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Abstract

When people choose between two alternatives, like between two colleges, some of the available information is comparable across the alternatives (alignable) and some is noncomparable (nonalignable). For example, when comparing colleges, the academic reputation of both schools may be known (alignable), while the quality of teaching may only be known for one school (nonalignable). Recent research has shown that people use more alignable than nonalignable information in decision making. In this experiment, we consider whether alignable information is preferred even when nonalignable information is important. In the study, some participants rated the importance and valence of a series of statements about colleges that differed in alignability. Other participants made choices between pairs of colleges whose descriptions incorporated these statements. The results indicate that alignable information is preferred to nonalignable information even when the nonalignable information is important. Results also showed that the interpretation of attribute valence depends on alignability. These observations suggest that alignability is more influential than attribute importance in the processing of choice information and that the use of alignable information may facilitate the interpretation of attribute information.

Imagine that you are a senior in high school beginning the process of applying to college. To help you make the decision, you gather a tremendous amount of information. You read brochures and books. You talk to friends, parents, teachers and counselors. In the end you must evaluate the information you have gathered and make a decision. Your collection of information about the characteristics of colleges contains two types of information. On some topics (e.g., school location and academic reputation) you have corresponding values for all of the schools you are interested in. On other topics (e.g., study abroad programs and availability of extracurricular activities) you have information from some of the schools but not others. Somehow you must combine this information in order to make your final decision.

We suggest that the structural alignment process of comparison is a key element in determining how information is used in choice (Medin, Goldstone & Markman, 1995). Structural alignment has been identified as a critical factor in the psychology of similarity (Gentner, 1983, 1989; Gentner & Markman, 1994; Medin, Goldstone & Gentner, 1993). On this view similarity comparisons involve three types of information - commonalities between the items, differences related to the commonalities (i.e. corresponding or *alignable* differences), and differences unrelated to commonalities (i.e. noncorresponding or *nonalignable* differences). To illustrate, consider the comparison of a dog and a cat. In this comparison, the fact that dogs and cats are both pets is a commonality, the fact that a dog barks and a cat meows is an alignable difference (related to the commonality that both animals make noise) and the fact that the dog fetches and the cat doesn't is a nonalignable difference. In one study, Markman & Gentner (1993) asked subjects to list the commonalities and differences of pairs of items of varying levels of similarity. Overall, participants listed more alignable differences than nonalignable differences. Furthermore, more alignable differences were listed for similar pairs than for dissimilar pairs and more nonalignable differences were listed for dissimilar pairs than for similar pairs. This result demonstrates that alignable differences are the central output of the comparison process. It also suggests that alignable and nonalignable differences are processed differently.

This theory can be applied straightforwardly to decision making. In the college example presented above, the alignable differences are the corresponding properties and the nonalignable differences are the noncorresponding properties. Just as the research in similarity suggests that the alignable differences are more important for comparisons than are nonalignable differences, previous research in choice has demonstrated that decision makers tend to focus more on corresponding pieces of information than on noncorresponding information (Markman & Medin, 1995; Slovic & MacPhillamy, 1974). Similarly, in consumer choice, when deciding between highly different types of products (e.g. a toaster and a smoke alarm) consumers attempt to abstract corresponding qualities (Johnson, 1988), which can be viewed as an attempt to make the properties of dissimilar items more comparable.

The selective use of alignable differences over nonalignable differences raises the possibility that decision makers systematically ignore information they believe to be important simply because it is nonalignable with information from another option. In this study, we examine this possibility directly. In this decision task, we ask

subjects to choose which of two universities they prefer after reading short descriptions of the schools. The descriptions are designed so that half of the relevant information is of high importance and half is of low importance. By varying the alignability of these items, we will be able to see whether alignability influences the decision maker's use of both important and unimportant information. We predict that subjects will focus more on important information than on unimportant information, but that they will use more alignable information for both important and unimportant items. In order to assess the information being used by subjects, we will analyze both justifications of choices given by subjects as well as think-aloud protocols from a separate group of subjects. Because we are interested in the impact of alignability on the use of information in choice, we focus on processing measures (e.g., justifications and protocols) rather than outcome measures (e.g., choices).

