustering situations. The following procedure was employed:

For each product category, a separate group of subjects were shown the two items, *a* and *b* in each category. They were also presented with a group of new brands corresponding to different locations, which varied along a single attribute associated with object *a*. For example, for the product category "stereos," *a* had a reliability rating of 90 and a sound quality rating of 65. The new brand *c* would have a reliability rating of 90 and sound quality rating that spanned a range from, say, 40–60. Next, *c* was varied on reliability and fixed on sound quality at 65. Subjects' task was to select the two of the three objects that formed a group. The positions for which *a* and the new brand formed a group was denoted as tight cluster, the positions for which *a* and *b* were grouped together was denoted as loose cluster, and the positions for which either *a* or *b* were equally likely to be paired with the decoy was denoted as no cluster. The modal attribute values of the new brand in each cluster were used to create the decoys used in the study. Exhibit A presents the objects and attribute values used in Study 1 (c_1, c_2, and c_3 are used to denote the tight cluster, loose cluster, and no cluster decoys).

Procedure. To test the hypotheses described above, a laboratory experiment using hypothetical choices was conducted. Subjects were 190 undergraduate students enrolled at a major west coast university, and participation was part of a course requirement. The task instructions emphasized that there were no right answers and that the experimenters were interested only in their opinion. The task involved making similarity and preference judgments for five different product categories. A between-subjects design was used with the four conditions differing in terms of the composition of the choice set. The different experimental conditions were created by adding c_1, c_2, or c_3 to the core choice set *a-b-i*. Thus, subjects viewed one of four choice sets (either *a-b-i*, *a-b-*c_1*-i*, *a-b-*c_2*-i* and *a-b-*c_3*-i*) for the five problems. Subjects, numbering between 45 and 50, were randomly assigned to different conditions, and the order in which the five problems were seen was also randomly determined.

For each of these categories, a set of alternatives was presented and the subjects had to make similarity and preference judgments. In the first part, respondents were asked to provide similarity judgments for each stimulus pair (either three or six depending on the experimental condition) on a 9-point scale ("1" indicated "not at all similar" and "9" indicated "very similar"). Since the treatment conditions judged higher numbers of stimulus pairs, the ratings were normalized for analyses and reporting purposes. The standardizing procedure used only the three stimuli pairs that were judged in all conditions[3] (i.e., *a-b*, *a-i*, and *b-i*).

In the second part, respondents were asked to make a choice for each pair for which they made similarity judgments. (In contrast with the usual studies on at-

[3] The reason for standardizing was to eliminate effects based purely on the difference in the number of pairs that are rated (Parducci, 1983). The decoy was not included in the data to be standardized as it can artifactually increase (decrease) the mean values in the loose and tight cluster conditions respectively.

TABLE 1

Impact of the Asymmetrically Dominated Decoy Location on the Target Share

	Core set	Tight cluster	Loose cluster	No cluster
Product category	% In core[a]	% With decoy C_1[a]	% With decoy C_2[a]	% With decoy C[a]
Automobile	44	63*	66*	41
Stereo	28	39	35	32
Apartment	34	44	51**	40
Manager	29	45**	46**	37
Applicants	46	64*	67*	51

[a] Percentage share of the target stimulus (a) in this condition.

* The difference in the target brand share between the core and the expanded set is statistically significant at the 0.01 level.

** The difference in the target brand share between the core and the expanded set is statistically significant at the 0.05 level.

traction effect that ask subjects to make a single choice among all objects in the choice set, the pairwise preference measure was needed since object i in the core set dominated both a and b.) The data of interest was the percentage of subjects choosing a from the stimulus pair a-b in each experimental condition. In order to control for order effects, subjects made either similarity judgments followed by choice or the other way around. No significant order effects were found, and the results have been pooled across subjects in the two order conditions.

Analysis and Results

The purpose of Study 1 was to test whether adding the decoy would be accompanied by a shift in similarity when the attraction effect was observed. Consistent with previous studies on the attraction effect, the share of the dominated brand increased when the decoy was added in the tight and lose cluster conditions (significant in three of the five and four of the five categories in which it was tested). The results are presented in Table 1, and are illustrated in the text for the automobile problem. The share of brand a was 44% in the core set; it increased to 63 and 66% with the introduction of c_1 and c_2 respectively. As seen in Table 1, similar results were obtained for the other problems. Across the five problems, the increase in share of brand a was 15% ($z = 3.2$, $p < .01$) in the tight cluster condition, and 17% ($z = 3.6$, $p < .01$) in the loose cluster condition. Thus, the results suggest that the attraction effect can be replicated for the modified stimuli that were used. Having demonstrated that the stimuli used can produce the attraction effect, we look at the similarity relationships in the different conditions.

