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Confirmatory Search and Asymmetric Dominance†

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ABSTRACT

Decision makers use confirmatory search strategies in judgment tasks. As a result of this, their attention towards task-relevant cues is biased in favor of cues supporting available responses. Changing these responses can alter the cues used in the judgment task and, subsequently, alter beliefs. We use this mechanism to predict and explain the emergence of the asymmetric dominance effect in judgment. In four sets of experiments, we document systematic changes in belief, as dominated options are added to the response set. These effects emerge for a number of naturalistic judgment tasks and are mediated by the increased accessibility of decoy-supporting cues. Finally, these effects can be eliminated when the decision maker's attention is drawn towards the cues supporting the non-dominant response. Copyright © 2014 John Wiley & Sons, Ltd.

KEY WORDS confirmation bias; decoy effects; judgment; cue accessibility; asymmetric dominance

INTRODUCTION

Which of the following contains the most number of calories? A. 20 oz of Sprite, B. 20 oz of Coca-Cola, or C. 16 oz of Sprite. If humans have fixed beliefs, beliefs that are independent of irrelevant contextual factors, then answers to this question should not depend on the availability of C as a response option. This, however, is not the case. In an experiment presented in this paper, we observed that the proportion of participants selecting option A saw a large and significant increase when participants were asked to choose between response options A, B, and C, relative to when they were asked to choose only between options A and B.

Findings such as the one illustrated here have been studied extensively with regard to preferential choice (Huber, Payne, & Puto, 1982; Huber & Puto, 1983). This research finds that adding or removing irrelevant alternatives—or decoys—from the set of available choice options can alter preferences. Recently, psychologists have begun extending this research to inference and judgment (Choplin & Hummel, 2005; Maylor & Roberts, 2007; Trueblood, 2012; Trueblood, Brown, & Heathcote, in press; Trueblood, Brown, Heathcote, & Busemeyer, 2013). As in the domain of preferential choice, this work finds that adding or removing irrelevant alternatives from the set of available responses can alter stated beliefs. Besides outlining the specific settings in which human judgment violates assumptions of rationality, understanding these effects can provide valuable insights regarding both the cognitive mechanisms underlying the formation of belief, and the relationship between these mechanisms and the various contextual factors involved in a judgment task.

This paper studies these cognitive mechanisms. We propose that decoy effects, such as the one discussed here, are products of confirmatory search processes (Klayman, 1995; Nickerson, 1998). The decision maker's memory and attention is biased towards cues supporting the responses in consideration. Adding an irrelevant decoy to the set of available responses can increase the accessibility of cues that support the decoy response. If the decoy is dominated by one of the core responses, then these cues also support the dominating response. This can alter the relative selection probabilities of the core responses, generating changes in stated belief.

CONFIRMATORY SEARCH AND DECOY EFFECTS

Confirmatory search is a very important determinant of thought and behavior, one with a long history of research in psychology. It typically refers to an unintentional selectivity in the acquisition and use of evidence that supports a focal hypothesis (Klayman, 1995; Nickerson, 1998). This selectivity can generate a disposition towards accepting the focal hypothesis, and changing the focal hypothesis can lead to changes in stated beliefs. Confirmatory search provides a rich and compelling explanation for a range of findings on hypothesis testing, information search and interpretation, and formal reasoning (Klayman & Ha, 1987; Koriat, Lichtenstein, & Fischhoff, 1980; Wason, 1960).

Recently, confirmatory search has also been used to explain decision-making anomalies such as the anchoring effect and the endowment effect. According to confirmatory search explanations for anchoring, memory and attention is biased towards cues that support the numerical anchor. This leads to an overall predisposition towards selecting responses close to the anchor, generating the anchoring effect (Chapman & Johnson, 1994, 1999; Strack & Mussweiler, 1997). Attention is similarly directed towards attributes supporting the endowed option, leading to an overall preference for the endowed option, thereby generating the endowment effect (Bhatia, 2013; Carmon & Ariely, 2000; Johnson, Häubl, & Keinan, 2007).

The dependence of information accessibility on the responses offered to the decision maker is also a key feature of bidirectional decision making. Research in this domain finds that the reliance on cues supporting preferred options

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increases during the decision (Glöckner, Betsch, & Schindler, 2010; Russo, Carlson, & Meloy, 2006; Simon, Krawczyk, & Holyoak, 2004). This can explain the sensitivity of final responses to the options offered at the start of the decision, as well as shifts in preferences and beliefs over the time course of the decision process (e.g. see Holyoak & Simon, 1999).