This study will also look at the way that alignability influences the processing and interpretation of the statements used in the decision task. This question will be addressed with a ratings task. Some subjects will be given corresponding pairs of statements (i.e., alignable statements) to rate, while others will rate the same statements, individually (i.e., nonalignable statements). We will examine these results to see if they can help explain the bias toward using alignable differences in decision making.

Method

Participants

Sixty subjects (20 per group) participated in the ratings task. Fifty-six subjects participated in the decision making task (32 with written task and 24 with verbal protocol task). All subjects were recruited from the Columbia University community and were paid or received course credit for their participation.

Materials

Ratings Task. For the ratings task, stimuli were statements about colleges. The statements were like those in the descriptions of schools in various guidebooks to colleges and universities. There were 16 pairs of statements. Both of the statements in each pair focused on the same topic (e.g., housing options, academic reputation, etc.). In each pair, one of the statements was positive (e.g., "There is a good amount of housing available in a variety of configurations and most of the students who want to live in singles are able to.") and the other was neutral (e.g., "Students are generally housed in double rooms with some single rooms available to seniors who request them."). Half of the pairs focused on topics that we believed Columbia University students would consider to be important college characteristics (e.g., housing options, academic reputation of the school, etc.) and half of the pairs focused on topics that we believed Columbia University students would think of as unimportant (e.g., quality of the gym, attractiveness of the campus, etc.). Statements were important or unimportant and positive or neutral. Negative statements were not included. Negative statements were omitted because we wanted the descriptions created from the statements to be generally attractive.

There were three groups of subjects. One group of subjects saw all of the statements, presented in pairs (the alignable group). Each of the other two groups saw only half of the statements, one from each pair (the nonalignable groups A and B). Nonalignable group A saw half of the positive statements and half of the neutral statements. Nonalignable group B saw the remaining positive and neutral statements. The materials were presented in booklets with the appropriate ratings scale appearing at the top of each page (i.e., for importance, 1 (not at all important) to 5 (extremely important) and for valence, 1 (extremely negative) to 7 (extremely positive)). The order of the items in each booklet was determined randomly. There were five or six pairs of statements per page for the alignable group and five or six single statements per page for the nonalignable groups. The pages of each booklet were randomly ordered for each subject.

Decision Task. For the decision task, the stimuli were pairs of paragraph descriptions of fictitious colleges and universities. Each description was made up of a cover story (filler sentences) and main sentences. The descriptions were set up so that some properties were directly comparable across the two descriptions in a pair (alignable). For example, both descriptions might talk about available housing options with one school having more options than the other. Other properties were not directly comparable across the two alternatives (nonalignable). For example, only one of the college descriptions might include information about the quality of teaching at the school.

The materials were constructed in the following way. We first wrote four "base pairs" of corresponding descriptions. The base pairs were then used to create the stimulus sets used in the decision task. In a base pair, each sentence in one description had a corresponding sentence in the other description. The descriptions in a base pair consisted of two corresponding cover stories (making up the two initial "filler" sentences and the final "filler" sentence in each description) and four corresponding main sentence slots, as shown in Table 1.

Sentence Type	College A	College B
1 - cover story	filler	filler
2 - cover story	filler	filler
3 - main sentence	positive	neutral
4 - main sentence	neutral	positive
5 - main sentence	positive	neutral
6 - main sentence	neutral	positive
7 - cover story	filler	filler

Table 1 - Listing of all sentences in a base pair

Sentence Type	College A	College B	Comparison Type
1 - cover story	filler	filler	commonality
2 - cover story	filler	filler	commonality
3 - main sentence	positive	neutral	nonalignable difference
4 - main sentence	neutral	positive	nonalignable difference
5 - main sentence	positive	neutral	alignable difference
6 - main sentence	neutral	positive	alignable difference
7 - cover story	filler	filler	commonality

Table 2 - Removing 2 noncorresponding positive sentences
leaves 2 alignable and 2 nonalignable differences

In each base pair, the corresponding filler sentences were approximately equivalent in meaning (commonalities). The corresponding main sentence slots were filled at random using the 16 corresponding pairs from the ratings task with the restriction that two positive and two neutral sentences were inserted in each description. Each of the 16 pairs was used once within a set of base pairs. Two different sets of base pairs were created in this way. The written task used stimuli constructed from both sets of base pairs, while the protocol task only used stimuli constructed from the first set.

