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Effects of Choice Task on Attribute Memory

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Winnowing process models of multiattribute choice in which alternatives are successively eliminated in stages based on partial information predict differential memory for minor attributes as a function of an alternative's relative desirability. This prediction, which differs from the results of judgment studies finding little or no relationship between evaluation and memory, was tested in two experiments in which the choice task (Choose 1 vs Choose 3) and the density of the option set were varied. Better memory for minor attributes of relatively desirable alternatives was observed for those conditions requiring the more difficult decisions, namely the Choose 1 task with a dense set of good alternatives. A third experiment replicated these results and demonstrated that the minor attributes did influence choice. The results of all three experiments are generally consistent with winnowing models. However, detailed analysis of the memory data revealed that only attributes of the chosen alternative were remembered better; this is not entirely consistent with those models. Implications of these results for models of memory and choice are discussed.

This paper reports studies of the relationship between choice and memory framed in the context of a "winnowing" model of the choice process. This winnowing model applies to multiattribute choice problems in which the alternatives vary on a number of attributes or characteristics. With suitable manipulations of task instructions and stimulus sets, the winnowing model makes differential predictions about how much will be remembered about the choice alternatives. The three experiments presented in this paper test those predictions.

The basis for the winnowing model rests on a sharp distinction between the concepts of choice and judgment (Einhorn & Hogarth, 1981). Both choice and judgment involve evaluation of alternatives, but *choice* im-

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plies selection of one or a small number of alternatives from a larger set, while *judgment* requires a global evaluation of each alternative. It may be the case that judgment serves choice in multiattribute tasks (i.e., one might judge all alternatives and then choose the alternative judged best overall); however, other models of choice (e.g., elimination of alternatives by within-attribute comparisons; Payne, 1976, 1982; Tversky, 1972a, 1972b; Tversky & Sattath, 1979) do not necessarily presuppose global judgments.

We suggest that winnowing—the process of reducing a large set of alternatives to successively smaller sets until a desired number of alternatives, usually only one, remains—is characteristic of multiattribute choice processes and in particular that winnowing distinguishes choice from judgment. Winnowing is a meta-choice process in that any of a number of different models of decision making can be incorporated within this framework.

Winnowing is clearly consistent with elimination-by-aspects and within-attribute processing models of choice. According to such models, when making multiattribute choices people first select an important attribute or aspect and then eliminate those alternatives which are not satisfactory on that attribute or which do not have that aspect. The standing of the eliminated alternatives on other attributes is never considered. Then another attribute or aspect is selected and the winnowing process continues until only a single alternative or the desired number of alternatives remains.

Although winnowing is often associated with elimination-by-aspects models, it is logically an independent concept because winnowing is also consistent with certain judgment-based models. For example, people may make multiattribute choices by forming overall judgments of each alternative, considering each alternative as a whole. Choice is then simply the selection of the alternative with the best overall judgment. Winnowing would be involved if only the most important attributes were used in the initial judgment and if, as is often the case, those initial judgments do not reveal a clear winner. The chooser would then be left with a set of reasonably good alternatives which all have about the same overall evaluation. If so, the remaining alternatives are again evaluated, this time possibly including more attributes, especially relatively minor attributes, in the evaluation. Further reevaluations may be required to winnow the choice to one. Each reevaluation may involve either a completely new evaluation process or simply an updating of the evaluation from the previous stage.

Hybrid or phased choice models in which across-alternative attribute comparisons are used in some phases and within-alternative judgments are used in other phases (e.g., Bettman & Park, 1980; Johnson & Russo, 1984; Olshavsky, 1979; Onken, Hastie, & Revelle, 1985) are not only consistent with but also imply a winnowing meta-process. In such models a given type of processing is presumed to be used only after the choice set has been winnowed to a manageable size.

Winnowing, because it is consistent with so many specific models of decision making, is a general and hence weak model. The reader may wonder what models of decision making it does not encompass. A decision model not consistent with winnowing is one in which judgment serves choice, in which a single evaluation is made of each alternative as a whole and the alternative with the best overall evaluation is selected. This model linking judgment and choice combines with the results of studies finding little or no relationship between memory and *judgment* (e.g., Anderson & Hubert, 1963; Riskey, 1979), to predict little or no relationship between memory and *choice*. In contrast, the winnowing model, despite its generality, predicts differential memory for attributes as a function of an alternative's relative desirability. We next examine the basis for these two predictions in more detail.

The prediction of little or no relationship between choice and memory is based on the combination of judgment-serves-choice models (e.g., linear compensatory models) and the results of several studies conducted from within a judgment rather than a choice framework. In the substantive domains of impression formation and consumer product evaluation, such studies have explored the judgment–memory relationship (e.g., Beattie & Mitchell, 1985; Dreben, Fiske, & Hastie, 1979; Lichtenstein & Srull, 1985; Riskey, 1979). Hastie and Park (1986) argue in a review of this research that the relationship between judgment and memory depends upon whether the judgments are simultaneous with the acquisition of information or whether they must be constructed from memory of the alternatives. As might be expected, judgments are related to memory when one must derive those judgments from previously presented but no longer available information. When judgments are formed simultaneously or "on-line," the relationship between those judgments and later memory for the alternatives' attributes disappears. Thus, we would expect to find very little relationship between choices and memory for attributes of those choices if judgment serves choice and if those judgments are made on-line in the presence of information about the alternatives.

