THE EFFECTS OF INCOMPLETE INFORMATION ON CONSUMER CHOICE

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The Effects of Incomplete Information on Consumer Choice

ABSTRACT

Two current trends, information overload combined with increased control of marketers (e.g., on the Internet) over the manner in which their products are sold and presented to buyers, suggest that deciding what information to provide or not to provide can determine a product's success in the marketplace. Although it has long been recognized that most purchase decisions are made with incomplete information, we still know very little about the effect of missing information on consumer choice. Building on earlier work by Slovic and MacPhillamy (1974), we demonstrate that a tendency to give more weight to attributes on which all considered options have values ("common attributes"), relative to attributes for which not all options have values ("unique attributes"), can often lead to intransitive preferences. Using process measures, it is further shown that buyers tend to interpret missing attribute values in a way that supports the purchase of the option that is superior on the common attribute. The results indicate that information presentation format and inferences about missing values cannot account for the observed effects of missing information on consumer choice. We also show that the purchase decisions of buyers who consider attribute importance prior to making a choice and those with high need for cognition are less susceptible to influence by missing information. Finally, the findings indicate that choosing from sets with missing information can impact buyer tastes and purchase decisions made subsequently. We discuss the theoretical and practical implications of this research.

Most studies of consumer decision making have examined choices among alternatives described on the same set of attributes. For example, consumers might be asked to choose among three portable PCs that are described in terms of speed, memory, weight, and price. However, in actual choices consumers rarely have full information (e.g., Dick, Chakravarti, and Biehal 1990; Johnson and Levin 1985; Ross and Creyer 1992; Simmons and Lynch 1991). Even when complete information is potentially available, obtaining attribute values for all options and making comparisons is typically much easier for some attributes (e.g., price) than for others (e.g., reliability). Accordingly, a most common problem consumers face is making choices with complete and easy to compare information on some attributes whereas only partial (or difficult to compare) information is available on other attributes.

Interestingly, although the importance of this problem has long been recognized (Slovic and MacPhillamy 1974), we still know very little about consumer choice under incomplete information. Several marketing researchers have examined how consumers treat missing information and how missing values affect the valuation of options (e.g., Meyer 1981; Ross and Creyer 1992; Sanbonmatsu et al. 1997; Yates, Jagacinski, and Faber 1978). For example, some researchers suggested that consumers form inferences about missing values (e.g., Johnson and Levin 1985) whereas others found little evidence for such inferences (Simmons and Lynch 1991). While these studies provided important insights, the fundamental question of how incomplete information affects consumer choice has not been investigated. One exception is the recent work of Zhang and Markman (1998), who proposed that a follower that offers superior values on common attributes (referred to as "alignable dimensions") is more successful in competing with a first-mover than a follower that offers unique ("non-alignable") features.

Beyond the theoretical significance of understanding consumer choice under incomplete information, this question has important practical implications. Marketers today have greater control over the information provided (or not provided) to consumers and the manner in which this information is presented. In particular, compared to the traditional retail channel, marketers that use the Internet or catalogs have much more control over the options shown on their (Web) pages and the attributes on which complete or partial information is provided. In addition, consumers increasingly face information

overload and, consequently, are unlikely to process all available product or service specifications. Accordingly, to the extent that incomplete information has systematic effects on purchase decisions, marketers can strategically design the information given to consumers such that the options they wish to promote appear most attractive. Consumers, on the other hand, should be aware of the effects of incomplete information on their preferences and may try to minimize errors and biases.

The main goal of this research is to improve our understanding of consumer choice under incomplete information. Specifically, using a generic problem where options have both *common attributes* (i.e., values are available for all considered options) and *unique attributes* (i.e., values are available for one option but not for others), we examine the effect of a systematic manipulation of missing values on consumer choice. We show that incomplete information may often lead to intransitive preferences,[1] though that effect may not be easily observed in the marketplace where consumers typically choose from one set of options at a time. Furthermore, we propose that, rather than ignore missing values, consumers use incomplete information to support their choices based on the common attributes. In a series of studies with a total of approximately 3,000 respondents, we examine the mechanisms underlying the impact of incomplete information on consumer choice, test alternative explanations, and explore the boundaries and consequences of these effects. The theoretical and practical implications of the results are discussed.

Consumer Choice With Incomplete Information

Missing information is ubiquitous. Product alternatives at the store, in catalogs, and on the Internet are seldom fully described, with detailed specifications often hidden in manuals that are not easily accessible. Although there has not been much research on the effect of incomplete information on consumer choice, several researchers have examined the manner in which missing values are treated, and in particular, whether and how consumers form inferences about missing values (e.g., Huber and McCann 1982; Johnson and Levin 1985; Ross and Creyer 1992; Sanbonmatsu, Kardes, and Sansone

[1] The notion that incomplete information might produce preference intransitivity was first raised in discussions with the late Amos Tversky.

1991; Simmons and Lynch 1991). Meyer (1981) proposed that missing information causes consumers to discount the attractiveness of an option. Other studies (e.g., Simmons and Lynch 1991) indicated that consumers often do not form inferences about missing values.

The original study of Slovic and MacPhillamy (1974) demonstrated that missing values can have a systematic effect on comparative judgments. In their experiments, subjects were asked to consider pairs of hypothetical high-school students and predict the difference between these students in terms of expected college GPA. Each pair had scores on one common dimension (e.g., English skills) and one unique dimension (e.g., Quantitative Aptitude for Student A and Need to Achieve Success for Student B). The results of regression analyses indicated that dimensions were weighed more heavily when they were common than when they were unique.

Intransitive Preferences Under Incomplete Information

The impact of incomplete information on consumer choice can be systematically studied using a generic problem in which considered options have both common and unique attributes. The missing values as well as the common and unique dimensions can then be manipulated in a way that allows us to test the hypotheses of interest. Consider the three health clubs described in Figure 1, and assume that consumers choose between health clubs A and B, B and C, or C and A. For each pair, there is one dimension with full information and two dimensions where the information is available for only one option.

The work of Slovic and MacPhillamy (1974) indicates that, for each pair of options, consumers are expected to overweigh the common attribute relative to the unique attributes. In explaining the overweighing of common attributes, Slovic and MacPhillamy suggest that the common dimension "provides a direct and unambiguous comparison between the alternatives on the attribute being judged" (p. 191). This, in turn, might give rise to intransitive preferences, an outcome of choice under incomplete information that has not been previously recognized.[2] Specifically, if indeed consumers

[2] A preference-or-indifference relation, denoted $\geq$, is transitive if $\forall$ {A, B, C}, $A \geq B$ and $B \geq C$ imply $A \geq C$. Preference *in*transitivity represents a clear violation of value maximization (e.g., Kreps 1990).

overweigh common relative to unique dimensions, then we would expect that Health Club A will tend to be preferred to Health Club B, B will be preferred to C, but C will be preferred to A.

If incomplete information can produce intransitive consumer preferences, then marketers could strategically design the information they provide to consumers in order to influence their purchase decisions. For consumers, on the other hand, intransitive preferences are clearly a potentially costly mistake, which they would likely want to correct. Violations of transitivity have rarely been observed in previous research, even though a well known illustration was published thirty years ago (Tversky 1969). Using an ingenious and rather complex procedure, Tversky demonstrated a systematic intransitivity in choices among pairs of gambles and among college applicants. The subjects in Tversky's experiments were pre-selected based on the tendency to use a lexicographic semi-order decision rule[3] and/or were informed in advance both which attribute was most important and that information was not completely reliable. Other researchers have built on Tversky's work (e.g., Shafir, Osherson, and Smith 1993), but documented violations of intransitivity at the individual level (within-subject) have remained rare.

Intransitivity in aggregate choice, which is related to violations of the independence of irrelevant alternatives assumption, was first documented in the 18th century by the French mathematician Condorcet (see discussion in Arrow 1963, Chapter 8). According to the *Condorcet criterion*, a candidate who receives a majority as against each other candidate should be elected. However, Condorcet discovered that pairwise majority comparisons could produce intransitivity and hence an indeterminacy in social choice. The recent 1999 Israeli elections provided an illustration of this phenomenon. Before the elections there were three leading candidates: Barak, Netanyahu, and Mordechai. Early pre-election polls indicated that most voters preferred Mordechai to Netanyahu whereas Mordechai and Barak were about equally popular. However, with all three candidates considered, Barak would receive the most votes, followed by Netanyahu (which subsequently contributed to Mordechai's decision to withdraw from the race).

[3] A lexicographic semi-order choice pattern is one where a semi-order (Luce 1956) or a just noticeable difference structure is imposed on a lexicographic ordering.

As shown above, our analysis of choice among options with common and unique dimensions suggests that violations of transitivity may in fact be common under incomplete information. Furthermore, by examining the manner in which missing values can lead to intransitivity as well as the psychological mechanisms, boundaries, and consequences of this effect, we can improve our understanding of the impact of incomplete product descriptions on purchase decisions.

Using Missing Information to Support Choice Based on the Common Attribute

A fundamental question in research on decision making under incomplete information is how, if at all, consumers treat the missing values. In Slovic and MacPhillamy's (1974) research, missing values determined which dimensions were common or unique, but no assumptions were made about the manner in which they were treated. Conversely, as described above, consumer researchers have examined inferences that consumers might form and the impact of missing information on the overall evaluation of options (e.g., Huber and McCann 1982; Johnson and Levin 1985; Meyer 1981; Ross and Creyer 1992; Sanbonmatsu et al. 1997). As Meyer pointed out, a missing value is a source of uncertainty, because the actual value may be unattractive. Accordingly, choosing a partially described option requires the consumer to assume that, even if the unobserved attribute values are inferior, the selected option is still acceptable. This suggests that a key concern about missing values is whether or not they could make a difference in the decision. Specifically, if consumers have a tentative choice candidate, they might consider a potentially poor value on the missing attribute as either a significant or an insignificant factor in the evaluation of that option.

Furthermore, prior research suggests that, to the extent that values on a common attribute provide support for preferring one of the considered options, consumers may use the missing information to bolster that tentative choice. Research by Montgomery (1983, 1989) implies that, whether a missing value is perceived as a significant factor might depend on whether it is consistent or inconsistent with the consumer's initial choice candidate. Although Montgomery did not specifically study incomplete information, he proposed that decision makers try to construct a dominance structure, such that the selected option can be perceived as dominating other options even when its values are not

superior on all dimensions. Montgomery did not test this proposition, but the intuitive notion of a search of de facto dominance suggests that consumers might treat missing values in such a way that supports their tentative preference. Specifically, consumers may tend to dismiss the significance of a missing value of their favored option, the one that is superior on the common attribute, while emphasizing the importance of the missing dimensions of other considered options.

Studies of motivated reasoning (e.g., Kunda 1990), motivated judgment (e.g., Kruglanski 1990), motivated inference (e.g., Psyzczynski and Greenberg 1987), confirmation bias (e.g., Lord, Lepper, and Ross 1979), and distortion of information (e.g., Russo, Medvec, and Meloy 1996) lead to a similar prediction. According to the motivated reasoning model, "people who are motivated to arrive at a particular conclusion attempt to be rational and to construct a justification of their desired conclusions that would persuade a dispassionate observer. They draw the desired conclusion only if they can muster up the evidence necessary to support it" (Kunda1990, pp. 482-483). Kruglanski (1990) argues that the desire to reach a particular judgment (i.e., the need for closure) leads individuals to engage in a more extensive search for alternative explanations when incoming information is inconsistent with the desired conclusion than when it is consistent with the conclusion. In the context of the present research, the relevant motivation may simply be the desire to reach closure and determine preference, with the common attribute providing the "hypothesis" that needs to be supported.