H1a and H1b predicted a systematic shift in similarity along the two dimensions due to the introduction of c_1. Table 2 reports the difference in mean standardized similarity ratings for each stimuli pair in the control and experimental conditions. A positive number indicates that the stimuli pair is perceived as less similar in the presence of the decoy. In all cases, the overall distance between a and b increased with the addition of c_1 (of which three were statistically significant). Also, as predicted under H1b, in four of the five cases there was an increase in the distance b-i (of which three were significant) and, in all five cases, there was no significant change in the distance a-i. Of particular interest was the predicted *pattern* of shifts across all three similarity judgments when c_1 was added—s(ab), s(ai) and s(bi)—and the corresponding shift in preference. As shown in Table 1, the three product categories for which the attraction effect was significant are "automobiles," "managers," and "applicants." These are the only three categories for which the predictions under H1a and H1b concerning s(ab), s(ai), and s(bi) hold simultaneously. Consistent with our theory, the attraction effect was observed only for those choice problems for which the predicted perceptual shift occurred on the two attributes.

H2a and H2b make specific predictions about the shift in perceptual distance when the decoy c_2 is introduced. The results are reported in Table 3. Focusing first on the individual predictions (H2a) the overall distance between a and b significantly decreased when c_2

TABLE 2

Impact of the Decoy of Similarity Judgments in the Tight Cluster Condition

	Similarity (ab)	Similarity (ai)	Similarity (bi)
Product category	Mean differences (Core−Decoy)	Mean differences (Core−Decoy)	Mean differences (Core−Decoy)
Automobile	0.68 (0.31)*	0.29 (0.25)	0.45 (0.27)**
Stereo	0.51 (0.29)	0.25 (0.20)	0.05 (0.25)
Apartment	0.40 (0.26)	−0.08 (0.21)	−0.09 (0.26)
Manager	0.61 (0.26)*	0.30 (0.20)	0.53 (0.25)*
Applicants	0.55 (0.24)*	−0.16 (0.26)	0.45 (0.28)**

Note. Entries are mean (SE) standardized differences in similarity judgments across the two conditions between stimulus pairs.

* The mean difference in similarity judgments of the stimulus pair between the two conditions is statistically significant at the 0.01 level.

** The mean difference in similarity judgments of the stimulus pair between the two conditions is statistically significant at the 0.05 level.

TABLE 3

Impact of the Decoy on Similarity Judgments in the Loose Cluster Condition

Product category	Similarity (*ab*) Mean differences (Core–Decoy)	Similarity (*ai*) Mean differences (Core–Decoy)	Similarity (*bi*) Mean differences (Core–Decoy)
Automobile	−0.90 (0.29)*	−0.66 (0.25)*	0.29 (0.21)
Stero	−0.88 (0.23)*	−0.44 (0.19)*	−0.09 (0.22)
Apartment	−0.40 (0.24)**	−0.11 (0.25)	−0.13 (0.26)
Manager	−0.60 (0.22)**	−0.49 (0.15)*	−0.35 (0.22)
Applicants	−0.72 (0.31)*	−0.58 (0.20)*	−0.20 (0.24)

Note. Entries are mean (*SE*) standardized differences in similarity judgments across the two conditions between stimulus pairs.

* The mean difference in similarity judgments of the stimulus pair between the two conditions is statistically significant at the 0.01 level.

** The mean difference in similarity judgments of the stimulus pair between the two conditions is statistically significant at the 0.05 level.

was added to the choice set for all five categories. As hypothesized under H2b, the distance *a-i* decreased in all five cases (significantly so in four cases). In contrast, the decrease in the distance *b-i* was not significant.

Again, of greater interest is the pattern of shift in the three similarity judgments when the attraction effect is observed. From Table 1, the four product categories in which the attraction effect was significant when c_2 was added are "automobiles," "apartments," "managers," and "applicants." As shown in Table 3, for these categories, the predictions also hold simultaneously for the three similarity judgments. Thus, the support for the proposed relationship between the shift in perceptual representation and the attraction effect was reasonably strong.