In this paper, we use the confirmatory search mechanism to study the dependence of belief on the set of response options offered to the decision maker in everyday cue-based judgment tasks. This type of dependence has been established in the domain of preferential choice, through a phenomenon known as the asymmetric dominance effect (Huber & Puto, 1983; Huber et al., 1982; Pettibone & Wedell, 2000, 2007). According to the asymmetric dominance effect, the addition of a decoy choice option that is inferior on all attributes compared with one of the initial options but not compared with the other can lead to an increase in the preference for the first, dominant option (the target), compared with the second, non-dominant option (the competitor). This effect has also recently been established in cue-based judgment and perceptual judgment tasks. Particularly, Trueblood (2012) and Trueblood et al. (in press) found that criminal judgments involving two suspects can be reversed if a third suspect, dominated in cue values by one but not the other of the initial suspects, is added to the consideration set. Likewise, Trueblood et al. (2013) found that judgments of relative magnitude of two shapes can be affected if a third shape with smaller length and width than one but not the other of the initial shapes is added to the consideration set (see also Choplin & Hummel, 2005).

Can confirmatory search processes predict the emergence of the asymmetric dominance effect in judgment? If memory and attention is biased towards the cues supporting the available responses, as suggested by research on the confirmation bias (Klayman, 1995; Nickerson, 1998), then adding novel decoy responses can alter the cues used in the judgment. Particularly, cues supporting the decoy option will be more likely to be recalled and attended to in the presence of the decoy than in the absence of the decoy. If these cues also support one, but not the other, of the core responses—as is the case with asymmetric dominance—then the relative selection probabilities of the core responses can change.

Consider, for example, the question presented at the start of this paper. Let us assume that decision makers are asked whether 20 oz of Sprite or 20 oz of Coca-Cola have the most calories. This question prompts the decision makers to think about which drink has higher calories. As decision makers are predisposed towards confirmatory search (which directs attention to cues supporting the available responses), they are likely to attend to cues supporting 20 oz of Sprite as a high calorie drink and to cues supporting 20 oz of Coca-Cola as a high calorie drink, and then to use these cues to determine their final response. Now, when the third option, 16 oz of Sprite, is added to the response set, the relative attention towards these cues can change. Again, because decision makers are likely to attend to cues supporting the available responses, they focus on cues supporting 20 oz of Sprite as a high calorie drink, to cues supporting 20 oz of Coca-Cola as a high calorie drink, and also to cues supporting 16 oz of Sprite as a high calorie drink. The cues that support 16 oz of Sprite as the correct response also support 20 oz of Sprite as the correct response, and thus, the cues supporting high calories in Sprite are more likely to be accessible when 16 oz of Sprite is included in the response set, compared with when it is not. This can lead to an increase in the response probability for 20 oz of Sprite, compared with 20 oz of Coca-Cola.

More abstractly, in a judgment involving two response options $\boldsymbol{x}$ and $\boldsymbol{y}$, decision makers are likely to focus on the set of cues that support option $\boldsymbol{x}$ (written as $\boldsymbol{C_x}$) and the set of cues that support option $\boldsymbol{y}$ (written as $\boldsymbol{C_y}$). When a third decoy response option, $\boldsymbol{d}$, is added to the response set, the attention towards the cues can change. Particularly, decision makers are also now likely to focus on the set of cues supporting option $\boldsymbol{d}$, written as $\boldsymbol{C_d}$. If $\boldsymbol{d}$ is dominated by $\boldsymbol{x}$ but not $\boldsymbol{y}$, then $\boldsymbol{C_d}$ is a subset of $\boldsymbol{C_x}$ but not $\boldsymbol{C_y}$. Subsequently, increased attention to the cues in $\boldsymbol{C_d}$ generates increased attention towards cues in $\boldsymbol{C_x}$ (or more specifically to the cues that $\boldsymbol{C_x}$ shares with $\boldsymbol{C_d}$). This does not generate any increased attention towards cues in $\boldsymbol{C_y}$. This can bias responses in favor of $\boldsymbol{x}$ relative to $\boldsymbol{y}$.[1]