The work on confirmation bias and distortion of information leads to a similar prediction without referring specifically to motivation. As Lord et al. (1979) demonstrated, potentially confirmatory evidence tends to be taken at face value while potentially disconfirmatory evidence is subjected to critical and skeptical scrutiny. Thus, any pattern of evidence processed in this manner will tend to bolster the initial belief. In addition, once evidence has been processed in this fashion, it tends to sustain the prior hypothesis when that hypothesis is subjected to new empirical disconfirmation or to attacks on its original basis. Russo et al. (1996) extended this research and showed that, even in the absence of any initial preference, a developing preference for one alternative during the decision process can lead to the distortion of new information so as to favor the leading alternative.

Although prior research on search for dominance, motivated reasoning and judgment, confirmation bias, and distortion of information has not dealt with decision making with incomplete information, it suggests that consumers might use missing information to support selection of the alternative that is superior on the common attribute, which is likely to be the tentative choice candidate. For example, when choosing between Health Clubs A and B in the preceding example, where A is superior on the common attribute, consumers might indicate that not knowing the driving time to Health Club A is not of great concern to them and does not materially affect the attractiveness of that option. Conversely, consumers who consider Health Clubs A and C, where A is inferior on the common dimension, might point to the (same) missing driving time information of Health Club A as a significant concern. An interesting question that cannot be easily investigated is whether such use of missing values is a strategy for rationalizing decisions that have already been made, or whether it precedes the final choice. The discussion leads to the following hypotheses:

H1: Binary choices under incomplete information, where options have both *common* and *unique* attributes, can lead to intransitive consumer preferences.

H2: Consumers are more likely to use an attribute as a reason for choice when that attribute is common rather than unique.

H3a: Consumers are more likely to indicate that a missing value of an option is a reason against that option when it is inferior, rather than superior, on the common attribute.

H3b: Consumers are more likely to indicate that a missing value of an option is not a reason against that option when it is superior, rather than inferior, on the common attribute.

Note that H3a and H3b are separate hypotheses, and it is quite possible that one would be supported and the other would not. For example, a consumer might say that a missing value of an option (that is inferior on the common attribute) is a significant concern without also indicating that the missing value of the other option is not a significant consideration, and vice versa. We tested Hypotheses 1, 2, and 3 in the studies described next.

Studies of Consumer Choice With Incomplete Information: Method Overview

We conducted a series of studies to test H1-H3 as well as the hypotheses discussed later. In these studies, the respondents were either recruited at domestic terminals of a major airport or at a popular science museum. Airport respondents received no compensation and museum respondents were paid $2 for their participation. The respondents were between 18 and 80 years old and represented a wide range of demographic characteristics. A total of approximately 3,000 respondents participated in the studies.

In each study respondents made choices (or ratings) in two or more categories, such as health club, portable PC, and congressional representative. The introduction to each problem specified the attributes on which options differed. In all cases we counterbalanced, between-subjects, the positions of options on the page to control for any order effects. For each attribute, the "range of typical attribute values found in the marketplace" was provided, consistent with the finding of Assar and Chakravarti (1984) that attribute range knowledge allows respondents to comprehend better brand-attribute information and make meaningful attribute tradeoffs. In addition, respondents were informed that, as in real life, some product information might be missing. [4]

Tests of preference intransitivity hypothesized to result from incomplete information can be done using either within- or between-subjects designs, with each approach having both an advantage and a disadvantage. In a within-subjects test, each respondent makes all three pairwise choices (between A and B, B and C, and A and C; see Figure 1), whereas in a between-subjects design respondents are randomly assigned to one of the three choice sets. The main advantage of a within-subjects design is that any observed intransitivity is not susceptible to alternative explanations that are related to taste heterogeneity and option similarity (see also Hutchinson, Kamakura, and Lynch 1999). On the other hand, within-subjects designs may often reveal the tested hypothesis to the respondents (see Kahneman and Tversky 1996). Furthermore, if respondents remember their earlier choices (e.g., that they chose A over B and B over C), a desire to appear consistent may constrain and determine subsequent choices

[4] To denote missing attribute values we used either “Information Unavailable” or “---“. There were no noticeable differences in the results between these two notations.

(e.g., lead to preferring A over C, even though, without recall of the earlier choices the respondent would have selected C over A). Indeed, in the within-subjects tests described below, respondents were least likely to select the option that was superior on the common attribute when choosing from the sets positioned third (i.e., last) in the questionnaire (compared to the option's choice likelihood in the between-subjects tests). Thus, the within-subjects tests are likely to be overly conservative and underestimate the true intransitivity rates. As indicated, we used both within- and between-subjects tests.

Another question that arises is how to measure the rate of preference intransitivity. In a within-subjects design one can simply use the share of respondents whose preferences across the three choice sets are intransitive, which can be compared to an appropriate benchmark (see below). Assessing the rate of intransitivity in a between-subjects design is more difficult, because each respondent makes just one choice. Suppose, for example, that in the problem presented in Figure 1, 65% of the respondents in one group choose A over B, 65% of a second group choose B over C, and 65% of those in a third group choose C over A. These results might be converted to an implied intransitivity estimate using a simple multiplication of the three choice shares (i.e., .65 x .65 x .65 = .27), based on the assumption that the three choice shares can be treated as independent (i.e., about 65% of the 65% who chose A over B would have also selected B over C, and so on).[5] To further reduce any ambiguity about the existence of intransitivity, one can use multiplication of choice shares to estimate the implied intransitivity only in cases where all three relevant choice shares are greater than 50%.

[5] This assumption appears reasonable and possibly even conservative for the following reasons. First, as shown in this research, choice based on the common attribute may represent in part individual differences, which suggests that those who choose based on the common attribute in one set would have had an above-average likelihood of choosing consistent with the common attribute if given another set. Second, as we show subsequently, when considered options are compared on common and unique dimensions, the importance weight of the common attribute tends to increase. Thus, one cannot assume that the tastes that guide the choice between options A and B are the same that determine the preference between B and C, which further supports the notion that choices are driven to a large degree by the common and unique attributes rather than by inherent attribute importance. Finally, under incomplete information, the fact that a respondent makes a choice that is consistent with the common attribute does not necessarily imply that this attribute is more important than the unique attributes. Indeed, there is evidence that consumers often have great difficulty using absolute, stand-alone attribute values (e.g., Drolet et al. 1999; Nowlis and Simonson 1997) and, consequently, the inherent importance of a unique attribute (if it exists) may often not be activated unless consumers have the benefit of comparisons.

Tests of Intransitive Consumer Preferences Under Incomplete Information (H1-H3)

Hypothesis 1 proposes that incomplete product information can lead to preference intransitivity. We examine this hypothesis using both within-subjects tests (e.g., in Figure 2, respondents choose from all three binary sets, {A,B}, {B,C}, and {A,C)) and between-subjects tests (each respondents makes just one choice per category).

Within-Subjects Tests of Preference Intransitivity

Method. Respondents (in three separate studies) made three binary choices in one of three categories, portable PC, yogurt, or cordless phone (see Figure 2 and Appendix A; see Appendix B for an example of the choice task and the information provided to respondents in a particular problem). We asked respondents not to look back at previous choices. The three binary choices in each category were mixed with other "filler" problems from unrelated categories.

Results. In the portable PC category, 28% (26 out of 94) of the respondents were intransitive in the hypothesized direction (i.e., chose option A over option B, B over C, and C over A); in the yogurt category 14% (20 out of 142 respondents) were intransitive; and in the cordless phone category 12% (16 out of 131 respondents) were intransitive. However, it is possible that a few of the subjects made choices randomly, and accordingly, the obtained intransitivity rate should be compared to a suitable benchmark. Note that it would be unreasonable to assume that *all* of the respondents made choices randomly (i.e., use as benchmark .5 x .5 x .5 = .125), considering the vast evidence of systematic effects on preferences.

A more suitable approach is to use the “reverse” intransitivity rate (i.e., the share of respondents who chose C over B, B over A, and A over C) as a benchmark. That is, if intransitivity reflects some other random factors that are unrelated to the overweighing of common attributes (e.g., guessing), then we would expect to observe also reverse intransitivity. However, across all three categories, we found only negligible reverse intransitivity rates. Specifically, in the portable PC category, one out of 94 respondents (~1%) was intransitive in the reverse direction; in the yogurt category none of the 142

respondents (0%) were intransitive in the reverse direction; and in the cordless phone category one respondent out of 131 (<1%) was intransitive in the reverse direction. In all three categories, the rate of the hypothesized intransitivity is significantly greater than that of the reverse intransitivity ($p<.001$ in all cases).

In summary, consistent with H1, we showed preference intransitivity in three categories, using within-subjects tests. However, as explained above, the within-subjects tests are likely to be overly conservative and underestimate the true intransitivity rates. Next, we test H1 using a between-subjects design.

Between-Subjects Tests of Preference Intransitivity

Method. Respondents were randomly assigned to one of six conditions, representing the three binary choices and the counterbalancing of option positions (as explained earlier). For example, in the Portable PC category, one group chose between PCs A and B, a second group chose between B and C, and a third group chose between C and A. In one study (with 185 respondents) there were four categories: health club, portable PC, yogurt, and cordless phone (see Figures 1 and 2 and Appendix A). In a subsequent study (with 124 respondents) we tested an additional category, congressional representative, using a similar procedure.

Results. Define P(A,B) as the aggregate choice share of option A in the binary set {A,B}, where P(A,B) + P(B,A) = 1. To test for intransitivity, we examine whether the proportion of respondents who chose the option superior on the common attribute, in all three binary sets within each category, are significantly greater than 50% (using the normal approximation of the binomial distribution). In addition, as explained earlier, we report the measure of implied intransitivity, based on a multiplication of the three relevant choice shares, and contrast it with the implied reverse intransitivity (i.e., P(C,B) x P(B,A) x P(A,C)).

Consistent with H1, in all five categories, $P(A,B) > {}^{1}/_{2}$, $P(B,C) > {}^{1}/_{2}$, and $P(C,A) > ½$ ($p<.05$ in all cases, see Table 1). For example, in the Portable PC category, 62% chose A over B, 64% chose B over C, and 79% chose C over A. The implied intransitivity rate in the PC category was 31% compared to 3% implied reverse intransitivity. The implied intransitivity and reverse intransitivity rates in other categories are reported in Table 1.

In a follow-up (between-subjects) study reported below, we asked respondents to provide written explanations for their choices. A similar pattern of intransitive choices was observed, suggesting that intransitivity is not diminished or enhanced when respondents consider the reasons for their preference. In summary, using both within- and between-subjects designs, we demonstrated systematic choice intransitivity in sets involving products and services that have common and unique attributes. Of

course, one cannot assume that any set of three options will produce preference intransitivity, as choice shares depend on the particular attribute values and the tastes of the decision makers.