H4 predicted that the greater the change in similarity between *a* and *b* with the addition of the decoy, the greater the corresponding change in preference for the target brand (i.e., the greater the magnitude of the attraction effect). To test this, the following regression equation was run:

$$\mathrm{DC} = \mathrm{b}_0 + \mathrm{b}_1\mathrm{DS},$$

where the dependent variable DC denotes the difference in *a*'s share and DS is the absolute difference in similarity between *a* and *b*. The regression results show that for both c_1 and c_2, the coefficient for DS is positive and significant ($r^2 = 0.79$, $p < .01$ and $r^2 = 0.55$, $p < .01$), thus strongly supporting the hypothesis. The data were examined to rule out an alternative explanation based on the notion that introducing the decoy may have changed the attribute attention and weights (Curry & Menasco, 1988). The choice data (1 = choose *a*, 0 = otherwise from the pair *a-b*) was regressed on s(*ai*) and *s*(*bi*) with and without the decoy. If the shift in preference was caused by the differential change in distance between *a* and *b* on the two attributes, then the logit estimates of the attributes weights should not vary across contexts. Conversely, if the logit estimates of weights change, this suggests that perceptual shifts do not capture the changes in preference. Although the logit coefficients changed in some cases, we did not find a systematic shift in favor of either attribute across the five categories.

H3a examined the change in preference for *a* when the decoy c_3 was introduced. The results, reported in the last column of Table 1, show that there was a slight change in *a*'s share but it did not reach statistical significance in any of the five categories. The mean increase in *a*'s share across the five categories was 4%. Since c_3 is dominated by *a* but not by *b*, the absence of an attraction effect for this decoy location suggests that asymmetric dominance by itself does not account for the effect. H3b predicted no change in distance *a-b* for this decoy location. Table 4 reports the difference in mean similarity ratings between the control and experimental conditions. With respect to the individual predictions, as hypothesized under H3b, in all five cases, the overall distance between *a* and *b* did not change significantly with the addition of c_3. Also as predicted, there was no significant change in the distances *a-i*, and *b-i*. Thus, the introduction of c_3 caused no change

TABLE 4

Impact of the Decoy of Similarity Judgments in the No Cluster Condition

Product category	Similarity (*ab*) Mean differences (*Core–Decoy*)	Similarity (*ai*) Mean differences (*Core–Decoy*)	Similarity (*bi*) Mean differences (*Core–Decoy*)
Automobile	0.28 (0.31)	0.12 (0.19)	0.16 (0.19)
Stereo	0.17 (0.26)	0.14 (0.17)	−0.12 (0.20)
Apartment	−0.22 (0.27)	−0.09 (0.18)	−0.08 (0.22)
Manager	0.32 (0.30)	−0.12 (0.19)	0.22 (0.16)
Applicants	0.41 (0.31)	0.28 (0.19)	0.14 (0.19)

Note. Entries are mean (*SE*) standardized differences in similarity judgments.

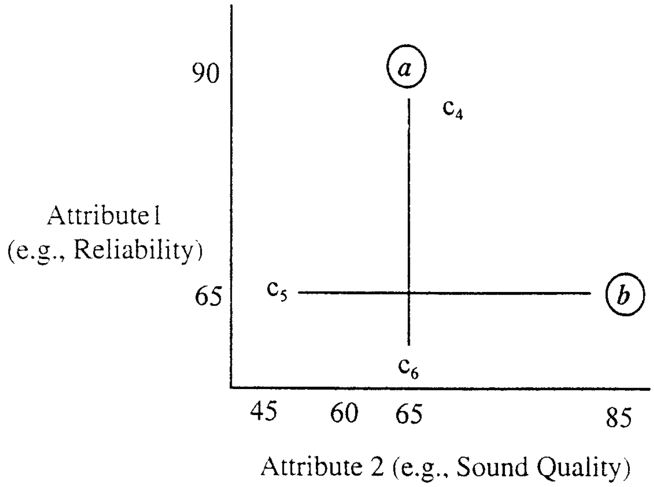

FIG. 4. Choice sets without symmetric dominance leading to violations of regularity.

in either relative preference or in similarity ordering of the two brands.

Violations of Preference Invariance in the Absence of Asymmetric Dominance

Study 1 demonstrated that changes in the perceptual distance between a and b was accompanied with corresponding changes in preference when decoys c_1 and c_2 were added to the choice set. Further, in the absence of distance shifts, adding an asymmetrically dominated decoy c_3 did not produce the attraction effect. While the primary focus was on the relationship between changes in similarity and preference ordering, the results suggest that the violation of perceptual invariance may be *necessary* in order to result in a violation of preference invariance. Thus, stronger support for the notion that perceptual changes are *sufficient* in producing the attraction effect would entail demonstrating an effect on preferences when no clear predictions are made by a dominance based explanation.