The prediction of a relationship between choice and memory is based on the research of Johnson and Russo (1984) and Biehal and Chakravarti (1982), who have used a choice versus judgment instruction manipulation. In their research, some subjects were instructed to choose the best alternative from a set and others were instructed to judge or rate each alternative in the set. Consistent with the models of Hastie and Park (1986) and Lichtenstein and Srull (1985), in judgment tasks memory for an alternative's attributes does not depend on the relative desirability of the alternative. In contrast, however, subjects who receive the choice instructions do have differential memory for attributes as a function of whether the alternative was chosen or not. Based on these results as well as on self-report data from verbal protocols, Johnson and Russo (1984) concluded that, at least in the early phases of the choice process, global judgments do not serve choice. Instead people may use what we have called winnowing, in which a few attributes are used early in the process to eliminate many alternatives from further consideration. Those winnowed alternatives then receive little if any attention later on, resulting in what Johnson and Russo (1984) termed a "one-sidedness effect"—much more complete memory of the attributes of chosen alternatives.

The experiments reported in this paper were designed to extend the research of Johnson and Russo on the relationship between choice and memory. Whereas a primary manipulation in their experiments has been choice versus judgment tasks, we manipulate aspects of the choice task and the set of alternatives. These manipulations are intended to affect the amount and difficulty of winnowing—the process of reducing a large set of alternatives to successively smaller sets until only the choice remains.

Combined with a few simple assumptions about attention and memory, winnowing predicts differential memory for attributes as a function of an alternative's relative desirability. If an attribute for an alternative is not processed, then it obviously cannot be remembered. Unfortunately, the converse is not necessarily true. Judgment and memory studies beginning with Anderson and Hubert (1963) have shown that an attribute can have an impact on the judgment independent of its memorability. However, it seems reasonable and consistent with other memory studies to postulate that the more attention and processing an attribute receives the greater the likelihood that it will be remembered, regardless of its ultimate impact on the choice. This assumption has been supported empirically in choice tasks by Biehal and Chakravarti (1986), and it is sufficient to derive memory predictions from the winnowing process. Winnowing implies that most of the attributes for undesirable alternatives which are rejected early in the choice process will receive little or no processing; hence, memory should be relatively poor for attributes of undesirable alternatives. Conversely, most of the attributes for desirable alternatives should receive greater attention and processing because those alternatives will have survived each winnowing stage. Not only will surviving alternatives be processed more often, but more of their attributes will be considered. If this increased attention produces better memory, then memory for an alternative's attributes, especially minor attributes of secondary importance that would be considered in only the later winnowing stages, should vary as a function of the alternative's relative desirability.

In particular, memory should be better for the attributes of chosen alternatives, especially so for the relatively minor attributes.

On the other hand, winnowing processes may not be involved in multiattribute choice. Instead a choice might be made in a single step rather than in a series of successive winnowings. If so, then differential memory for attributes does not seem likely. Without winnowing, given attributes would receive essentially the same amount of attention and processing across alternatives. Some important attributes would receive considerable attention and more minor attributes might or might not receive attention. Hence, memory for minor attributes of alternatives might be either good or poor on the whole, but there would be no reason to expect it to be good or poor contingent upon the relative desirability of the alternative.

Our experimental manipulations are designed to affect the amount and difficulty of winnowing required to make a choice. This manipulation of the winnowing process is in turn assumed to affect the degree to which relatively minor attributes are used in the choice process. One such manipulation is the number of alternatives which must be chosen. If a winnowing process is used, choosing, say, three alternatives should require the processing of fewer attributes than choosing a single alternative. A similar manipulation is the density of good alternatives in the choice set. Again, assuming a winnowing strategy, selecting the best alternative from a set containing only one good alternative should require the processing of fewer attributes than selecting the best alternative from a set containing many good alternatives. In the latter case, unless a "satisficing" strategy (Simon, 1957, 1976) is used, additional attributes must be processed in order to winnow the set of good alternatives to a single choice.

All the studies reported in this paper used the same general paradigm. We present subjects with written descriptions of alternatives, including both major (important) and minor (relatively unimportant) attributes of each alternative. We vary the choice task (some subjects must choose the one best alternative while other subjects must choose the three best alternatives) and/or the structure of the set of alternatives (the density of good alternatives in the choice set) so as to require different degrees of information processing of the minor attributes if winnowing is used. We then give an unannounced cued recall test to assess differential memory as a function of relative desirability of the alternative.

The context of our cover story is automobile choice because it allows the easy construction of hypothetical alternatives varying on a number of major and minor attributes with which subjects are familiar. To ensure that all subjects were using the same basis for evaluating the cars, we asked them to recommend choice(s) for a rental car agency according to instructions in a memo from the company president. The memo asked the buyer to maximize certain attributes (the major attributes). All car descriptions also contained information on other attributes not mentioned in the president's memo (the minor attributes).

EXPERIMENT 1

The basic manipulation in Experiment 1 was whether one alternative or three alternatives were to be chosen. The alternative set was constructed so that consideration of only three attributes defined as major by the memo from the president of the rental agency was sufficient to identify the three best cars. Those subjects instructed to choose only one car had the problem of further winnowing this set of three good alternatives to a single choice. They could either choose randomly (as in a satisficing model) or they could use the additional information about relatively minor attributes to make the final choice. In the latter case, the winnowing process requires the better alternatives to be processed more extensively and in greater detail than the obviously bad alternatives. Hence, the expectation is that minor attributes will be processed little if at all in the Choose 3 condition but will be processed much more extensively in the Choose 1 condition. This extra processing of minor attributes in the Choose 1 condition will be concentrated in the good alternatives which were not eliminated on the basis of their standing on the major attributes. Therefore, the prediction based on the winnowing process is that there will be better memory for car features in the Choose 1 than in the Choose 3 condition, but only for better alternatives. The prediction for a simple choice model not involving winnowing is that memory will not vary as a function of choice condition or car desirability.