The preference intransitivity could be explained based on the tendency to overweigh common attributes (Slovic and MacPhillamy 1974), though such an explanation is moot on the question of how consumers treat missing attribute values. Are such values totally ignored? Do consumers form inferences about these values? Do missing values diminish the attractiveness of options? According to the research reviewed earlier, all of these outcomes might occur. In addition, building on the notion of a search for dominance (Montgomery 1983), motivated reasoning (e.g., Kunda 1990) and related research, H3 suggests that missing values can be used to support the choice of options that are superior on common attributes. Next, we employ process measures to test how consumers treat common attributes and missing information.

The Treatment of Common Attributes and Missing Values: Process Measures

Although the observed pattern of intransitive preferences is consistent with the hypothesized overweighing of common attributes, it does not provide much insight into the role of missing values in the decision processes that lead to intransitive preferences. To examine more directly the impact of incomplete information on the construction of preferences, we use both written choice explanations and think-aloud protocols to test H2, suggesting that common attributes are more likely to be relied upon as reasons for choice, and H3, regarding the manner in which missing values are used to bolster preferences based on the common attributes. In addition, we assess the relationship between reliance on common attributes and choice difficulty, which, as explained subsequently, might serve as an indicator of the decision conflict felt when choosing "against" the common attribute. In all cases we employed a between-subjects design, as described earlier.

Written Explanations Of Choices With Incomplete Information

Method. One hundred fifteen respondents, recruited in a science museum, made one binary choice in each of three categories: health club, yogurt, and cordless phone (see Figure 1 and Appendix A).[6] Prior to marking each choice, respondents were asked to explain the decision in writing.

Results. The choice explanations provided by respondents were coded by two independent judges, who were unaware of the study's hypotheses. The interjudge reliability was 88%, and disagreements were resolved by discussion.

H2 was tested by examining whether the percentage of respondents who used an attribute as a reason for choice was greater when that attribute was common compared to when it was unique. The results support the prediction -- across the three categories (a total of nine attributes), attributes were used as reasons for choice in 59% of the cases (199/338) when they were common compared to 40% (269/676) when they were unique ($\chi^2 = 33.0$, $p<.001$). This effect was statistically significant and in the hypothesized direction in all three categories (57% vs. 42% in health club, 57% vs. 44% in yogurt, and 63% vs. 33% in cordless phone; $p<.05$ in all cases). For example, the driving time attribute of the health club category was used as a reason for choice in 59% of the cases (24/41) when it was common compared to 40% (26/72) when it was unique. The direction of the results was consistent for all nine attributes.

We tested H3a by examining whether the percentage of respondents who explicitly used a missing attribute value as a reason against an option was greater when that option was inferior, rather than superior, on the common attribute. Examples of such reasons include, "I need to know the time to the club. Anytime over 10-15 minutes makes a workout very time consuming and decreases the probability of use. If you don't use a club, why join?" and "The time it takes to get there is very important. Too far and I wouldn't get there regardless of cost." Correspondingly, we tested H3b by examining whether the percentage of respondents, who explicitly indicated that a missing attribute value of an option was not a reason against it, was greater when that option was superior, rather than inferior,

[6] For the cordless phone category there was a minor variation in one attribute value (relative to the value shown in Appendix A). Specifically, Cordless Phone C had a useful reception range of 650 feet (rather than 800 feet).

on the common attribute. Examples of such reasons include, "Driving time is really not a question for me, if I get a good workout" and "Usually driving time is not a problem for me." See Appendix C for a more detailed description of the coding scheme employed in analyzing the written explanations and the think-aloud protocols described below.

Consistent with H3a, across three categories (and nine missing attribute values), a missing value of an option was used as a reason against that option in 20% of the cases when it was inferior on the common attribute compared to 10% when the same option was superior on the common attribute ($\chi^2 = 12.9$, $p<.005$). This effect was in the hypothesized direction in all three categories, and statistically significant ($p<.05$) for the yogurt and cordless phone categories (22% vs. 15% in health club, 17% vs. 7% in yogurt, and 20% vs. 7% in cordless phone). As an example, in the health club category, the missing driving time of Club A was used as a reason against that health club in 24% of the cases when Club A was inferior on the common attribute (set {C,A} in Table 2) compared to 15% when Club A was superior (set {A,B} in Table 2). The results were in the hypothesized direction for eight out of the nine missing values (see Table 2).

Consistent with H3b, across three categories (and nine missing attribute values), the percentage of respondents who explicitly indicated that a missing value of an option was not a reason against it was 12% when it was superior on the common attribute compared to 1% when the same option was inferior on the common attribute ($\chi^2 = 29.2$, $p<.001$). This effect was in the hypothesized direction in all three categories and statistically significant ($p<.01$) for the health club and yogurt categories (13% vs. 0% in health club, 15% vs. 1% in yogurt, and 7% vs. 4% in cordless phone). As an example, in the health club category, respondents explicitly indicated that the missing driving time of Club A was not a reason against that health club in 10% of the cases when Club A was superior on the common attribute (set {A,B} in Table 2) compared to 0% when Club A was inferior (set {C,A} in Table 2). The results were in the hypothesized direction for seven out of the nine missing values (see Table 2).[7] Finally, we also

[7] Although not a direct test of H3a and H3b, one can also examine the role of missing values by holding the choice set constant and comparing the share of respondents, who indicate that a particular missing value of an option is a reason against choosing it, to the share of respondents who indicate that the missing value is not a significant factor. For example, for respondents who are choosing between Clubs A and C (where Club A was inferior on the common

examined the pattern of reasons based on respondents' ultimate choice. Specifically, we divided the written explanations data into two groups, one for respondents who chose in a direction consistent with the common attribute, and one for respondents who chose against the common attribute. This analysis provided an even stronger support for both H3a and H3b.[8]

However, one possible limitation of written choice explanations is that they do not capture the entire decision process and the various factors considered by respondents. Accordingly, we conducted an additional test of H2 and H3 using think-aloud protocols (e.g., Ericsson and Simon 1980).

Think-Aloud Protocols of Choices Under Incomplete Information

Method. Sixty four respondents, who were recruited at an airport, were asked to think aloud (and were recorded on tape) as they made choices in a practice problem and in three categories previously used in the between-subjects tests (health club, yogurt, and portable PC). Respondents were randomly assigned to one of the three sets in each category.

Results. The think aloud protocols were coded by two independent judges. The interjudge reliability was 86%, and disagreements were resolved by discussion. The judges employed the same coding scheme (described in Appendix C) that was used by the two judges who coded the written explanations. The tests of the hypotheses were similar to those used for the written explanations.

The results support H2: across the three categories (a total of nine attributes), attributes were used as reasons for choice in 51% of the cases (98/192) when they were common compared to 40% (155/384) when they were unique ($\chi^2 = 5.9$, $p<.025$). This effect was in the hypothesized direction in all three categories, but statistically significant ($p<.05$) only for portable PC (55% vs. 46% in health

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attribute), we would expect the percentage of respondents who indicate that the missing driving time of Club A is a reason against that option to be higher than the percentage of respondents who indicate that the missing driving time of Club A is not a significant factor. Correspondingly, for respondents who are choosing between Clubs A and B (where Club A was superior on the common attribute), we would expect the opposite to occur, i.e., the percentage of respondents who indicate that the missing driving time of Club A is a reason against that option should be lower than the percentage of respondents who indicate that the missing driving time of Club A is not a significant factor. Across the three categories there are 18 possible such contrasts. Consistent with the results relating to H3a and H3b we find that the majority (13 out of 18) of such comparisons were in the right direction.

[8] More detailed results can be obtained from the first author.

club, 41% vs. 36% in yogurt, and 58% vs. 39% in portable PC). The direction of the results was consistent for seven out of nine attributes.

Consistent with H3a, across three categories (and nine missing attribute values), a missing value of an option was used as a reason against that option in 42% of the cases when it was inferior on the common attribute compared to 28% when the same option was superior on the common attribute ($\chi^2 = 8.4$, $p<.005$). This effect was in the hypothesized direction in all three categories, but statistically significant ($p<.01$) only for yogurt (48% vs. 36% in health club, 44% vs. 19% in yogurt, and 35% vs. 28% in portable PC). As an example, in the health club category, the missing driving time of Club A was used as a reason against that health club in 33% of the cases when Club A was inferior on the common attribute (set {C,A} in Table 3), compared to 17% when Club A was superior (set {A,B} in Table 3). Out of nine such contrasts (three categories with three missing values in each), the results were in the hypothesized direction in eight cases (see Table 3).

Finally, consistent with H3b, across three categories (and nine missing attribute values), the percentage of respondents who explicitly indicated that a missing attribute value of an option was not a reason against it was 36% when it was superior on the common attribute compared to 22% when the same option was inferior on the common attribute ($\chi^2 = 17.3$, $p<.001$). This effect was in the hypothesized direction in all three categories, and statistically significant ($p<.01$) for the health club and yogurt categories (31% vs. 13% in health club, 41% vs. 17% in yogurt, and 36% vs. 22% in portable PC). For example, in the health clubs category, respondents explicitly indicated that the missing driving time of Club A was not a reason against that health club in 39% of the cases when Club A was superior on the common attribute (set {A,B} in Table 3) compared to 24% when Club A was inferior (set {C,A} in Table 3). Out of nine such contrasts (three categories with three missing values in each), the results were in the hypothesized direction in all cases (see Table 3).[9]

[9] As indicated earlier, in the written explanations section (see Footnote 7), there are 18 different contrasts (holding the choice set constant) which can be performed to test the underlying notion of H3a and H3b. Consistent with the results relating to H3a and H3b in the think-aloud protocols study, we find that the majority of contrasts (14 out of 18) are in the expected direction.

In summary, the two process measures provide new insights into the interplay between the overweighing of common attributes and the treatment of missing values, which underlies the observed preference intransitivity.[10] Respondents appear to form a tentative preference on the basis of the common attribute and then use the missing information to support that preference. As discussed earlier, this process is consistent with Montgomery's (1983) notion of search for a dominance structure as well as with research on motivated reasoning and judgment (e.g., Kunda 1990) and distortion of information (e.g., Russo et al. 1996). Whether consciously or not, consumers adjust their assessment of the significance of incomplete information in a way that makes the option superior on the common attribute appear dominant. Specifically, respondents tend to point to missing values as significant problems or insignificant problems depending on whether the partially described option is inferior or superior on the common attribute.

Choice Difficulty

Anecdotal evidence gathered during the data collection for the within-subjects study described earlier suggested that respondents whose preferences were intransitive found the choice task easier than those whose preferences were transitive. A possible explanation for such a phenomenon is that choices that are contrary to the common attributes (i.e., choosing an option that is inferior on the common attribute) are psychologically more difficult and involve greater decision conflict because they are inconsistent with the seemingly strongest cue. If this conjecture is correct, then we should expect that consumers who choose options that are inferior on the common attributes will tend to perceive the choice as more difficult than those whose choices are consistent with the common attributes.

H4: Consumers will rate a choice as more difficult after selecting the option that is inferior on the common attribute.

[10] In addition to these process measures, we tested respondents' recall for binary sets with missing values. The results indicated that (a) in 97% of the cases respondents correctly remembered which values were missing, (b) respondents had better recall for (absolute) attribute values when the value of the other option on that attribute was missing, which suggests that, for common attributes, it is less essential to remember the absolute values, and (c) respondents had better recall for the superior compared to the inferior values on the common attributes, consistent with evidence that consumers have better recall for options they select (e.g., Biehal and Chakravarti 1986). More information about the recall test can be obtained from the first author.