In order to provide further support for the perceptual framework, we created locations where the decoy was not asymmetrically dominated by a but was expected to change the distance between a and b along the two attributes. One way of doing this is by locating the decoy c_4 along the efficient frontier[4] and close to a so as to form a tight cluster (Fig. 4). Recall that the effect of context on similarity does not require asymmetric dominance, but only that the proximity between the two be sufficiently high so as to increase the density around the region where a is located. If our hypotheses concerning the similarity shifts associated with the attraction effect are correct, then the shift in the pattern of distances induced by the tight cluster decoy should continue to hold, causing a corresponding shift in relative preference.

A second way of testing perceptual effects as underlying changes in the preference for a is by locating the decoy where it is dominated by both a and b (c_5 and c_6, respectively, in Fig. 4). Although an explanation based on *asymmetric* dominance would make no prediction on the effect on a's share for these two decoy locations, a perceptual-based explanation predicts a systematic yet different effect on preference for a. Based on the previous discussion on the loose cluster decoy, adding c_5 increases the range along the dimension on which b is superior. As a result, the perceived distance between a and b on attribute-2 should decrease, thereby reducing a's disadvantage and result in an increase in the relative preference for a. In similar vein, the relative preference for a should decrease when c_6 is added to choice set as it makes the distance between a and b smaller on the attribute on which a is superior.

In summary, we argue that similarity changes may be sufficient in producing the changes in preference ordering. We test this premise by locating the decoy where (i) it is not dominated by either a or b (location c_4) or (ii) it is dominated by both a and b (locations c_5 and c_6). In the first case, the introduction of c_4 along the efficient frontier is predicted to increase a's share. In the latter case, the preference between a and b is predicted to systematically change depending on location of the decoy. Based on the changes in underlying perceptual distances, we predict an increase in a's share when c_5 is introduced, and an increase in share of b when c_6 is introduced. The formal hypotheses are as follows:

H5. $p(a; b\{a, b\}) < p(a; b\{a, b, c_4\})$, for the decoy c_4.

H6a. $p(a; b\{a, b\}) < p(a; b\{a, b, c_5\})$, for the decoy c_5.
H6b. $|s_{att1}(ab\{a, b\}) - s_{att1}(ab\{a, b, c_5\})| < |s_{att2}(ab\{a, b\}) - s_{att2}(ab\{a, b, c_5\})|$

H7a. $p(a; b\{a, b\}) > p(a; b\{a, b, c_6\})$, for the decoy c_6.
H7b. $|s_{att1}(ab\{a, b\}) - s_{att1}(ab\{a, b, c_6\})| > |s_{att2}(ab\{a, b\}) - s_{att2}(ab\{a, b, c_6\})|$

STUDY 2

Procedure

The task and the instructions were similar to those in Study 1, differing only in terms of the location of the decoys and the product categories. In one case, c_4 was

[4] The "efficient frontier" is a region between a and b where an object is neither dominated nor relatively inferior (in any objective sense) to either a or b.

EXHIBIT B
Stimuli Descriptions for the Core Set and the Different Decoy Location

Product category	Brand *A* (Target)	Brand *B* (Foil)	Decoy C_4 (EFF)	Decoy C_5 (Range 1)	Decoy C_6 (Range 2)
Automobile					
Comfort rating[a]	50	70	63	50	30
Gas mileage	27	21	23	14	21
Beer					
Quality rating[a]	50	70	55	50	30
Price/6-pack	1.80	2.60	2.00	3.40	2.60
Battery					
Life (no. of hours)	22	30	28	22	14
Price/Pair (%)	1.50	2.10	1.95	2.70	2.10
Restaurant					
Food quality rating	7	8.5	7.5	7	5.5
Driving time (min)	14	26	18	38	26
VCR					
Picture rating[a]	65	80	68	65	50
Reliability rating[a]	85	75	83	65	75

[a] The attribute was rated on a 100-point scale except Food Quality which was rated on a 10-point scale.

added along the efficient frontier between *a* and *b* so as to form a tight cluster with *a*. In contrast, c_5 and c_6 were dominated by both brands and extended the range on the attribute on which either *a*, or *b*, was superior. Subjects viewed one of four choice sets (either *a-b*, *a-b-*c_4, *a-b-*c_5 and *a-b-*c_6) for the five problems. Exhibit B lists the five categories used in this study as well as the attribute values for the core set and the three decoy locations.