Method

Each subject read descriptions of 15 hypothetical cars. Each car was presented on a separate page with a paragraph describing the car in terms of three major attributes (gas mileage, comfort, reliability) and with a list of whether eight minor attributes (door edge guards, body stripes, three-speed windshield wiper, tinted glass, rear-window defogger, guidematic headlight control, low-fuel indicator, and automatic parking brake release) were or were not included in the standard model. A sample description of one of the cars appears in Appendix A. The set of 15 cars was constructed so that three of the automobiles were good on all three major attributes, and all others were deficient on one or more of the major attributes. Each car had exactly five (and, consequently, did not have three) of the eight minor features. Which features were present and which absent was determined randomly.

Subjects were students enrolled in an introductory psychology course fulfilling a research participation requirement. They were instructed to assume the role of a buyer for a rental car agency with the task of making a purchase recommendation to the company president. Subjects then read the instructions from the president. These instructions emphasized that this company's customers wanted good gas mileage, comfort, and reliability. The president's instructions also indicated the number of cars to be recommended for purchase, either one or three. Finally, the president's instructions emphasized that the subject would be asked to justify his or her recommendation(s). Half of the 34 subjects were randomly assigned to the Choose 1 condition and the other half to the Choose 3 condition.

After reading the president's instructions each subject was given a packet of 15 automobile descriptions, each description on a separate page which could be sorted. Subjects were given as much time as they desired to study the 15 automobile descriptions and they were given a form which could be used for taking notes if desired. When subjects indicated that they were ready to make their recommendation the experimenter recorded the time and gave them a form for recording their choice(s).

After making their recommendation(s), subjects completed a cued recall memory task about which they had not been warned. Subjects were presented with the name and the paragraph description of each car and were asked to indicate for each of the eight minor attributes whether the car did or did not have that feature.

The dependent variable is memory for presence or absence of the minor attributes. With only two possibilities, subjects could obviously produce some correct answers just by guessing. A memory score[1] was computed to correct for guessing. If $p(P)$ is the proportion of present features correctly identified as being present and $p(A)$ is the proportion of absent features correctly identified as being absent, then the memory score is given by

$$\text{memory score} = p(P) - [1 - p(A)] = p(P) + p(A) - 1.$$

Random guessing implies $p(P) = 1 - p(A)$, so if subjects were guessing the memory score would equal zero, on average. Better performance than guessing would be reflected in positive memory scores. Separate average memory scores were computed for each subject for the best three and for the worst three alternatives; the worst three cars were clearly dominated on the major attributes by all the other alternatives.

Memory scores were analyzed in a 2 × 2 mixed design with the between variable being choice task (Choose 1 vs Choose 3 instructions) and

[1] All analyses reported in this paper were also replicated using d' scores derived from the signal detection model. The results for d' were identical so the conceptually simpler memory score is used throughout for reporting the results.

the within variable being relative car desirability (best three cars vs worst three cars as defined by standing on the three attributes defined as important in the president's memo).

Results

Consistent with the construction of the stimuli on the major attributes, 100% of the subjects in the Choose 1 condition chose one of the best three cars and 100% of the subjects in the Choose 3 condition chose at least two of the best three cars. This indicates that subjects did pay attention to the stimulus materials and the instructions in making their choices. The average memory scores are displayed in Fig. 1 as a function of choice task and car desirability. As expected from a winnowing process, the interaction between choice task and relative car desirability is significant, $F(1,32) = 6.55$, $p < .025$. A detailed analysis of the interaction using a specific contrast to compare the mean memory score for the best three cars for those subjects in the Choose 1 condition against all the other cells, $F(1,32) = 28.3$, $p < .001$ for a Scheffé comparison, indicates that the best memory for minor attributes occurred in the Choose 1 task for the set of the three best cars. In fact, the only condition for which memory is significantly better than guessing is for the best cars in the Choose 1 task. Evidently, only in the winnowing process required to reduce the set of three best cars to a single recommendation was the pro-

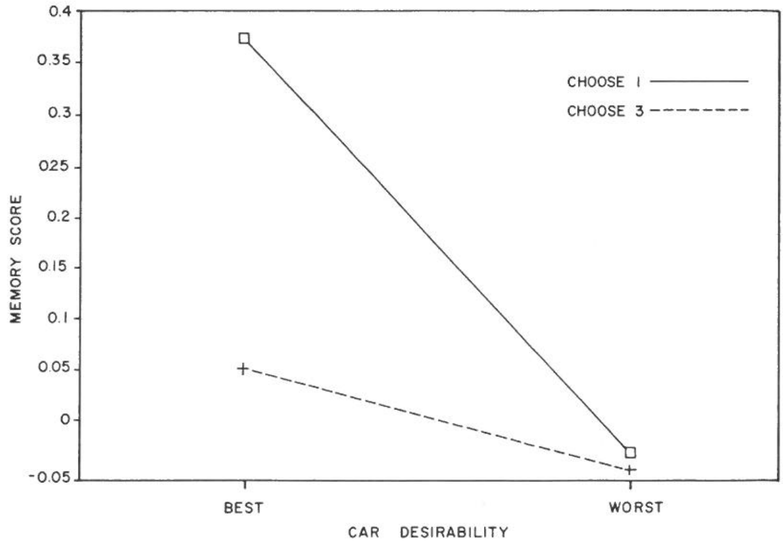

FIG. 1. Memory score (corrected for guessing) as a function of choice task and relative desirability for Experiment 1.

cessing of the minor attributes sufficient to allow them to be remembered.