Method. One hundred seventy respondents made choices in two product categories, yogurt and cordless phone, and were randomly assigned to one of three choice sets in each category. Immediately after making *each* choice, respondents were asked to rate "how difficult was it to make *this* choice?" on a 0 (not at all difficult) to 10 (very difficult) scale.

Results. Consistent with H4, the mean choice difficulty rating (averaged across respondents) was higher for choices of options that were inferior on the common attribute than for choices of options that were superior on the common attribute (M=4.1 versus M=3.4, t=3.0; df=586; $p<.005$). This effect was in the hypothesized direction in both categories, but statistically significant only for yogurt (M=4.1 vs. M=3.0 in yogurt, and M=4.1 vs. M=3.7 in cordless phone; $p<.001$ and $p>.1$, respectively). The direction of the results was consistent for all three binary choice sets in the yogurt category and for two out of three binary choice sets in the cordless phone category.

These results can be seen as indicators of the process that underlies the overweighing of common attributes. They suggest that choosing against the common attributes is associated with more difficult decisions, because of the inconsistency with the most diagnostic dimension. Another way to look at these findings is by examining the share of the options superior on the common attribute between choices rated as difficult compared to choices rated as easy (based on a median split). As implied by H4 and the above results, the mean choice share of options superior on common attributes (averaged across six binary sets) was higher for respondents who rated their decisions as easy than for respondents who rated their decisions as difficult (68% versus 57%, $\chi^2 = 6.5$, $p<.05$). This effect was in the hypothesized direction in both categories, but statistically significant only for yogurt (67% vs. 54% in yogurt and 68% vs. 61% in cordless phone; $p<.05$ and $p>.1$, respectively). The implied intransitivity in the high choice difficulty group was 15% and 24%, for the yogurt and cordless phone, respectively, compared to 30% for both categories in the low difficulty group (see Table 4).

It is noteworthy that, typical biases and effects on consumer decision making are most pronounced when consumers are uncertain about their preferences and have difficulty making choices. By contrast, the present results demonstrate a bias that directly impacts the perceived choice difficulty

and, consequently, decisions that are perceived as easier are more biased than those that are perceived as difficult.

In summary, the results pertaining to choice difficulty, the other process measures, and the observed preference intransitivity are consistent with our analysis of the impact of incomplete information on consumer choice. However, there are several alternative explanations that must be considered. These accounts, which are examined in the next section, relate to (1) information presentation format, (2) differences in the states of information across the three choice sets that generate the intransitivity, and, relatedly, (3) inferences about missing values.

Alternative Explanations

Although the observed preference intransitivity suggests that missing information can produce systematic biases in consumer decision making, a question that naturally arises is what other factors might explain this seemingly irrational choice behavior. In particular, it is possible that preference intransitivity is due to the manner in which we presented attribute and missing value information. Indeed, prior research has demonstrated that presentation format can have a major impact on choice processes (e.g., Bettman and Kakkar 1977).

A second possible alternative explanation for the observed preference intransitivity relates to prior research on the impact of incomplete information, which suggests that consumers might spontaneously form inferences about missing values (e.g., Ross and Creyer 1992). Specifically, since the experimental design that generated the preference intransitivity involves showing different binary sets with missing information, it is possible that systematic inferences produce the intransitivity. We investigate these rival explanations, as described next.

The Role of Information Presentation Format

There might be two possible concerns about the manner in which we presented the choice sets in the studies described earlier. First, the information presented format made the missing values more salient than they are in the context of typical purchase decisions. For example, a marketer of a relatively

heavy laptop computer is unlikely to emphasize the fact that weight information is not provided. Second, although consumers are sometimes presented with a matrix of brand by attribute information (e.g., on the Web or in Consumer Reports), store displays and catalogs often describe each option individually. A matrix format, which encourages side-by-side comparisons, may exaggerate the reliance on common attributes. However, even when information is not presented in a matrix form and missing values are not flagged, our analysis suggests that consumers will continue to rely on the common attribute, which is easy to use and is likely to appear most diagnostic. To test the effect of information presentation format on preference intransitivity, we conducted the studies described next.[11]

Decreasing the salience of missing information. Figure 3 illustrates the option presentation format we used to test the effect of decreasing the salience of missing information. We used this format in three categories employed earlier in the between-subjects tests (with minor variations in some attribute values). Preference intransitivity was observed in all cases, and there was no noticeable difference in effect magnitude compared to the original presentation format.

Sentence format. Another presentation format that we examined involved describing the options in a sentence, rather than the traditional matrix display. For example, PC options were described as follows:

"The following information is available: Portable PC A has 16MB Ram of memory and 8 hours of battery life. Portable PC B has 166MHz speed and 3 hours of battery life."

This presentation format decreases the salience of missing values and also makes it more difficult to conduct within-attribute comparisons. We used this format in three categories that were employed earlier in the between-subjects tests (with minor variations in some attribute values). Preference intransitivity was observed in all cases, and there was no noticeable difference in effect magnitude compared to the original presentation format.

In summary, the results indicate that preference intransitivity observed under incomplete information is robust across different presentation formats and response modes. Thus, even when the

[11] To conserve space, we report only the key finding for each presentation format. Detailed results and statistical tests by category can be obtained from the first author.

missing information is less conspicuous and within attribute comparisons more difficult to perform, respondents appear to detect which attributes are common or unique and overweigh the former. However, this evidence does not rule out the possibility that consumers identify the missing values and form inferences about them, which generates intransitive preferences. Next, we investigate whether inferences might account for our findings.

The Role of Inferences About Missing Values

As indicated earlier, one of the key issues examined in prior research on the role of incomplete information is whether consumers form inferences about missing values (e.g., Johnson and Levin 1985; Ross and Creyer 1992; Simmons and Lynch 1991). Inferences could be partially responsible for the observed intransitivity, because each binary set provides somewhat different information, which might generate different inferences. If indeed consumers form different inferences about missing values contingent on the considered set, then one cannot unambiguously argue that preference intransitivity has occurred, since the options may not be (perceived as) the same across sets (though this argument is less compelling with respect to intransitive preferences obtained in a within-subjects test). In addition, consumers might form particular inferences about missing values, which could account for the intransitivity. For example, consumers might assume that both options (in each binary set) are similar on the unique dimensions (i.e., missing values are close to the observed values on these attributes), in which case it would be reasonable to give more weight to the common attributes.

These rival explanations based on inferences can be tested by keeping the information constant across the three conditions used for demonstrating preference intransitivity, while varying the two options from which a choice is made. Specifically, as illustrated in Figure 4, we presented and asked respondents to consider all three options, without informing them in the problem introduction that they would subsequently choose between only two of the alternatives. Furthermore, to make it more difficult to ignore the (subsequently) unavailable option, it was positioned between the two available options. As an additional safeguard, each respondent made a choice in only one product category, portable PC or yogurt, to prevent respondents from anticipating the manipulation in the second category.

Table 5 presents the results in the portable PC and yogurt category (see Figure 2 and Appendix A for the attribute values used). Define P(A,B|C) as the choice share of option A in the condition where respondents were asked to consider all three options, A, B, and C, but were eventually asked to choose only between options A and B. Thus, P(A,B|C) + P(B,A|C) = 1. As predicted, in both categories, $P(A,B|C) > {}^1/_2$, $P(B,C|A) > {}^1/_2$, and $P(C,A|B) > {}^1/_2$ (see Table 5). These results are similar to those obtained earlier in the original (between-subjects) test, where respondents saw only two options per category.

These results are noteworthy as respondents in all conditions received the same information and, consequently, had no basis for making different inferences about missing values. Furthermore, the fact that intransitivity is observed with this design suggests that the overweighing of common attributes is not determined by the total amount of information available about each attribute, which was held constant. Instead, consumers appear to overweigh common attributes when they evaluate one (available) option relative to another. The finding that consumers focus on the local choice set and fail to use readily available information about other options is consistent with the findings of Simonson and Tversky (1992) regarding the determinants of context effects.

When discussing the possibility of inferences, Slovic and MacPhillamy (1974) mention anecdotal evidence that some respondents enter the midpoint (or average value) of each unique attribute's range. Unlike Slovic and MacPhillamy, in the tests described so far, we did not provide the average values and, instead, presented the range of values on each dimension. Handwritten numbers entered voluntarily by a few of our respondents suggested that they also calculated the midpoint of the range. Slovic and MacPhillamy speculated that substituting average for missing values might account for the overweighing of common attributes. Interestingly, however, if subjects indeed replace missing values with the mid-range or average values, then the option that is superior on the common dimension is usually inferior on the other two dimensions (due to the manner in which the binary sets used in the tests of intransitivity were designed). Prior research indicates that consumers often use the *majority of confirming incidents* decision rule, whereby they select the option that is superior on the majority of dimensions (e.g., Bettman, Johnson, and Payne 1991). If such a rule is indeed employed, then

substituting the average value for missing values is likely to reverse the direction of intransitivity (i.e., respondents will consistently select the option that is inferior on the common attribute and is superior on the two other attributes).[12]

We tested this conjecture in the portable PC category replacing the missing values with meaningful values that were close to the midpoint of each unique attribute's range (shown in italics in Table 6). As shown in the table, preference intransitivity was again observed, but this time the direction of the effect was reversed. Clearly, inferences that involve substituting average for missing values cannot account for the overweighing of common attributes or for the preference intransitivity produced by missing information.

More generally, inferences do not appear to account for the impact of incomplete information on intransitive preferences. This, however, should not be interpreted as indicating that no inferences are formed about missing values. In fact, the written explanations and think-aloud protocols described earlier revealed that, across four categories, inferences were mentioned explicitly with respect to between 6% and 17% (or, 12% on average) of the missing values. But these inferences do not account for the overweighing of common attributes and the resulting preference intransitivity. Next, we examine moderators of the effect of incomplete information on consumer choice.

The Boundaries of the Effect of Incomplete Information on Consumer Choice

The effect of missing information on choice can be seen as another illustration of the construction of preferences (e.g., Payne, Bettman, and Johnson 1992). Here, consumers appear to shift the weights of attributes depending on whether they happen to be common or unique. A question that naturally arises is what factors moderate the degree to which attribute weights vary according to the configuration of missing information. Slovic and MacPhillamy (1974) examined several potential boundary conditions for the overweighing of common attributes, including (a) measuring all three dimensions on the same scale, (b) pre-warning subjects about the bias in favor of common attributes, (c) proving feedback (after

[12] The authors are grateful to Robyn Dawes for suggesting this possibility.

each judgment) that promotes equal weighing of dimensions, (d) providing monetary rewards for equal weighing of dimensions, and (e) providing detailed information about the distributions of the values of the three attributes. None of these debiasing techniques diminished the tendency to overweigh common attributes, indicating that this phenomenon is highly robust (for more details, see Slovic and MacPhillamy 1974, pages 180, 185-186).[13]

In this research we examine two mechanisms that could be expected to moderate the degree to which consumers overweigh common attributes and exhibit preference intransitivity. First, if consumers evaluate and commit to particular (relative) attribute weights prior to evaluating a choice set with missing information, then they might be less likely to modify those weights based on the choice set. And second, some individuals may be more predisposed to being influenced by missing values, because they are less inclined to exert the cognitive effort necessary for using unique attributes values. We examine these moderators next.