From each set of base pairs, four different stimulus sets were created by selectively removing individual sentences from each description. To create each stimulus set, two *noncorresponding* sentences of the same valence were removed from each pair of descriptions leaving two alignable differences (the remaining corresponding sentences) and two nonalignable differences (the remaining non-corresponding sentences). This is illustrated in Table 2 where two noncorresponding, positive, main sentences have been removed (sentence 3 from college A and sentence 4 from college B, as indicated by the X's). In this example, two nonalignable differences remain (sentence 3 from college B and sentence 4 from college A - two noncorresponding neutral statements) and two alignable differences remain (sentence 5 from both schools and sentence 6 from both schools).. Different pairs of sentences were removed from the base pairs to create the four different stimulus sets. In this way, each sentence was used as an alignable difference and as a nonalignable difference across the four stimulus sets. This structuring of materials is similar to that used by Markman and Medin (1995) for the descriptions of video games in their second experiment.

Procedure

Ratings Task. Participants in the ratings task were randomly assigned to one of the three conditions - alignable (where all the statements were presented in corresponding pairs) or nonalignable A or B (where half of the statements, one from each pair were presented). Subjects in the alignable condition were told to read both items in a pair before rating them and to consider the items as though they referred to two different universities. The valence ratings task was done first. For this task, subjects considered each statement as though it came from a description of a college and rated its positivity/negativity. After this was completed, they did the importance ratings task. For this task subjects were told to

imagine that they were giving advice to a younger brother or sister applying to college and to rate how important their younger sibling should consider each statement when deciding where to go to school.

Decision Task. Participants in the decision tasks were told to imagine that they were helping a younger sibling to decide where to apply to college. They read a series of pairs of descriptions of colleges and had to choose which school their sibling should apply to. For the written task, subjects read a pair of stories on a computer screen, selected one school and then typed a justification for their selection. For the verbal protocol, subjects first participated in a few warm-up tasks. Then the materials were presented on sheets of paper and subjects read the stories aloud and thought aloud while making their choices. Verbal protocols were recorded on audio tape. For both the written and verbal presentations, the order of presentation of the four pairs of schools was randomly determined and right/left presentation of the descriptions was varied between subjects.

Scoring

The written justification for each choice were scored by counting separately the number of references to the alignable and nonalignable properties from the relevant college descriptions. Only statements that clearly referred to the specific information in the descriptions were counted. When one justification included multiple references to a single alignable or nonalignable property, it was counted as one reference. Any single justification could be counted as mentioning a maximum of two alignable and two non-alignable properties. The verbal protocols were transcribed and then scored in the same way as the written justifications.

Results

First we examine the results from the importance ratings task in order to determine which of the 16 pairs of properties used were considered important and which were unimportant. Next we evaluate the results of the decision tasks to look at the influence of alignability and importance on choice. Finally, we present evidence from the ratings tasks which suggesting that the availability of corresponding (alignable) statements influences the way people evaluate properties of options.

	Properties Mentioned			
Method	Alignable High Importance	Nonalignable High Importance	Alignable Low Importance	Nonalignable Low Importance
Written	1.72	0.91	1.22	0.87
Verbal	3.17	1.58	2.92	2.08

Table 3 - Mean Alignable and Nonalignable Properties used per subject in Written Justifications and Verbal Protocols broken down by importance level.

Importance of Individual Items

Mean importance ratings for the pairs of items were calculated by averaging the importance ratings for both items in each pair in the alignable and nonalignable conditions. The range of mean values for the importance ratings was somewhat restricted (2.72 - 4.40 on a 1 to 5 scale). This reflects the fact that the participants tended not to use the lower end of the scale: 18 of 30 subjects (60%) neglected to use the rating "1" ("not at all important"), even though half of the items were designed to be of little or no importance. The eight items with the lowest mean importance ratings were considered to be the low importance items (Range of means: 2.73 - 3.60) and the eight items with the highest mean importance ratings were considered to be the high importance items (Range of means: 3.75 - 4.40).