It is worth exploring the condition in which memory was better than guessing with a more detailed analysis. In the winnowing process for the Choose 1 condition, the alternative chosen, being the survivor, should have been processed more extensively than any of others, but only slightly more than the last alternatives to be eliminated. In fact, one could argue that the last alternative to be winnowed receives just as much processing as the chosen alternative. But Johnson and Russo (1984) suggest there is a one-sidedness effect such that the chosen alternative receives even more attention. Is there a difference in memory for the chosen alternative versus the two rejected cars in the set of the best three? Although the means were in the direction of the one-sidedness effect (.45 for the chosen automobile, .29 for the two rejected cars), the difference was not statistically significant, $F(1,16) = 1.26$, $p > .25$.

With only subjects in the Choose 1 condition for the best three cars doing better than chance, it is clear that many subjects were guessing. It is therefore interesting to examine the bias in guessing. Figure 2 presents the proportion of "Present" responses as a function of choice task and car desirability. For the minor attributes of the best cars subjects responded "Present" 64% of the time and for the worst cars only 48%; this difference is significant, $F(1,32) = 15.3$, after an appropriate variance-stabilizing transformation for proportions, $p < .001$. This is especially true, interaction $F(1,32) = 6.2$, $p < .025$, for the Choose 3 condition: 70% "Present" responses for the best cars and 43% for the worst cars. The earlier analysis showed that for the Choose 3 condition memory was not better than guessing for either car type. Thus, when subjects cannot remember the presence or absence of a minor feature they tend to make a guess which is congruent with the relative desirability of the car as determined by the major attributes. This is equivalent to a subjective correlation between major and minor attributes.

It is important to ask whether the better memory exhibited by those subjects in the Choose 1 condition for the set of three best cars might simply be due to longer time studying the car descriptions. The average time to make a recommendation did not differ significantly (22.2 min for Choose 1, 22.1 min for Choose 3, $F(1,32) = 0.007$, $p > .85$). This of course does not imply that the distribution of time across the stimulus components was the same in both conditions.

EXPERIMENT 2

Results of Experiment 1 demonstrate that minor attributes were processed in the Choose 1 condition sufficiently to be remembered but were

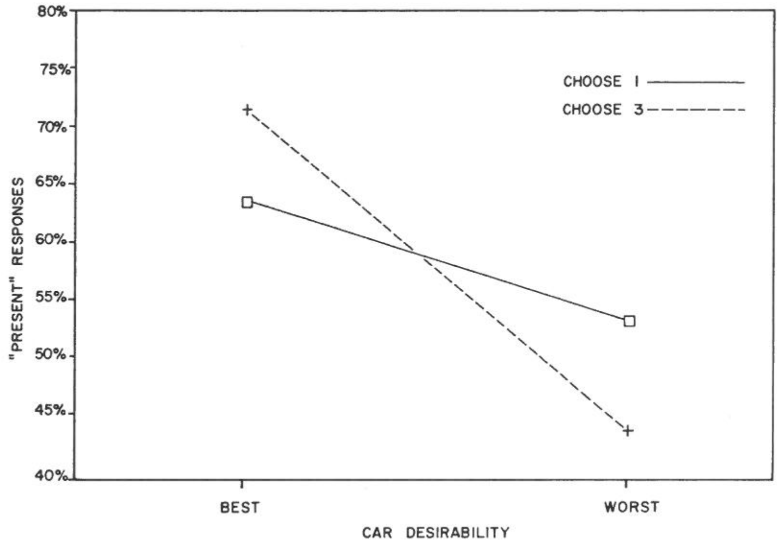

FIG. 2. Likelihood of "Present" responses as a function of choice task and relative desirability for Experiment 1.

at best superficially processed in the Choose 3 condition. However, the Choose 1 vs Choose 3 difference is a rather gross manipulation and the Choose 3 condition may also be an unusual choice task. A more subtle and more natural manipulation of degree of winnowing is changing the density of good alternatives in the choice set. If the task is to Choose 1 and there is one alternative that clearly dominates all the others on the major attributes, then there will in a winnowing model be little or no need to process the information about the minor attributes. However, if there are several good alternatives (as in the first experiment), then the winnowing process will require more extensive consideration of the minor attributes.

In this experiment we altered the set of alternatives so that for half of the subjects there was one dominating alternative and for the other half there were three alternatives which dominated all the others but not each other. That is, there was either a sparse or dense set of good alternatives. As a replication, we also gave half of the subjects the Choose 1 instructions and the other half the Choose 3 instructions. Thus, half of Experiment 2, the half with the dense set of alternatives, was an exact replication of Experiment 1.

The expectation for the Choose 1 task based on winnowing is that only those choosing from the set with three good alternatives will have better memory for the minor attributes. Those choosing one from the set of alternatives with a clear winner should have no better memory than those in the Choose 3 condition in the first experiment because extra processing in a winnowing stage is not required.

Note that those in the Choose 3 condition have a difficult problem when choosing from the sparse choice set which has one dominating alternative. Those subjects must somehow select two other alternatives which are deficient on one of the major attributes. Alternatives that they would like to eliminate cannot be eliminated because of the requirement to make three recommendations. They may resolve this entirely in terms of tradeoffs between the major attributes or they may resort to the minor attributes to do the final eliminations. Thus, we expect some, but not very much, memory for the Choose 3 condition for the sparse set of alternatives with one dominating alternative.