Thinking about Attribute Importance as a Moderator of the Effect of Missing Values on Choice

Decision theorists have recommended that decision makers carefully consider their tastes and values before making choices (e.g., Hammond, Keeney, and Raiffa 1998). Thinking about the importance of each dimension is likely to have two effects. First, by considering the importance of each attribute, consumers can define more clearly their preferences, which are often fuzzy and unstable. And second, stating attribute importance weights is a form of commitment that could guide subsequent choices. Accordingly, we expect that after rating attribute importance, consumers will be less influenced by missing information and will, consequently, be less likely to exhibit preference intransitivity.

H5: Consumers who think about and rate the importance of product dimensions before making a choice from a set with missing information are less likely to exhibit intransitivity.

[13] In the present research, we examined whether the overweighing of common attributes persists when consumers rate each option separately, as opposed to choosing between them (with the ratings converted to choices; see Nowlis and Simonson 1997). Tentative results suggest that, even when respondents evaluate each option individually (with both options on the same page), overweighing of common attributes and preference intransitivity are still observed, though the effects might be smaller.

There are two possible methods to statistically test H5 and, more generally, determine the effect of a boundary condition on the magnitude of preference intransitivity. Consistent with our earlier analysis, one method consists of testing whether at least one binary choice set *failed* to yield a significant majority share for the option superior on the common attribute (using the normal approximation of the binomial distribution). A second method is to compare the shares of the options superior on the common attribute between the debiasing condition and the original between-subjects test. In addition, we can contrast the implied intransitivity rate for the original (between-subjects) test with the implied intransitivity rate that is obtained when the manipulation being investigated is applied. We employ these methods to assess the effect of evaluating attribute importance before choice (H5) and, subsequently, the role of need for cognition.

Method. One hundred fifty respondents were randomly assigned to one of three choice sets in the portable PC and in the yogurt categories. Prior to considering and making a choice between each pair of options, respondents were asked to rate the importance in general of the three attributes on a 1 (not at all important) to 10 (very important) scale.

Results. As shown in Table 7, rating attribute importance before choice weakened the preference intransitivity in the portable PC category. In particular, the share of PC B in the set {B,C} was only 43%, compared to 64% obtained in the original between-subjects test reported earlier ($\chi^2 = 4.8$; $p<.05$). Correspondingly, when respondents rated attribute importance before choice, the implied intransitivity rate in the PC category was 20%, compared to 31% in the original test. In the yogurt category, the pattern of preference intransitivity in the importance rating task also appears weaker, though the results are somewhat ambiguous. The share of Yogurt C in the set {C,A} was only 50%, compared to 70% in the original between-subjects test ($\chi^2 = 4.1$; $p<.05$). However, there was no noticeable difference in terms of the implied intransitivity rates, which was 28% in the attribute importance rating task compared to 29% in the original test.

Overall, these results suggest that, if consumers need to consider their tastes before making a choice, they are less influenced by the presence of missing information. In other words, this

manipulation shifts (at least partially) the construction of preferences from the choice stage to a pre-choice phase in which consumers must determine the relative importance of each dimension.

Need for Cognition as a Moderator of the Impact of Missing Information

The overweighing of common attributes in the face of missing information can be seen as an example of people's limited cognitive capacity. Indeed, while intransitivity is a clear violation of rational decision making, one might argue that relying on common more than on unique attributes is a reasonable heuristic that takes advantage of dimensions on which making unambiguous comparisons is easiest. Thus, for example, a consumer who does not like to think much and is less inclined to spend effort on speculations regarding missing values or on the assessment of absolute (stand-alone) attribute values (e.g., Nowlis and Simonson 1997) is likely to rely primarily on the common dimension. This analysis leads to the prediction that consumers, who are more predisposed to thinking before making purchase decisions, should be less influenced by missing values and less likely to exhibit preference intransitivity. The *need for cognition* (NFC) scale measures the tendency of individuals to engage in and enjoy effortful thinking (Cacioppo and Petty 1982; Cacioppo et al. 1996). This individual difference has been shown to impact the extent of information acquisition and the depth of information processing.

In the context of the present research, high NFC might have two effects. First, consumers with high NFC are more likely to think about missing values and try to assess absolute attribute values when a clear within-attribute comparison is not possible. And second, high NFC consumers are more likely to spontaneously consider their tastes and values before making choices. Furthermore, such consumers are likely to have stronger and more accessible preferences, because they routinely tend to think about their tastes and values before making decisions. Both of these tendencies should lead high NFC consumers to be less influenced by missing information and, consequently, less likely to exhibit preference intransitivity.

H6: Relative to consumers with low need for cognition, consumers with high need for cognition are less likely to exhibit preference intransitivity.

Method. One hundred ninety respondents made choices in three product categories: portable PC, yogurt, and cordless phone, and were randomly assigned to one of three choice sets in each category (as described earlier). After making choices in the three categories, respondents received other "filler" problems from unrelated studies. Finally, respondents were asked to complete the 18-item (short) version of the Need For Cognition scale (Cacioppo et al. 1996).

Results. Respondents were divided into two groups, high NFC and low NFC, based on a median split of average item scores. As shown in Table 8, in the portable PC category, the preference intransitivity was weaker for respondents with high NFC. In particular, the share of PC B in the set {B,C} was only 46% for high NFC respondents, compared to 75% for low NFC respondents ($\chi^2 = 5.5$; $p<.025$). Correspondingly, the implied intransitivity rate in the PC category was 25% for high NFC respondents compared to 33% for low NFC respondents. Similarly, in the yogurt category, the preference intransitivity was weaker for respondents with high NFC. Specifically, the share of Yogurt C in the set {C,A} was only 40% for high NFC respondents, compared to 81% for low NFC respondents ($\chi^2 = 8.9$; $p<.005$). Accordingly, the implied intransitivity rate in the yogurt category was lower for high NFC respondents than for low NFC respondents (17% versus 41%, respectively). Interestingly, the same sets (of the three sets in each category) that were significantly affected by attribute importance ratings were similarly influenced by NFC, which could suggest that the same process underlies both results. Finally, in the cordless phone category, the preference intransitivity was also weaker for respondents with high NFC. Specifically, the share of Phone C in the set {C,A} was only 29% for high NFC respondents, compared to 61% for low NFC respondents ($\chi^2 = 5.5$; $p<.025$). Accordingly, the implied intransitivity rate was lower for high NFC respondents than for low NFC respondents (23% versus 33%, respectively).

These results support the notion that consumers who tend to exert more cognitive effort when making choices are less influenced by the presence of missing information, leading to more consistent preferences. Similarly, Smith and Levin (1996) show that framing effects (e.g., Tversky and Kahneman 1981) are eliminated among high NFC individuals. In the present research, the elimination of

intransitivity was predicted based on the notion that high NFC consumers are more likely to consider all dimensions, even those that are not common to both considered options.

Boundaries of the Effects of Incomplete Information on Consumer Choice: Discussion

Slovic and MacPhillamy (1974) show that the tendency to overweigh common attributes is very robust and persists even when respondents are explicitly told to beware of the bias and are provided with a monetary incentive to avoid it. In the present research, we identified two factors that can reduce the overweighing of common attributes. First, articulating attribute importance before making choices from sets with missing information is likely to create locally stable weights that guide the subsequent choices and reduce the dependence of preferences on whether attributes are common or unique.

A second moderator of the impact of missing information is the individual's need for cognition. The results suggest that consumers with high need for cognition, who are more likely to consider both the common and unique dimensions and might have more accessible pre-stored preferences, are less susceptible to influence by missing information. Future research might examine the process by which need for cognition moderates the impact of missing information, and specifically, whether the critical factor is differences in pre-stored tastes or differences in the manner in which high and low need for cognition consumers process common and unique attributes. In the next section, we investigate whether incomplete information affects not only current choices, but also subsequent tastes and preferences.

The Effect of Choosing With Incomplete Information on Consumer Tastes and Subsequent Choices

The results presented so far indicate that incomplete information can have substantial impact on consumer choices, leading potentially to preference intransitivity. The studies, as well as the earlier research of Slovic and MacPhillamy (1974), involved showing respondents partially described options and examining the effect of common and unique attributes on preferences for these options. An intriguing question that has not yet been studied is whether missing information can affect not only the

(partially described) options being evaluated, but also tastes (or attribute importance) and subsequent choices. In particular, is it possible that making a choice from a set with incomplete information biases subsequent choices with full information? We explore this question by examining the impact of incomplete information on both attribute importance and on subsequent choices, as described next.

The Effect of Incomplete Information on Attribute Importance

A great deal of research has shown that consumer tastes are often fuzzy, unstable, and might be influenced by previous choices they make (e.g., March 1978; Simonson 1991; Simonson and Tversky 1992). In the context of consumer choice with incomplete information, the tendency to overweigh common attributes might influence how consumers perceive their tastes, which in turn, might impact subsequent choices. That is, attributes are likely to be perceived as more important after consumers make a choice from a set in which that attribute was common rather than unique.

In addition, we showed earlier that, when making choices under incomplete information, consumers use the missing values to support choosing the option that is superior on the common attribute. In particular, they tend to regard the missing value of the option that is inferior on the common attribute as a serious concern whereas the missing value of the option that is superior on the common attribute is treated as a less significant consideration. This process suggests a more subtle effect of incomplete information on the subsequent importance of attributes. Specifically, the finding that the common attribute influences the perceived significance of missing values suggests that the weights of the two unique attributes may also be affected by the choice set that consumers evaluate. The same unique attribute is expected to be perceived as more important when the missing value on that attribute belongs to the option that is inferior on the common attribute compared to the importance of that unique attribute in a set where the missing value belongs to the option that is superior on the common attribute. Consider again the portable PC example in Figure 4. In the set {A,B}, PC A is superior on the common attribute, and the battery life of PC B is missing. To support choosing PC A, consumers may treat battery life as important and, consequently, treat the missing value of PC B as a serious concern. Conversely, in the set {B,C), the same missing battery life value belongs to the option that is superior on the common attribute and, consequently, consumers may treat the battery life attribute as less important,

with the implication that the missing value is not a significant factor. The discussion leads to the following hypotheses.

H7: After making choices with incomplete information, consumers will regard attributes as more important when they were common compared to when they were unique.

H8: After making choices with incomplete information, consumers will regard unique attributes as more important when the missing value belongs to options that are inferior on the common attribute compared to when the missing value belongs to options that are superior on the common attribute.

Method. We conducted a study in which one hundred fifty respondents evaluated a set of two options in each of three categories: portable PC, yogurt, and cordless phone. In each category, they explained their preference, marked their choice, and then rated the importance of each attribute on a 0 (not at all important) to 10 (very important) scale. Similar to preceding (between-subjects) studies, respondents were randomly assigned to one of three binary sets within each category.