Decision Making Tasks

The number of alignable and nonalignable differences mentioned in the justifications and protocols were tabulated using the scoring method outlined above. These tabulations were further broken down for low and high importance items. These results are presented in Table 3 and were analyzed with a 2 X 2 ANOVA.

As predicted, more alignable differences than nonalignable differences were mentioned in both the written justifications (m = 2.94, alignable; m = 1.81 nonalignable; $F (1, 31) = 11.06$, $p < 0.01$) and the protocols (m = 5.96, alignable; m = 3.66, nonalignable; $F (1, 23) = 31.87$, $p < 0.01$). These results confirm the pattern found by Markman & Medin (1995). This pattern was obtained both for the high importance items and for the low importance items in both the written and protocol tasks. This finding is critical because it shows that nonalignable features may receive less attention than alignable features, even when they are considered to be important.

This general trend can also be found at the level of individual subjects and individual items. At the subject level, in the written task, 20 of 32 subjects (63.0%) referred to more alignable differences, there were 6 ties and 6 subjects showing the reverse pattern (18.5% each). For the protocol task, 20 of 24 subjects (83.3%) mentioned more alignable properties, with 2 ties and 2 showing the reverse pattern (8.3% each). At the item level, in the written task 10 of 16 items (62.5%) were listed more often in the alignable condition, there were 5 ties (31.2%) and 1 item showed the reverse pattern (6.3%). In the protocol task, 15 of 16 items (93.7%) were mentioned more often in the alignable condition and there was 1 tie (6.3%).

It is important to note here that the verbal protocols were unplanned, lengthy responses while the written justifications were planned and short, typically only one or two sentences. This difference helps to explain why the participants performing the protocol task mentioned twice as many alignable and nonalignable differences as those performing the written task.

The following example, taken from one of the verbal protocols, illustrates the type of responses given by our subjects. In this example, the subject is choosing between two schools where "faculty accessibility" and "the variety of major programs" were alignable properties and "academic reputation of the school" and "teaching quality" were nonalignable properties. The subject said, "Um . . . well Mountwell University seems to be probably smaller because the teachers are more accessible and more enthusiastic and Hillsdale however has a lot of programs and independent people can make up their own programs which is a good thing . . . some reason I keep picking all the universities on the right hand side . . . but I don't know these are just really similar, but I guess I'd go with Hillsdale because it's not that important to me to have accessible professors."

In this example, the subject mentions both of the alignable properties - faculty accessibility and the variety of majors. Furthermore, the information about faculty accessibility is then used to make an inference about the relative sizes of the universities. The subject does not mention the nonalignable facts that teaching is strongly emphasized at Mountwell and that Hillsdale has an excellent academic reputation, even though these are considered to be among the most important college characteristics to Columbia University students. This subject does not fill-in the missing information and make either of the plausible inferences that Hillsdale's reputation is better or that the teaching at Mountwell is better. In fact the subject seems somewhat at a loss to come up with differences between the schools stating that "they are just really similar". This is illustrative of participants' strong tendency to favor alignable over nonalignable differences.

From this illustration, it is easy to see how this type of data (i.e., protocols and justifications) allows us to examine the way subjects process information relevant to a decision. We can evaluate which information is considered in the decision process and how it is used. We can also evaluate which information does not enter into consideration. Outcome data (i.e., subjects' choices), on the other hand, does not provide this benefit. It is for this reason that we favor analyzing justifications and protocols as a method for learning about the processing of decision information.

	Valence Ratings		Importance Ratings	
Statement Type	Alignable	Nonalignable	Alignable	Nonalignable
Positive	5.86	6.17	3.91	3.77
Neutral	4.04	4.81	3.58	3.55

Table 4 - Valence and Importance ratings of Alignable and Nonalignable Properties for both positive and neutral statements

Finally there is one surprising result. Contrary to our expectation, the high importance items were not used more often than the low importance items. In the written task, the effect of importance was only marginally significant (m = 2.69, high importance; m = 2.06, low importance; $F(1,31) = 3.54$, $p < 0.07$) and in the protocol task there is was no effect of importance (m = 4.62, high importance; m = 5.00, low importance, $F(1, 23) < 1$). In part, this may be due to some of the materials being insufficiently different in perceived importance. However, this result provides some indication that the importance of information is less crucial to choice than other factors like alignability.