Method

The basic materials, instructions, and procedures are the same as those for Experiment 1. Half of the 40 subjects received the same set of 15 hypothetical cars as used in the first study. The other half received a set of 15 cars structured so that only one alternative was tops on all three major attributes emphasized by the company president. The analysis is based on a $2 \times 2 \times 2$ mixed design with two between factors—choice task (Choose 1 vs Choose 3) and choice set density (dense, no dominating alternative vs sparse, one dominating alternative)—and one within factor—car desirability (best three vs worst three). Memory scores corrected for guessing were computed as in Experiment 1.

Results

Consistent with condition and the construction of the stimuli on the major attributes, for the sparse condition 87% of the subjects with the Choose 1 task chose the best car and 95% of those with the Choose 3 task included the best car in their chosen set of three; for the dense condition, 100% of the subjects with the Choose 1 task chose one of the best three cars and 90% of those with the Choose 3 task included at least two of the three best cars in their chosen set of three. This again indicates that subjects were paying attention to the stimulus materials and instructions in making their choices.

The average memory scores are displayed in Fig. 3 as a function of choice task, choice set density, and car desirability. For the dense choice set, which is the exact replication of Experiment 1, the previous results are reproduced: memory is best for features of the top three cars in the Choose 1 condition (for the specific contrast, $F(1,56) = 9.9$, $p < .005$). For the sparse choice set, as expected, the superior memory in the Choose 1 condition disappears (choice task $\times$ choice set density interac-

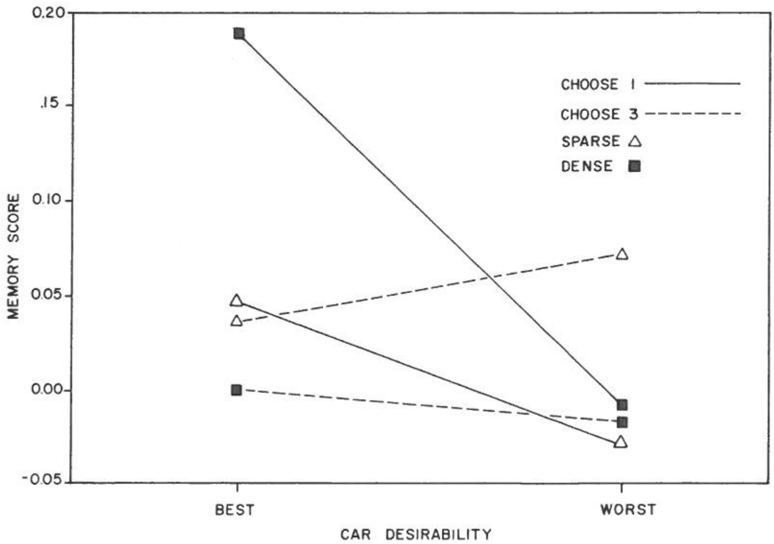

FIG. 3. Memory score (corrected for guessing) as a function of choice task, choice set density, and relative desirability for Experiment 2.

tion, $F(1,56) = 4.2$, $p < .05$). For the Choose 3 task in the sparse choice set in which some subjects were expected to use the minor attributes to make their difficult choice, there is a suggestion of better than chance memory; however, this effect is not reliable, $F(1,56) = 2.7$, $p < .15$.

As in Experiment 1, the Choose 1 condition was the only condition for which memory was better than guessing for the best cars, but only in the dense choice set. It is again worthwhile to perform a more detailed examination of memory for the best alternatives in this one condition. For this experiment there is a significant difference between memory for attributes of the chosen alternative and memory for attributes of the two alternatives not chosen (mean for chosen cars is .55 and, for unchosen cars in the set of the best three, $-.03$, $F(1,14) = 37.4$, $p < .0001$). All of the superior memory for this condition can be attributed to better memory for the minor attributes of the chosen car; this is a strong one-sidedness effect.

It is again important to ask whether these differences could be due to differential study time. A 2 x 2 (choice task $\times$ choice set density) between-subjects analysis of variance revealed a significant main effect for choice task, $F(1,56) = 5.9$, $p < .025$. However, the interaction corresponding to the memory effect is not significant, $F(1,56) = 0.3$, $p > .50$, and the significant main effect is in the opposite direction expected to produce better memory. The average time to study the materials and reach a decision in the Choose 1 condition, which produced the better memory for the best cars, is 18 min versus 21.6 min for the Choose 3 condition. In this case, it is clearly the type and distribution of processing and not the total amount of processing that facilitates better memory for the minor attributes.

EXPERIMENT 3

The previous two studies demonstrate that variations in the choice task and the structure of the choice set induce differences in information processing which, in turn, affect the memorability of minor attributes. However, the evidence that it is indeed the minor attributes that actually determine the choice is circumstantial. It could be, for example, that the better memory results from study of the chosen alternative after it has been chosen in order to be able to justify the choice. Or, as in the judgment and memory literature, the impact of an attribute on the choice may be independent of its memorability. Experiment 3 was designed to test explicitly whether the minor attributes do determine choice in the Choose 1 condition but not in the Choose 3 condition and whether memory for those minor attributes would parallel their impact on the choice. In this study, one of the three best alternatives has the minor features that are known from a pilot study of comparable subjects to be most desirable. The other two have an equal number of features, but features known to be less desirable. If subjects in the Choose 1 condition do attend to the minor attributes to winnow the three best cars to a single choice, then they ought to chose the car which has the relatively more desirable minor attributes. If the subjects in the Choose 3 condition do not process the minor attributes because they are not needed to winnow the set of alternatives to three, then they should not have access in memory to those minor features after they make their recommendations for the three best cars. Then, if they are asked as a surprise task after the stimulus materials are removed to select the one best car, they should not have access in memory to the minor features and should guess more or less randomly among the three best alternatives. These predictions are tested in the third experiment.