Results. Consistent with H7, the mean post-choice importance rating, across the three attributes in the portable PC category, was higher after making choices in which the attributes were common compared to when the attributes were unique ($M=7.8$ versus $M=7.0$, $t=3.0$, $df=403$, $p<.005$). A similar effect was observed in the yogurt and in the cordless phone categories ($M=7.1$ vs. $M=5.9$, $t=3.8$, $df=418$, $p<.0005$ in yogurts and $M=7.7$ vs. $M=6.5$, $t=4.1$, $df=377$, $p<.0005$ in cordless phones). The direction of the results was consistent for all nine attributes. These results support the prediction that choices from sets with incomplete information affect perceived attribute importance in a manner consistent with the overweighing of common attributes.

Consistent with H8, the mean post-choice importance rating of unique attributes was systematically influenced by whether the missing value belonged to the option that was superior or the option that was inferior on the common attribute. Across the three categories (a total of nine attributes), the average importance of unique attributes was lower when its missing value in the preceding choice set belonged to the option that was superior on the common attribute ($M=6.3$ vs. $M=6.7$, $t=1.8$, $df=800$, $p<.05$). This effect was in the hypothesized direction in all three categories, but statistically significant

only for portable PC and marginally significant for yogurt (M=6.7 vs. M=7.4 in PC, M=5.7 vs. M=6.1 in yogurt, and M=6.4 vs. M=6.5 in cordless phone; $p<.05$, $p<.1$, and $p>.1$, respectively). The direction of the results was consistent for seven out of nine attributes.

These results indicate that choices with incomplete information can produce a shift in subsequent attribute importance ratings. However, a stronger test of whether the effect of incomplete information extends beyond the choice set being evaluated can be conducted by examining subsequent choices, rather than ratings of attribute importance.

The Effect of Choice with Incomplete Information on Subsequent Choices

A reasonable interpretation of the finding that choices from sets with incomplete information influence subsequent attribute importance is that consumers infer their tastes from their choices (e.g., Simonson 1991). If indeed incomplete information causes a change in perceived tastes, then we should expect subsequent choices in the same category to be also affected, such that the overweighing of common attributes is transferred to later choices.[14] We test this prediction by asking respondents to make three choices in the same category, with incomplete information in the first two but not in the third set.

It could be argued that the fact that respondents use consistent attribute importance weighs in three consecutive choices reflects an attempt to be consistent. It is thus important to examine whether the effect on tastes extends beyond the contiguous choices. As described subsequently, we examine the effect of choices under incomplete information also when the subsequent choice is separated by unrelated tasks.

H9: After making choices with missing information, consumers will continue to overweigh previously common attributes in choices with complete information. This will result in a systematic and predictable bias in choice with complete information.

[14] The authors are grateful to Lee Ross for suggesting this possibility.

Method. In one of two categories, yogurt or portable PC, 348 respondents made choices from two priming ("background") sets with incomplete information followed by a target set with full information (see Figure 5 for an example in the yogurt category). The priming sets were manipulated (between-subjects) such that, within each version, the same attribute was "common" in both priming sets. The target set was the same for both conditions, and it was designed such that one option was superior on the attribute that was the common dimension in the priming sets of one version and the other option was superior on the common attribute of the other version (a third attribute had the same values for both options in the target set). As in previous studies, we counterbalanced the positions of options and provided respondents with a "range of typical attribute values found in the marketplace" for each attribute. Based on the earlier results, we expect the choice shares in the target set to differ between the two versions, such that respondents would be more likely to prefer the option that is superior on the dimension that was common in the priming sets they evaluated.

To further examine whether the shift in weights due to choices from sets with incomplete information is momentary or extends beyond the contiguous selection, we ran another study (with 200 respondents) in which the target set was separated from the priming sets. Specifically, after choosing from the two priming sets in a category, respondents participated in a series of unrelated tasks (that took approximately ten minutes), before choosing from the target set.

Results. Consistent with the preceding results, in all cases a clear majority of respondents chose from the priming sets the option that was superior on the common dimension. We next examined the choices from the common target set (with full information). As predicted by H9, in the yogurt category there was a difference of 26% in the shares of the two options, consistent with overweighing of the attribute that was common in the priming sets ($\chi^2 = 8.0$; $p<.005$). Similarly, in the PC category (see sets in Appendix D), there was a difference in the predicted direction of 15% in choice shares between the two versions ($\chi^2 = 5.3$; $p<.025$). The pattern of results was similar in the study in which the priming and target sets were separated by other choice problems, with a difference of 23% ($\chi^2 =3.9$; $p<.05$)

and 12% (χ^2 = 1.5; p>.1) between the two (priming) versions in the yogurt and PC categories, respectively.

Discussion. The findings show that incomplete information does not only affect current choices, but also subsequent tastes and choices. Of course, one should not conclude based on these results that a choice with incomplete information can permanently change consumer preferences, which tend to be fuzzy and unstable. However, the results of this research indicate that the impact of incomplete information and, specifically, the overweighing of common attributes can transfer to later decisions with full information.

DISCUSSION

A major consequence of the changes that are taking place with respect to channels of distribution, the rise of the Internet and catalogs, and the new electronic media is the increasing control of marketers over the content and manner of presentation of product information. When selling a product on the Internet, for example, the seller can decide what information to provide, what information not to provide, and how difficult it will be for prospective buyers to obtain additional information about particular attribute values. Thus, just as marketers use various promotions to enhance the purchase likelihood of their products, they might use the information they provide or not provide and the manner in which it is provided to affect purchase decisions. The critical question, then, is whether incomplete information has systematic influence on consumer preferences, which might be employed to affect purchase decisions. Beyond its practical importance, this question has significant theoretical implications. Although as early as 1974 Slovic and MacPhillamy showed that incomplete information leads to overweighing of common attributes, we still know very little about the effect of missing information on consumer choice. Considering that most consumer choices involve some degree of missing information, understanding how consumers process common and unique dimensions and how they treat missing values is essential for the development of a theory of consumer decision making.

In a series of studies, we investigated the impact of incomplete information on consumer choice and showed that it can often lead to intransitive preferences. More importantly, the findings provide insights into the decision processes induced by missing information, the boundaries of the effects, and the consequences of making choices from sets with missing values. In this section we review the key findings and discuss their theoretical and practical implications.

Summary of Findings and Theoretical Implications

When choosing between options that have both common and unique attributes, it seems reasonable to place greater weight on the common dimension/s. Whereas common attributes allow a consumer to directly compare options on the same scale, using unique attributes is much more demanding, requiring an evaluation of the utility of an individual value (e.g., 10-minute driving time), as well as inferences about missing values. Yet, if consumers systematically overweigh common attributes, their preferences can be intransitive, as we show in this research using both within- and between-subjects tests, which is clearly a non-optimal choice pattern. To make sure that our results are not due to a particular information presentation format that makes missing values salient, we tested different formats, including one in which each option was described using sentences, with no mention of the values that were missing. The results indicate that the preference intransitivity observed in choices from sets with missing information was remarkably robust across presentation formats.

We also examined the role of inferences and information conveyed by each binary set in moderating preference intransitivity. A key test involved showing all respondents the same three options, with the only difference being the identity of the option that was "unavailable" (which was revealed only after the three options were evaluated). Considering that all respondents had the same information, differential inferences about missing values cannot account for the observed preference intransitivity. It should be noted that we are not arguing that no inferences are made about missing values. In fact, in studies that included process measures we found that between 6% and 17% of the choices involved an explicit mention of an inference about a missing value. However, our results

indicate that inferences cannot account for the preference intransitivity produced by choice sets with missing values.

The findings provide insights into the process by which missing values affect preferences. Although the overweighing of common attributes (Slovic and MacPhillamy 1974) triggers the process, the missing values play an important role as well. Specifically, rather than ignore missing values, consumers appear to adjust the weights of unique attributes in a manner that supports choices based on the common attributes. That is, if the option which is superior on the common attribute has a missing value, consumers are more likely to treat that omission as inconsequential, whereas missing values of options that are inferior on the common attributes are used as reasons for rejecting these options.

In addition to written reasons for choice and think-aloud protocols, we used a less conventional process measure based on the reported difficulty of making a choice. We reasoned that a choice based on the common attribute, without making the effort to interpret the unique attributes, is easier and associated with less decision conflict, leading to lower difficulty ratings. Consistent with this proposition, the pattern of intransitive preferences was more pronounced among those who perceived the choice task as easier.

We examined the boundaries of the tendency to overweigh common attributes and the resulting preference intransitivity, focusing on two factors. First, the findings suggest that consumers who evaluate attribute importance before making choices from sets with incomplete information are less influenced by whether an attribute is common or unique. Second, high need for cognition consumers are less likely to overweigh common attributes and exhibit preference intransitivity. Evidently, those who are more inclined to think and invest the effort to interpret unique dimensions as well as those who consider their tastes prior to making choices are capable of avoiding the tendency to rely on common attributes. An interesting question that might be studied in future research is whether incentives to think harder can cause low need for cognition consumers to process information as high need for cognition consumers do, or whether avoiding the lure of the common attribute is a skill that cannot be acquired through enhanced effort (see Slovic and MacPhillamy 1974, for a discussion of the role of cognitive effort).

Finally, the findings indicate that missing information does not only affect the preference for the (partially described) options under consideration, but it can also impact tastes and preferences in subsequent choices. Thus, for example, we showed that choices from sets with missing values and a common attribute can later influence choices from sets with full information. Furthermore, the results indicate that choices from sets with incomplete information systematically increase the perceived importance of the attributes that were common in those sets as well as the unique attributes for which the alternative superior on the common attribute had a value and the other option did not. These findings do not mean that missing values can permanently change consumers' tastes, but they do indicate that the effect on preferences extends beyond the immediate choice. The notion that the effects of incomplete information can persist after a delay is consistent with the results of Zhang and Markman (1998).

Practical Implications

Beyond the theoretical significance of understanding consumer decision making under incomplete information, this issue has important practical implications. Our findings indicate that by withholding or making less salient values on certain attributes, marketers can increase the perceived importance of other (common) attributes. Moreover, the fact that we observed systematic preference intransitivity indicates that marketers can strategically construct choice sets that increase the attractiveness and purchase likelihood of designated (high-margin) options they wish to promote. Such use of incomplete information to influence purchase decisions is much easier to implement in the current environment, taking advantage of new media and channels.

For example, companies that provide side-by-side product comparisons on the Internet, on-line auction sites, and on-line retailers have great control over the product information they provide and the manner of presentation. Consumers who use these Internet services often rely solely on the information provided in the sites when making a product choice, consistent with evidence that buyers tend to focus on the observed set without considering other options they have encountered in the past (e.g., Simonson and Tversky 1992). The option presentation format used by many Internet retailers and information

services closely resembles the format we used in our studies and frequently involves cases where particular attribute values are missing for some of the options (see Figure 6 for an example). Similarly, traditional retailers and direct marketers can typically influence the content and format of provided attribute information. Of course, certain attributes (e.g., price) usually must be presented and a seller who omits too many important attribute values may discover that buyers prefer to shop elsewhere (Dhar 1997). However, information about other attributes may or may not be presented, without significantly affecting purchase likelihood.

A possible limitation of our research is that we used a relatively simple case of choice under incomplete information, whereby consumers made binary choices between options described on three attributes. Future research could investigate the impact of larger sets of options and dimensions on consumer preferences under incomplete information. We took an initial step in that direction by using both within- and between-subjects designs with four alternatives and four dimensions.[15] Our results indicate that, if anything, the preference intransitivity is stronger in these designs. It seems reasonable that as consumers evaluate more options and dimensions, the choice complexity will increase and, consequently, consumers will rely even more strongly on dimensional processing (Bettman et al. 1991) and on common attributes. Future research may also examine whether and in what manner the effect of missing information on consumer choice is moderated by the attributions made by consumers about the causes of having incomplete information.