In contrast to Study 1, Study 2 did not contain the alternative *i*. Although the neutral brand *i* was added to the choice set in order to have a meaningful measure of the change in distance along each attribute, it changed the context compared to previous studies. Accordingly, *i* was dropped and subjects were asked to make similarity judgments for each attribute (i.e., "rate the similarity between *a* and *b* on ride quality"). Similar to previous attraction effect studies, subjects made a single choice for each of the categories in three conditions (e.g., *a-b*, *a-b-*c_5, and *a-b-*c_6). Since c_4 was a viable choice, they made pairwise choices for the set *a-b-*c_4. Subjects, numbering between 59 and 61, were randomly assigned to one of the four conditions, and the order in which the different problems were seen was also random.

Analysis and Results

Study 2 served two purposes. First, it allows us to identify new effect on preferences based on similarity changes for previously untested decoy locations. Second, it allows us to reconfirm whether violations in preference invariance are accompanied with violations in perceptual invariance. The results are presented in Table 5. H5 was generally supported, and the attraction type effect was observed in all five categories. The relative increase in *a*'s share across the five choice problems was 16% ($t = 3.9$, $p < .01$) when the decoy c_4 was added to the choice set (*ab*). Thus, the relative preference for *a* over *b* was greater when even when the decoy and the target brand *a* involved the same trade-off on the two attributes as between *a* and *b*.

Consistent with H6a, the relative preference for *a* increased in all five categories when the decoy c_5 was added to the core set. Across the five product categories, the relative share of *a* increased on average by 17% ($t = 4.1$, $p < .01$). Also as predicted, the stimulus distance decreased significantly along *attribute-2* but not *attribute-1* for all five categories when c_5 was added to the choice set. Further, the change in attribute distance was the highest for the product categories in which the increase in preference for *a* was the strongest.

H7 tested the effect of adding the decoy c_6 that extended the range for the attribute on which *a* was superior. As predicted, there was a significant decrease in the share of *a* over the five categories (11%, $t = 2.1$, $p < .05$). The decrease in *a*'s share was significant in only three of the five categories in which it was tested and in the predicted direction in two other categories. Also as predicted, the change in distance along *attribute-1* was greater than along *attribute-2* for those categories in which the change in relative preference ordering between *a* and *b* was the strongest. Thus, the data generally support the notion that shifts in preference can be associated with shifts along the perceptual dimensions.

TABLE 5

Impact of the Decoy Location on the Target Share in the Close (Efficient Frontier) and Distant (Doubly Dominated) Conditions

Product category	% In core[a]	% With decoy c_4[a]	% With decoy c_5[a]	Similarity diff[b] $s(ab)_1$	Similarity diff[b] $s(ab)_2$	% With decoy c_6[a]	Similarity diff. $s(ab)_1$	Similarity diff. $s(ab)_2$
Automobile	44	64*	58**	0.6	1.2***	25**	0.9***	0.2
Beer	26	42	45*	0.4	1.6***	18	0.6	0.4
Battery	66	72	78**	0.2	0.8***	52**	1.2***	0.3
Restaurant	44	58**	56*	0.8	1.7***	28**	1.4***	0.8***
VCR	36	64*	55*	0.4	1.4***	28	0.8***	0.2

[a] Percentage share of brand *a* in this condition.
[b] This measures the *absolute difference* in similarity between *a* and *b* on attributes 1 and 2, respectively.
* The difference in the target brand share when the decoy is added is statistically significant at the 0.01 level.
** The difference in the target brand share when the decoy is added is statistically significant at the 0.05 level.
*** The change in $s(ab)$ with the introduction of the decoy is statistically significant at the 0.05 level.

The results of Study 2 demonstrate that preference ordering can be influenced by adding decoys that are dominated by both alternatives. In the Tversky and Simonson (1993) framework, the trade-off contrasts is proposed as the mechanism underlying attraction effect. Thus, a decoy that makes the trade-off comparison between *a*-*b* more attractive for *a* increases the preference for *a*. This suggests that if *c* is added close to *a* along the efficient frontier, with the same trade-off on the two attributes for *a*-*b* and *a*-*c*, no change in relative preference ordering is expected as no contrast occurs in trade-off comparisons. Similarly, adding a decoy that is dominated by both *a* and *b* does not create a trade-off contrast that favors either alternative and hence would be considered irrelevant and not influence the relative preference of *a* over *b*. We suggested that trade-offs among attributes are made on modified perceptual distance between stimuli. To the extent preference shifts are observed for decoys that do not cause trade-off contrasts, it calls attention for the need to consider the changes in underlying representation.