Method

The basic stimulus materials and instructions were as in Experiment 1. The one exception was that minor attributes were not randomly assigned to alternatives. A pilot test with a different but comparable sample of subjects identified 4 options, from a set of 30, which received high desirability rankings and 4 which received low desirability rankings. The 4 most desirable were rear-window defogger (median rank 8), AM–FM radio (4), steel-belted radial tires (4), front-wheel drive (9); the 4 least desirable were coat hooks (25), luggage rack (26), trunk carpet (27), and deluxe wheel covers (26). For each of the 15 hypothetical cars 4 features (i.e., minor attributes) were labeled "present" and 4 were labeled as "absent." The relative desirability of the features assigned varied across cars. One of the automobiles (counterbalanced across subjects and conditions) in the set of the best three (defined by standing on the major attributes) was assigned three of the most desirable features and one of the less desirable features; the two other cars in the best set were assigned three of the less desirable features and one of the more desirable features. Thus, one of the cars in the best set was loaded with the most desirable minor attributes. If subjects were forced to choose among the best three then this loading of desirable features ought to elicit choice of this car. Features were assigned randomly to all the other cars so that each car had exactly 4 minor features.

The only change in procedure was that we asked those in the Choose 3 condition to recommend the one best car after they had indicated that they were ready to make a decision. Thus, all subjects ultimately performed the same choice task although they prepared themselves for different tasks. Half of the 40 subjects were randomly assigned to the Choose 1 condition and the other half to the Choose 3 condition.

Results

The assignment of the most desirable minor attributes to one of the top cars had a strong effect on the choices of those in the Choose 1 condition but no effect for those in the Choose 3 condition. For Choose 1, 80% selected the car with the desirable minor attributes while for Choose 3, only 20% selected that car, $\chi^2(1) = 12.1$, $p < .01$. The 20% for the subjects in the Choose 3 condition does not differ significantly from the 33% expected by chance, binomial $p > .15$. The 20% accuracy contrasts sharply with the high levels of accuracy observed in the previous experiments. This is strong evidence that the minor attributes did determine choice of the best car for those subjects in the Choose 1 condition but not for those in the other condition, who prepared themselves only to recommend three cars.

Do these differences in choice correspond to differences in memory? Figure 4 displays the memory scores, corrected for guessing, as a function of choice task and relative car desirability. There is a significant main effect with the minor features of the best cars being better remembered than the minor features of the three worst cars, $F(1,38) = 15.2$, $p < .001$. As in the previous studies there is a significant interaction between choice task and car desirability, $F(1,38) = 5.5$, $p < .025$, indicating that this is only true for the Choose 1 condition. The negative memory scores, which indicate performance worse than expected by chance (the mean of $-.13$ for the bottom three cars in the Choose 1 condition is significantly

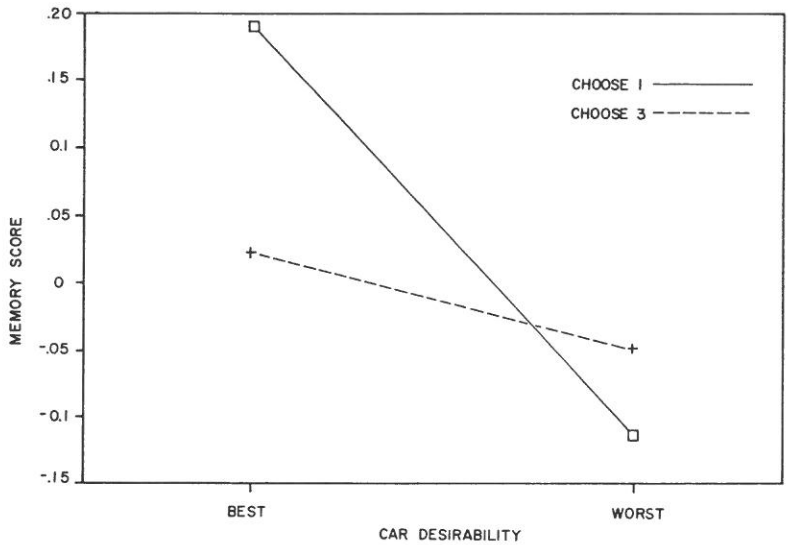

FIG. 4. Memory score (corrected for guessing) as a function of instructed choice task and relative desirability for Experiment 3.

different from 0, $F(1,38) = 7.0$ $p < .025$) is perplexing. We have no theoretical explanation for this unexpected result.

As in the previous experiment, a detailed analysis of memory in the Choose 1 task reveals substantially better memory for the minor attributes of the chosen car from the set of the three best alternatives (.42 for the chosen car, .05 for the two cars not chosen, $F(1,19) = 12.4$, $p < .005$). Once again, better memory in the Choose 1 task cannot be attributed to differential total study time because the means (20.9 min for Choose 1 and 19.0 min for Choose 3) are not significantly different, $F(1,32) = 0.96$, $p > .60$.

DISCUSSION

The three experiments clearly demonstrate that memory for minor attributes of alternatives is dependent upon characteristics of both the choice task and the choice set. Characteristics of choice tasks and choice sets which required more winnowing or made the winnowing more difficult produced better memory for minor attributes. This pattern of results is consistent with expectations based on the winnowing meta-process model of multiattribute choice. In this section we discuss the implications of these results for the relationship between evaluation and memory, consider some alternative explanations for these results, and discuss a few inconsistencies.