When studying the effects of incomplete information on choice, it is important to recognize that the distinction between common and unique attributes is more of a continuum than a dichotomy. Although in some cases attributes are unambiguously unique (i.e., entirely missing for some of the options), in other cases they may only be partially unique (i.e., vaguely described or more difficult to obtain for some of the options). Furthermore, marketers might be able to influence consumer choice by making dimensions seem unique even when they are in fact common. For instance, by representing attribute levels with different labels or scales, marketers might be able to discourage consumers from

[15] In these designs, each binary choice set had two common dimensions, which favored the same alternative, and two unique dimensions.

making certain within attribute comparisons that do not favor their product or service. In such cases, many consumers will not exert the necessary cognitive effort to translate the values into a single, comparable scale and, consequently, will underweigh this dimension in their decisions.

Such uses of missing information to influence purchase decisions may appear unethical. Certainly, marketers should not provide deceptive information or exclude information that they are required to provide. However, just as marketers employ product comparisons that highlight their advantages while downplaying their disadvantages, a calculated use of missing information is a legitimate means for promoting products and services. At the same time, it is important to educate consumers about making purchase decisions with incomplete information. Moreover, companies that are in the business of assisting consumers make more informed decisions (e.g., personalogic.com and DealTime.com) can help consumers overcome the pitfalls of missing information by eliciting attribute weights before suggesting options. Finally, as we gain a better understanding of the impact of missing information on buyer decision making, we will be able to identify new techniques that consumers can use to avoid mistakes while providing marketers new ways to use incomplete information in designing communication strategies.

Table 1: Results of Between-Subjects Tests

Category \ Binary Set	P(A,B)	P(B,C)	P(C,A)	Implied Intransitivity	Implied Reverse Intransitivity
Portable PC	P(A,B) = 62% (n=55; p<.05)	P(B,C) = 64% (n=56; p<.025)	P(C,A) = 79% (n=56; p<.001)	31%	3%
Health Club	P(A,B) = 66% (n=61; p<.01)	P(B,C) = 65% (n=60; p<.025)	P(C,A) = 70% (n=60; p<.01)	30%	4%
Yogurt	P(A,B) = 61% (n=57; p<.05)	P(B,C) = 69% (n=52; p<.01)	P(C,A) = 70% (n=53; p<.01)	29%	4%
Cordless Phone	P(A,B) = 66% (n=59; p<.01)	P(B,C) = 64% (n=58; p<.025)	P(C,A) = 64% (n=58; p<.025)	27%	4%
Congressional Representative	P(A,B) = 63% (n=41; p<.05)	P(B,C) = 71% (n=42; p<.01)	P(C,A) = 66% (n=41; p<.025)	30%	4%

Table 2: Treatment of Missing Values in the Written Explanations Study

Health Club Category

	Club A	Club B	Club C
Annual Membership Fee	$230/year	$420/year	---
Variety of Exercise Machines	Average	---	Very good
Driving Time to Health Club	---	6 minutes	18 minutes
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	8/33=24%	10/39=26%	7/41=17%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	6/39=15%	3/41=7%	8/33=24%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	0/33=0%	0/39=0%	0/41=0%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Superior* on a Common Attribute	4/39=10%	2/41=5%	9/33=27%

Yogurt Category

	Yogurt A	Yogurt B	Yogurt C
Total Fat	8g	---	1g
Vitamins A and C	---	50%	20%
Blind Taste Rating	85	75	---
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	3/42=7%	6/36=17%	10/37=27%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	2/36=6%	2/37=5%	4/42=10%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	0/42=0%	1/36=3%	0/37=0%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Superior* on a Common Attribute	6/36=17%	6/37=16%	5/42=12%

Cordless Phone Category

	Phone A	Phone B	Phone C
Brand	Cobra	---	Sony
Sound Quality by Consumer Reports	94	78	---
Blind Taste Rating	---	1,000 feet	650 feet
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	6/36=17%	2/35=6%	14/39=36%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	4/35=11%	2/39=5%	2/36=6%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	1/36=3%	3/35=9%	0/39=0%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Superior* on a Common Attribute	6/35=17%	2/39=5%	0/36=0%

Table 3: Treatment of Missing Values in the Think-Aloud Study

Health Club Category

	Club A	Club B	Club C
Annual Membership Fee	$230/year	$420/year	---
Variety of Exercise Machines	Average	---	Very good
Driving Time to Health Club	---	6 minutes	18 minutes
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	7/21=33%	7/18=39%	17/25=68%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	3/18=17%	8/25=32%	12/21=57%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	5/21=24%	1/18=6%	2/25=8%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Superior* on a Common Attribute	7/18=39%	8/25=32%	5/21=24%

Yogurt Category

	Yogurt A	Yogurt B	Yogurt C
Total Fat	8g	---	1g
Vitamins A and C	---	50%	20%
Blind Taste Rating	85	75	---
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	6/18=33%	11/21=52%	11/25=44%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	3/21=14%	7/25=28%	2/18=11%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	2/18=11%	4/21=19%	5/25=20%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was	8/21=38%	13/25=52%	5/18=28%

Superior on a Common Attribute			
Portable PC Category			
	Portable PC A	Portable PC B	Portable PC C
Speed	---	166Mhz	100MHz
Memory	12MB Ram	---	24MB Ram
Battery Life	8 hours	3 hours	---
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Inferior* on a Common Attribute	8/18=44%	9/25=36%	4/21=19%
% of Respondents Indicating that the Missing Value is a Reason Against the Option – in a Choice Set where the Option was *Superior* on a Common Attribute	11/25=44%	6/21=29%	1/18=6%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Inferior* on a Common Attribute	2/18=11%	8/25=32%	4/21=19%
% of Respondents Indicating that the Missing Value is *Not* a Significant Factor – in a Choice Set where the Option was *Superior* on a Common Attribute	8/25=32%	8/21=38%	7/18=39%

Table 4: The Effect of Choice Difficulty

Category and NFC \ Binary Set	P(A,B)	P(B,C)	P(C,A)	Implied Intransitivity
Yogurts: Difficult Choices	P(A,B) = 57% (n=44; p>.1)	P(B,C) = 48% (n=42; p>.1)	P(C,A) = 56% (n=41; p>.1)	15%
Yogurts: Easy Choices	P(A,B) = 68% (n=53; p<.01)	P(B,C) = 69% (n=54; p<.01)	P(C,A) = 65% (n=60; p<.02)	30%
Cordless Phones: Difficult Choices	P(A,B) = 65% (n=40; p<.05)	P(B,C) = 75% (n=40; p<.01)	P(C,A) = 49% (n=57; p>.1)	24%
Cordless Phones: Easy Choices	P(A,B) = 56% (n=55; p>.1)	P(B,C) = 84% (n=56; p<.01)	P(C,A) = 64% (n=45; p<.05)	30%

Table 5: Choice Shares With Information About All Three Options

Category \ Binary **Choice** Set	P(A,B|C)	P(B,C|A)	P(C,A|B)	Implied Intransitivity	Implied Reverse Intransitivity
Portable PC	P(B,C|A) = 68% (n=37; p<.025)	P(A,B|C) = 65% (n=31; p<.06)	P(C,A|B) = 65% (n=37; p<.05)	29%	4%
Yogurt	P(A,B|C) = 66% (n=41; p<.025)	P(B,C|A) = 64% (n=39; p<.05)	P(C,A|B) = 63% (n=43; p<.05)	27%	5%

Table 6: Portable PC Problem with Substitution of *Averages* for Missing Values

	Portable PC A	Portable PC B	Portable PC C
Speed (range: 85 to 200MHz)	*140MHz*	166Mhz	100MHz
Memory (range: 4 to 32MB Ram)	12MB Ram	*16MB Ram*	24MB Ram
Battery Life (range: 1 to 11 hours)	8 hours	3 hours	*6 hours*
Choice Shares	P(A,C) = 62% (n=121; p<.01)	P(B,A) = 64% (n=112; p<.01)	P(C,B) = 70% (n=111; p<.001)

Table 7: The Effect of Rating Attribute Importance Before Choice

Category and Condition \ Binary Set	P(A,B)	P(B,C)	P(C,A)	Implied Intransitivity
Portable PCs: Choice Shares After Importance Rating	P(A,B) = 56% (n=50; p>.1)	P(B,C) = 43% (n=51; p>.1)	P(C,A) = 83% (n=46; p<.001)	20%
Portable PCs: No Rating (original between-subjects test)	P(A,B) = 62% (n=55; p<.05)	P(B,C) = 64% (n=56; p<.025)	P(C,A) = 79% (n=56; p<.001)	31%
Yogurts: Choice Shares After Importance Rating	P(A,B) = 69% (n=48; p<.01)	P(B,C) = 80% (n=44; p<.001)	P(C,A) = 50% (n=48; p>.1)	28%

Yogurts: No Rating (original between-subjects test)	P(A,B) = 61% (n=57; p<.05)	P(B,C) = 69% (n=52; p<.01)	P(C,A) = 70% (n=53; p<.01)	29%

Table 8: The Effect of Need For Cognition

Category and NFC \ Binary Set	P(A,B)	P(B,C)	P(C,A)	Implied Intransitivity
Portable PCs: High NFC	P(A,B) = 65% (n=23; p<.1)	P(B,C) = 46% (n=35; p>.1)	P(C,A) = 82% (n=28; p<.001)	25%
Portable PCs: Low NFC	P(A,B) = 61% (n=33; p>.1)	P(B,C) = 75% (n=28; p<.01)	P(C,A) = 73% (n=26; p<.01)	33%
Yogurts: High NFC	P(A,B) = 55% (n=22; p>.1)	P(B,C) = 78% (n=23; p<.01)	P(C,A) = 40% (n=25; p>.1)	17%
Yogurts: Low NFC	P(A,B) = 71% (n=24; p<.025)	P(B,C) = 71% (n=24; p<.025)	P(C,A) = 81% (n=21; p<.01)	41%
Cordless Phones: High NFC	P(A,B) = 84% (n=49; p<.001)	P(B,C) = 93% (n=29; p<.001)	P(C,A) = 29% (n=24; p<.025)	23%
Cordless Phones: Low NFC	P(A,B) = 64% (n=28; p<.075)	P(B,C) = 85% (n=27; p<.001)	P(C,A) = 61% (n=33; p>.1)	33%

Figure 1: Health Clubs Described with Missing Information

	Health Club A	Health Club B	Health Club C
Annual Membership Fee (range: $200 - $550)	$230/year	$420/year	(Information Unavailable)
Variety of Exercise Machines (range: Poor to Excellent)	Average	(Information Unavailable)	Very good
Driving Time to Health Club (range: 5 – 30 minutes)	(Information Unavailable)	6 minutes	18 minutes

Figure 2: Portable PC Problem

	Portable PC A	Portable PC B	Portable PC C
Speed (range: 85 to 200MHz)	(Information Unavailable)	166Mhz	100MHz
Memory (range: 4 to 32MB Ram)	12MB Ram	(Information Unavailable)	24MB Ram
Battery Life (range: 1 to 11 hours)	8 hours	3 hours	(Information Unavailable)

Figure 3: Presentation Format With Decreased Salience of Missing Information

Portable PCs

Imagine that you decided to buy a portable personal computer. Assume that the two alternatives described below differ *only* in terms of their *speed* (market range: 85MHz - 200MHz), *memory* (market range: 4MB - 32MB), and *battery life* (market range: 1 hour - 11 hours). The two portable PCs have similar prices. The following information is available:

Portable PC A	Portable PC B
Memory: 16MB Ram	Speed: 166Mhz
Battery life: 8 hours	Battery life: 3 hours

Which portable PC would you choose? A B

Figure 4: Binary Choice Task With Information About All Three Options

Portable PCs

Imagine that you decided to buy a portable personal computer. Assume that the alternatives described below differ *only* in terms of their *speed* (market range: 85MHz - 200MHz), *memory* (market range: 4MB - 32MB), and *battery life* (market range: 1 hour - 11 hours). Consider the following three portable PCs which have similar prices:

	Portable PC A	Portable PC B	Portable PC C
Speed	180MHz	100MHz	(Information Unavailable)
Memory	(Information Unavailable)	24MB Ram	20MB Ram
Battery Life	3 hours	(Information Unavailable)	8 hours

The store you visit has only two of the above portable PCs in stock, portable PC A and portable PC C. (Therefore, you *cannot* choose portable PC B.)