DISCUSSION

While context effects have been identified in the domains of both preference and perception, the two streams of literature have generally proceeded independently. The present research suggests that violations of preference invariance such as the attraction effect are also associated with systematic changes in the underlying cognitive representation—i.e., context effects in the domain of similarity. In particular, we have demonstrated that a representation that takes into account systematic changes in the perceptual distance among the objects may be sufficient in accounting for the attraction effect. The implications of our findings are as follows:

- Asymmetric dominance is neither necessary nor sufficient in producing an attraction-type effect;
- In situations where the hypothesized adjustments in perceived similarity does not occur, neither do the presumed shifts in preferences;
- It is possible to identify new preference violations for previously unexamined decoy locations that are consistent with the dimensional shift theory;
- The introduction of a decoy at certain locations in the "perceptual space" may affect *neither* preferences nor the underlying perceptions, thus providing boundary conditions for the impact of introducing new alternatives on preference among the original choice set.

The findings presented thus raise the possibility that perceptual-based mechanisms are sufficient to account for context induced violations of invariance. The current studies add to a growing stream pointing to the insights to be gained from focusing on the internal cognitive representation in an area that has tended to focus on preferential or reason-based factors. Using the attraction effect as an illustration, the aim was to provide a better understanding of the cognitive process underlying context induced preference reversals. This research suggests that, just as consumer preferences have been shown to be context-dependent, unstable and therefore "constructed" as opposed to revealed (Payne, Bettman, & Johnson, 1992), so too may be beliefs and perceptions. Although a single process for explaining context effects is attractive, the results of the two studies suggest that other processes may also be operating. For instance, in a few cases when the attraction effect was observed, it did not correspond with changes in similarity. More research will be necessary to identify the processes responsible for these effects.

The notion of a common underlying process also enables us to address several important yet unexplored questions about context effects. For instance, Simonson (1989; Simonson & Tversky, 1992) show that the relative preference for an option increases when it is seen as a middle or a compromise alternative. However, little is known about which of the two extreme brands are more likely to lose market share to the middle alternative. The current framework can be used to test whether the systematic change in the perceptual representation can account for the differential loss in the share of the extreme brands. In particular, data that shows asymmetrical shrinking or stretching on the two dimensions may be able to account for the differential loss.

Recently, Medin, Goldstone, and Markman (1995) describe a series of parallel findings to the ones presented in this paper and speculate that decision making may entail a similarity judgment—thus lending important support to the possibility that in some instances perceptual processes alone are enough to account for the effect on preferences. Of course, in the absence of other data and theory, the general *equivalence* between patterns of perception and preference judgments identified in the current research makes the direction-of-causality an issue for additional research. Future research should directly examine the impact on judgments of preference and perception for additional decision contexts. In general, future research could look for parallels or differences between effects that have been documented in one domain and not in the other. For instance, similarity may, like preference, also be stable across contexts with relatively familiar stimuli. Building on the research on situational factors in choice (Payne, Bettman, & Johnson, 1993), one could test predictions on how similarity varies with task factors such as time pressure.

An important implication of the current research concerns the use of multidimensional spatial representations. These are at the foundation of much work in consumer behavior theory as well as marketing practice, where they are often the basis for the definition of product-market structures ("perceptual maps"). Thus, while a multidimensional representation may provide an adequate representational model of the similarity and preference structure, the representation itself may not be fixed.[5] Technical scaling issues aside, if the introduction of a new point ("brand") into a multidimensional space is not neutral, but fundamentally alters the relative distances between the pre-existing brands in the space, then markets may be a good deal less stable than is traditionally assumed. If so, then consumer research and associated marketing practice may have to move more in the direction of focusing on both theory and techniques which address the *dynamics* or evolution of perceptual representation and hence preference formation.

[5] Green, Maheshwari, and Rao (1969) reported that the interpoint distances of a core set of stimuli remained stable over different stimulus set composition. However, they used a much larger number of additional stimuli and did not vary the context systematically. In addition, they asked the subjects to use the *same frame of reference* to make similarity judgments.

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