Evaluation and Memory

The present results showing a relationship between evaluation and memory stand in marked contrast to the many judgment studies that have found no relationship when judgments are made on-line. Our data are in complete agreement with and represent an extension of the results of Biehal and Chakravarti (1982, 1986) and Johnson and Russo (1984), who have demonstrated a relationship between evaluation and memory for choice tasks. A likely explanation for finding a relationship for choice tasks but not for judgment tasks is that choice invokes different, or at least additional, processes than does judgment. In particular, the hypothesized winnowing meta-process directs attention sufficient for memory to minor attributes only when required by task characteristics (e.g., number of alternatives to be chosen) or choice set characteristics (e.g., density of alternatives). For example, when the set of good alternatives is relatively sparse, minor attributes are not included in the evaluation and hence are not remembered; when the set of good alternatives is relatively dense, they are included and remembered.

The conditional processing of attributes suggested by our results is inconsistent with several choice strategies that have been described in the literature. A simple, one-pass, judgment-serves-choice model in which each alternative is evaluated separately and then the alternative with the best evaluation is chosen is inconsistent with the results of the three studies reported here. Such models provide no mechanism for allowing the evaluation of one alternative to depend upon the evaluation of other alternatives, but such dependency is clearly implied by the conditional processing of attribute information suggested by these results.

Our results also eliminate a class of models involving what we might call a "get the facts straight first" strategy. Using such a strategy, people would first acquire information about the alternatives and form memory representations (whether these representations were organized by alternatives, by attributes, or by both is irrelevant) and then apply their choice process to those memory representations. That is, an external representation would be converted to an internal representation before choice (Biehal & Chakravarti, 1986). Experiment 3 shows that this strategy is not used. The representations formed by those who prepared themselves for the Choose 3 task were inadequate to allow them to choose the best alternative, which was selected by those with the Choose 1 task. Thus, storage of information depended on the choice task.

It is also interesting to note that our subjects apparently did not use a "satisficing" strategy (Simon, 1957, 1976). Those in Choose 1 conditions could easily find an alternative which would satisfy the requirements of the company president. However, when there was more than one satisfactory alternative in terms of the major attributes, they also considered the minor attributes in order to select the optimal alternative even though the president's memo did not instruct them to do so. Especially convincing is Experiment 3, which demonstrates that the minor attributes are indeed used to make the final choice from among the satisfactory alternatives. This is not a strong rejection of a satisficing model, however, because the costs of considering the additional information were not high. Nevertheless, it is striking that subjects did attempt to optimize when they could.

Inconsistencies and Alternative Explanations

Although the general pattern of results is consistent with a winnowing process, one detailed aspect of the results is inconsistent. The inconsistency is that the superior memory in Choose 1 conditions is due almost entirely to better memory for the one chosen car. In Experiments 2 and 3 memory for the two rejected cars in the set of the best three was not better than chance. This is inconsistent because the winnowing process among the last three good alternatives should require almost as much attention to the minor attributes of the rejected alternatives as to those of the chosen alternative. If increased attention produces better memory, then there should be some but not major differences in memory for the best three alternatives. We know from Experiment 3 that the minor attributes of the three best cars were processed because they had a dramatic influence on choice. Why then were they not remembered for the two good cars that were not chosen?

One possible explanation is that the better memory for aspects of the chosen car resulted from further study of the chosen car in order to be able to justify the choice to the company president. That is, the better memory resulted not from processing of the minor attributes during choice but rather from additional processing or rehearsal after the choice was made. This explanation seems unlikely because there would be no reason to presume that those in Choose 3 conditions would not also study the minor attributes post-choice in order to justify their decision. Memory scores no better than chance in all the Choose 3 conditions suggest that this is not the case.

A weaker form of the justification explanation is that those in the Choose 1 condition base their choice on the minor attributes but then only rehearse those aspects of the chosen alternative which support their choice. Those in the Choose 3 conditions did not use the minor attributes and so had nothing to rehearse for those attributes. This suggests that subjects in the Choose 1 condition intended to support their choice absolutely rather than relatively because, without memory for the minor attributes of the two rejected cars, relative comparisons are impossible. If the process used to make the choice is relative, as implied by winnowing, then it is surprising that subjects appear to prepare to justify that choice absolutely rather than relatively. However, this may indeed be what subjects do. That would be generally consistent with studies in concept formation (e.g., Bourne, 1974; Bourne & Guy, 1968) and logical problems (e.g., Johnson-Laird & Wason, 1970; Wason, 1960) which have shown a bias to rely on positive, confirming instances rather than negative, disconfirming arguments.

Given that memory for the minor attributes of the chosen alternative is not perfect, an explanation of why the better memory is concentrated in just the chosen alternative will probably require investigation of the precise kinds of information that are remembered. Is it the inconsistent information (i.e., the missing features on an otherwise excellent alternative) which is better remembered against a background of positive information? Or are the features that are present remembered better because they can be used to justify the choice? Unfortunately, our design cannot answer these questions because it was not possible to correct for guessing separately for the present and absent aspects. A useful next step would therefore be the use of designs which could distinguish memory for present features versus memory for absent features. There is clearly much more to understand about the relationship between evaluation and memory.