Importance and Valence Ratings

The mean importance and valence ratings are presented in Table 4. There were no significant effects of alignability or item type (positive or neutral) on the importance ratings.

The valence ratings showed a different pattern. As expected, subjects gave higher valence ratings to positive statements (m = 6.02) than to neutral statements (m = 4.43), where 4.0 was the neutral point on the ratings scale, $F(1, 30) = 62.78$, $p < 0.01$. Alignability also influenced valence ratings, with nonalignable statements (m = 5.49) rated higher than alignable statements (m=4.95), $F(1,30) = 11.02$, $p<.01$. This suggests that statements were perceived more positively when they were presented without a corresponding alternative value.

There is a trend towards an interaction, although it is not significant. The pattern of means suggests that there may be a greater difference between the valence ratings of the positive and neutral items when they are alignable than when they are nonalignable. This pattern can be clearly seen in a post-hoc analysis in which we eliminated from consideration pairs of statements where the positive statement was not rated more positively than the neutral statement by our subjects. We only examined the 12 pairs of statements for which a paired t-test on the alignable valence ratings found the positive items to be of significantly higher valence than the neutral items. For this analysis the main effects that were found in the original analysis were again obtained. The perceived valence of positive statements (m = 6.17) was higher than that of neutral statements (m = 4.51), $F(1, 22) = 60.44$, $p < 0.01$. The perceived valence of nonalignable properties (m = 5.68) was higher than alignable properties (m = 5.01), $F(1, 22) = 37.77$, $p < 0.01$. Finally, the interaction is also significant, $F(1, 22) = 25.71$, $p < 0.01$, reflecting the pattern described above. The difference between the mean perceived valence of positive and neutral properties was greater for the alignable properties (diff. = 2.22) than for the nonalignable (diff. = 1.11) properties. This effect may reflect that it is more difficult to determine the absolute valence of an isolated fact than it is to determine the valence of that same fact relative to an alignable fact.

General Discussion

These results demonstrate that people tend to focus more strongly on alignable differences than on nonalignable differences during choice regardless of the importance of the information. Thus subjects may ignore important information simply because it is nonalignable, and may use unimportant information simply because it is alignable. Surprisingly, we found no evidence that importance influenced the selection of information used to make decisions. This pattern of data was obtained both in an on-line think-aloud protocol task and in a post-hoc written justification task.

The results replicate and extend Markman & Medin's (1995) studies in which more alignable information than nonalignable information appeared in subjects' post-hoc justifications of choices between video games. Further, this study introduced the think-aloud methodology to the study of alignability in decision making. Although this change in methodology increased the amount of information contributed by each subject, it did not alter the pattern of results. Thus the tendency to use alignable information in choice does not seem to be an artifact of the justification method. Further, the think-aloud method is important because it enables us to identify more of the information that subjects use and to look at how it is used. In particular, it will allow for a more detailed analysis of the use of inferences, abstractions and the filling-in of missing values in choice.

The ratings tasks shed light on why people prefer to use alignable information. The valence ratings indicate that people change their interpretations of information depending on whether the information is presented alone or in correspondence with other information. People may prefer to use alignable information when they have difficulty determining the absolute value of an attribute. Alignable information eases interpretation because it provides the decision maker with a point of comparison.

There is some reason to believe that novices and experts may differ in their reliance on alignable information. Experts can fill-in missing values by using their domain knowledge (Gardial & Biehal, 1991). Sanbonmatsu, Kardes & Herr (1992) found that bicycle experts were more likely to take missing information into account than were less knowledgeable subjects. Apparently the less knowledgeable subjects did not know the absolute valence of the missing

properties and so they could not incorporate that information into their decisions. This finding suggests that experts may be less dependent on alignable information because they are better able to evaluate attributes. We are currently examining this issue by looking at the decision making processes of students with different levels of expertise about college life.

Acknowledgments

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