Which available portable PC would you choose?	A	(Out of stock)	C

Figure 5: Design of Attribute Priming Study in the Yogurt Category

Condition 1: Taste Priming Manipulation

	First Binary Choice Set		Second Binary Choice Set	
	Yogurt A	**Yogurt B**	**Yogurt A**	**Yogurt B**
Total Fat	3g	---	---	5g
Vitamins A and C	---	20%	35%	---
Blind Taste Rating	90	78	85	72

Condition 2: Vitamins Priming Manipulation

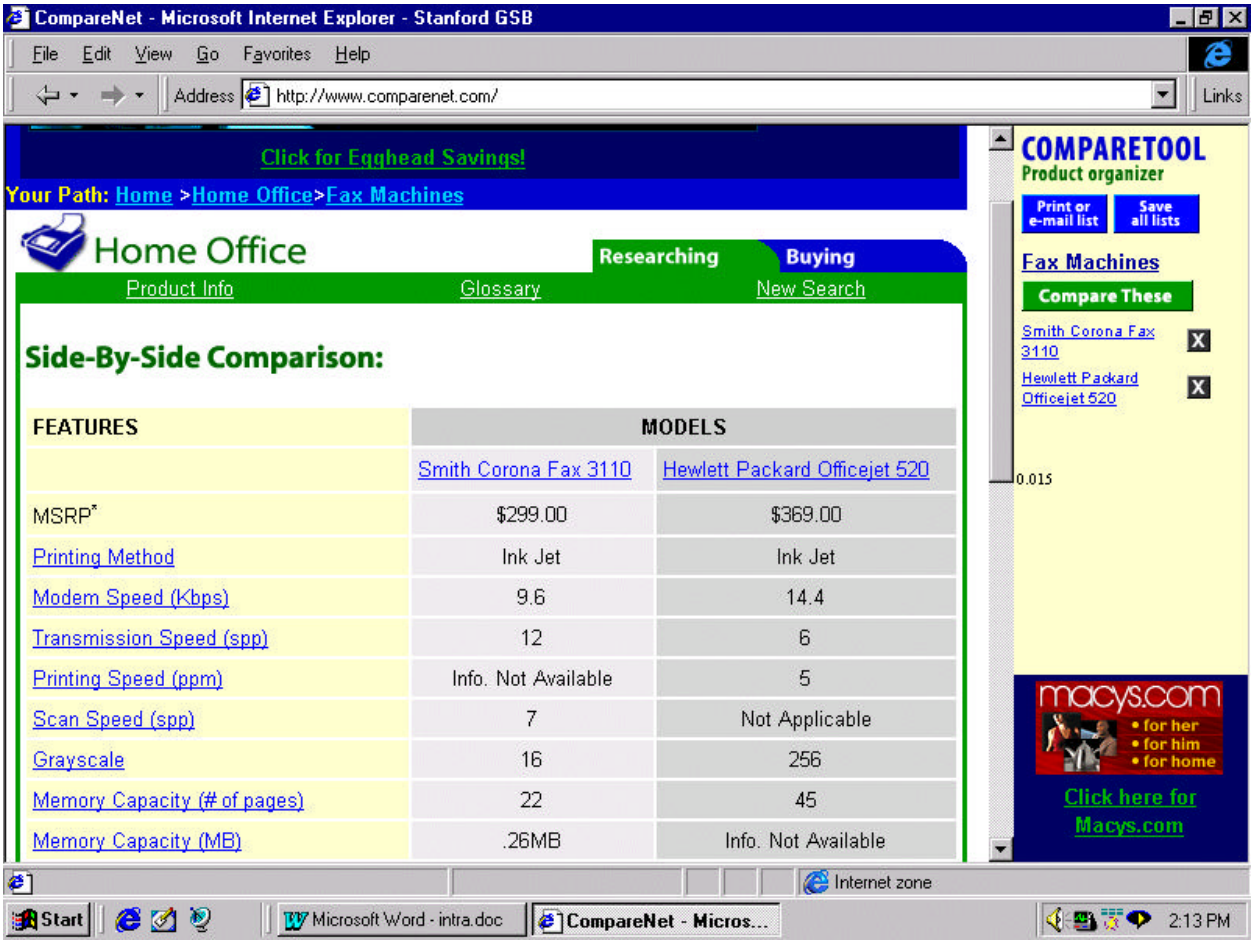
	First Binary Choice Set		Second Binary Choice Set	
	Yogurt A	**Yogurt B**	**Yogurt A**	**Yogurt B**
Total Fat	---	1g	1g	---
Vitamins A and C	50%	10%	55%	5%
Blind Taste Rating	80	---	---	70

Target Choice Set with Full Information (Used in Both Conditions)

	Yogurt A	**Yogurt B**
Total Fat	4g	4g

Vitamins A and C	15%	60%
Blind Taste Rating	87	75

Figure 6: An Example of a Web-Based Product Comparison with Missing Information



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Appendix A: 3 Additional Categories with Intransitive Consumer Choices

Yogurt Problem (Choice Shares from Between-Subjects Design)

	Yogurt A	Yogurt B	Yogurt C
Total Fat (range: 0g to 15g)	8g	(Information Unavailable)	1g
Vitamins A and C (range: 0% to 65% of RDA)	(Information Unavailable)	50%	20%
Blind Taste Rating (range: 0 to 100, where 0 is poor and 100 is exceptional)	85	75	(Information Unavailable)

Cordless Phone Problem (Choice Shares from Between-Subjects Design)

	10-Channel Cordless Phone A	10-Channel Cordless Phone B	10-Channel Cordless Phone C
Brand	Cobra	(Information Unavailable)	Sony
Sound Quality by Consumer Reports (range: 25-100)	94	78	(Information Unavailable)
Useful Range (range: 300 –1,100 feet)	(Information Unavailable)	1,000 feet	800 feet

Congressional Representative Problem (Choice Shares from Between-Subjects Design)

	Candidate A	Candidate B	Candidate C
Increase in Employment Rate in the District (range: 0% - 10% increase in employment)	9%	$3^1/_2$%	(Information Unavailable)

Personal Conduct (range: very low - excellent)	(Information Unavailable)	Excellent	Average
Crime Reduction (range: 0% - 30%)	15%	(Information Unavailable)	20%

Appendix B: Example of choice task and information provided to respondents

Making Choices

Please read the information in each of the following problems very carefully. In each problem you will choose between two options. In real life we often do not have all the information about all the characteristics of every alternative. Similarly, you will be given whatever information is available about each option. If a particular piece of information is missing, you will see "Information Unavailable". In addition, for each product characteristic you will be shown the range of typical values offered in the marketplace. There are no right or wrong answers. We are only interested in your preferences.

Portable PC

Imagine that you decided to buy a portable personal-computer. Assume that the two alternatives described below differ *only* in terms of their *speed* (market range: 85MHz - 200MHz), *memory* (market range: 4MB - 32MB), and *battery life* (market range: 1 hour - 11 hours). The two portable PCs have similar prices. The following information is available:

	Portable PC A	Portable PC B
Speed	(Information Unavailable)	166MHz
Memory	12MB Ram	(Information Unavailable)
Battery Life	8 hours	3 hours
Which portable PC would you choose?	A	B

Appendix C: Coding Scheme Used in the Analysis of the Written Explanations and Think-Aloud Protocols

Code A. Product characteristics (codes related to the weighing of attributes)

1 - Attribute mentioned as a criteria for choice.
0 - Otherwise.

Code B. Uncertainty avoidance (codes related to the missing values)

Each of the two missing values (i.e., each of the two "Information Unavailable" entries) are coded separately as follows:

1 - If the respondent mentioned that the absence of this information (and/or the possible value it may assume) hurts the option to which it belongs (or even prevents her from choosing this option). Also, this code includes cases where the respondent mentions that a bad value on this attribute is harmful. In addition, cases where the respondent mentions that knowledge of this unique attribute's value is relatively important
2 - If the respondent mentioned that the absence of this information (and/or the possible value it may assume) does not hurt the option to which it belongs. Also, this code includes cases where the respondent mentions that a bad value on this attribute is not harmful. In addition, cases where the respondent mentions that knowledge of this unique attribute's value is relatively not important.
0 - If the respondent does not refer to the absence of this information at all.

Code C. Inferences about the missing information (codes related to the missing values)

Each of the two missing values (i.e., each of the two "Information Unavailable" entries) are coded separately as follows:

1 - The respondent inferred a particular value for the missing information based on the inter-attribute correlation (intra-alternative inference).
2 - The respondent inferred a particular value for the missing information based on the provided range for that attribute (inter-alternative inference).
3 - The respondent inferred that the missing value was zero.
4 - The respondent inferred that the missing value was supportive of her choice.
5 - The respondent inferred that the missing value was detrimental to her choice.
0 - The respondent did not infer a particular value for the missing information.

Appendix D: Design of Attribute Priming Study in the Portable PC Category

Condition 1: Memory Priming Manipulation

	First Binary Choice Set		Second Binary Choice Set	
	Portable PC A	**Portable PC B**	**Portable PC A**	**Portable PC B**
Speed	100MHz	---	---	90MHz
Memory	24MB Ram	12MB Ram	16MB Ram	8MB Ram
Battery Life	---	8 hours	6 hours	---

Condition 2: Speed Priming Manipulation

	First Binary Choice Set		Second Binary Choice Set	
	Portable PC A	**Portable PC B**	**Portable PC A**	**Portable PC B**
Speed	166MHz	100MHz	190MHz	120MHz
Memory	---	24MB Ram	---	16MB Ram
Battery Life	3 hours	---	7 hours	---

Target Choice Set with Full Information (Used in Both Conditions)

	Portable PC A	**Portable PC B**
Speed	175MHz	110MHz
Memory	16MB Ram	30MB Ram
Battery Life	6 hours	6 hours