Other Implications

The effect of choice set density on the use of minor attributes demonstrated in Experiment 2 makes it interesting to consider the density of choice sets for real multiattribute decision problems. For some consumer choices such as automobiles, the choice set is very dense. Given almost any set of attributes to be considered important for those choices, it is possible to find a rather large set of alternatives satisfying requirements on those attributes. The consumer must therefore resort to minor and maybe even trivial aspects in order to make a choice. For other choices for which the set of good alternatives is rather sparse, minor attributes would be expected to play almost no role in the choice process.

CONCLUSION

Understanding the complex cognitive and memorial processes involved in multiattribute choice requires the use of many different techniques and dependent variables to examine different facets of the total process. This study demonstrates the usefulness of testing memory following choice tasks. Our results are in general agreement with hypotheses derived from a winnowing meta-process model for choice, but the detailed analysis showing that the better memory was almost exclusively concentrated in the chosen alternative suggests that such models cannot entirely account for the data.

APPENDIX A

Sample Automobile Description

Mirage

The Mirage has been billed as this year's truly fuel-efficient automobile. The 1984 EPA mileage estimates for the Mirage are 36 mpg, 44 estimated highway. Mirage is a large luxury sedan which will carry five people in comfort and all of their luggage in the rear storage compartment. Many individualistic "touches" have been added to the interior to promote comfort. The Mirage is the commonsensical car to buy if outstanding reliability is desired. The Mirage has proven itself over and over again to be a practically maintenance-free automobile.

	Standard option
1. Door edge guards	Yes
2. Body stripes	Yes
3. Three-speed windshield wiper	No
4. Tinted glass	Yes
5. Rear-window defogger	Yes
6. Guidematic headlight control	No
7. Low-fuel indicator	No
8. Automatic parking brake release	Yes

REFERENCES

Anderson, N. H., & Hubert, S. (1963). Effects of concomitant verbal recall on order effects in personality impression formation. *Journal of Verbal Learning and Verbal Behavior*, **2**, 379–391.

Beattie, A. E., & Mitchell, A. A. (1985). The relationship between advertising recall and persuasion: An experimental investigation. In L. F. Alwitt & A. A. Mitchell (Eds.), *Psychological processes in advertising effects*. Hillsdale, NJ: Erlbaum.

Bettman, J. R., & Park, C. W. (1980). Effects of prior knowledge and experience and phase of the choice process on consumer decision processes: A protocol analysis. *Journal of Consumer Research*, **7**, 234–248.

Biehal, G., & Chakravarti, D. (1982). Information-presentation format and learning goals as determinants of consumers' memory retrieval and choice processes. *Journal of Consumer Research*, **8**, 431–441.

Biehal, G., & Chakravarti, D. (1986). Consumers' use of memory and external information in choice: Macro and micro perspectives. *Journal of Consumer Research*, **12**, 382–405.

Bourne, L. E., Jr. (1974). Stimulus selection and memory strategies in concept problems. *Memory and Cognition*, **2**, 270–274.

Bourne, L. E., Jr., & Guy, D. E. (1968). Learning conceptual rules: II. The role of positive and negative instances. *Journal of Experimental Psychology*, **77**, 488–494.

Dreben, E. K., Fiske, S. T., & Hastie, R. (1979). The independence of item and evaluative information: Impression and recall order effects in behavior-based impression formation. *Journal of Personality and Social Psychology,* **37**, 1758–1768.

Einhorn, H. J., & Hogarth, R. M. (1981). Behavioral decision theory: Processes of judgment and choice. *Annual Review of Psychology,* **32**, 53–88.

Hastie, R., & Park, B. (1986). The relationship between memory and judgment depends on whether the judgment task is memory-based or on-line. *Psychological Review,* **93**, 258–268.

Johnson, E. J., & Russo, J. E. (1984). Product familiarity and learning new information. *Journal of Consumer Research,* **11**, 542–550.

Johnson-Laird, P. N., & Wason, P. C. (1970). A theoretical analysis of insight into a reasoning task. *Cognitive Psychology,* **1**, 132–148.

Lichtenstein, M., & Srull, T. K. (1985). Conceptual and methodological issues in examining the relationship between consumer memory and judgment. In L. F. Alwitt and A. A. Mitchell (Eds.), *Psychological processes and advertising effects: Theory, research, and application.* Hillsdale, NJ: Erlbaum.

Olshavsky, R. W. (1979). Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational Behavior and Human Performance,* **24**, 300–316.

Onken, J., Hastie, R., & Revelle, W. (1985). Individual differences in the use of simplification strategies in a complex decision-making task. *Journal of Experimental Psychology: Human Perception and Performance,* **11**, 14–27.

Payne, J. W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational Behavior and Human Performance,* **16**, 366–387.

Payne, J. W. (1982). Contingent decision behavior. *Psychological Bulletin,* **92**, 382–402.

Riskey, D. R. (1979). Verbal memory processes in impression formation. *Journal of Experimental Psychology: Human Learning and Memory,* **5**, 271–281.

Simon, H. A. (1957). *Models of man: Social and rational.* New York: Wiley.

Simon, H. A. (1976). *Administrative behavior: A study of decision-making processes in administrative organizations* (3rd ed.). New York: The Free Press.

Tversky, A. (1972a). Elimination by aspects: A theory of choice. *Psychological Review,* **79**, 281–299.

Tversky, A. (1972b). Choice by elimination. *Journal of Mathematical Psychology,* **9**, 341–367.

Tversky, A., & Sattath, S. (1979). Preference trees. *Psychological Review,* **86**, 542–578.

Wason, P. C. (1960). On the failure to eliminate hypotheses in a conceptual task. *Quarterly Journal of Experimental Psychology,* **12**, 129–140.

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