While there are existing theories that can predict the emergence of the asymmetric dominance effect in judgment (Pettibone & Wedell, 2000, 2007; Roe, Busemeyer, & Townsend, 2001; Wedell & Pettibone, 1996), confirmatory search mechanisms make unique predictions regarding process-level measures and outcomes in the judgment task. For example, if confirmatory search is the cause of the asymmetric dominance effect, then decision makers in a cue-recall task should be more likely to list cues supporting the decoy (which also support the target) compared with cues supporting the competitor, when the decoy is included in the response set. Additionally, experimentally increasing the accessibility of memory cues supporting the competitor should eradicate the asymmetric dominance effect.

We present four sets of experiments that used these predictions to test the role of confirmatory search in the asymmetric dominance effect for judgment. In Experiment 1, we observed the emergence of the asymmetric dominance effect for a number of naturalistic, everyday judgments, and in Experiment 2, we observed this effect when the information supporting the response options was explicitly presented to the decision maker. In Experiment 3, we used a cue-recall task to show that memory biases mediate the effect of the asymmetrically dominated response options on response probabilities. Finally, in Experiment 4, we found that experimentally manipulating the accessibility of the memory cues available to the decision maker removed the asymmetric dominance effect.

[1]This could be further extended to settings with continuous cue values. Here, confirmatory search would predict that the probability of attending to a cue is proportional to the total amount of support the cue provides to the responses in consideration. Cues that have high values for the available responses would be more likely to be attended to and would subsequently play a larger role in the judgment process. Note that such a model has been proposed by Bhatia (2013) and is discussed in more detail at the end of this paper.

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EXPERIMENT 1

The asymmetric dominance effect has recently been shown to emerge in judgment tasks. This work either uses perceptual stimuli (Trueblood et al., 2013) or else uses a multi-cue design similar to previous choice experiments (Trueblood, 2012; Trueblood et al., in press). With perceptual stimuli, participants are asked to make judgments of magnitude involving different shapes, with dominated decoys having lower values than the target on dimensions such as width and length (see also Choplin & Hummel, 2005). In multi-cue judgment, participants are asked to make judgments involving different response options, with each response option having a numeric value on one of two cues. The asymmetrically dominated decoy has a lower numeric value than the target on both these cues but has a higher numeric value than the competitor on one of these cues.

Both perceptual and multi-cue questions are useful for demonstrating the existence of the asymmetric dominance effect for judgment. However, they are very different from the types of responses used in everyday judgment tasks. Studying naturalistic questions is fundamental for establishing the relevance of the asymmetric dominance effect in everyday judgment. These options are also often more conducive for exploring the cognitive process underlying judgment. In Experiment 1, we tested for the emergence of the asymmetric dominance effect in everyday judgment tasks, ones in which response options display a naturalistic dominance structure, rather than the experimentally constructed dominance structure used in prior work (see also Windschitl & Chambers, 2004, for related work involving naturalistic inference questions).

Method

One hundred and forty-three US college students ($M_{age} = 21.71$, $SD_{age} = 4.87$, 63% female) participated for course credit. Participants were presented with 15 different questions involving everyday judgments. The order that these questions were presented in was randomized across participants. Eight of these questions served as filler questions, and contained two or three non-dominated responses. The remaining seven questions were of interest for our analysis. These questions pertained to judgments of both magnitude and probability, and covered areas as diverse as food and drink calories, sports outcomes, music trivia, relative travel times, city and state populations, and geographical distances. All questions were answered on a computer screen in a laboratory cubicle, and participants were unable to consult external sources to answer these questions.

Each participant was randomly given one of three response sets for each of these seven questions. These response sets consisted of two core responses (control condition), two core responses and a decoy dominated by the first core response (decoy-1 condition), or two core responses and a decoy dominated by the second core response (decoy-2 condition). The order of the 15 questions, as well as the order in which responses were presented for each of these questions, was randomized across participants. The questions and response sets for the seven non-filler questions are shown in Table 1.

For all of these seven questions, any memory cue indicating that the first decoy is the correct response also indicates that the first core response (but not the second core response) is correct, and any memory cue indicating that the second decoy is the correct response also indicates that the second core response (but not the first core response) is correct. Hence, the asymmetric dominance effect predicts that the proportion of participants selecting the first core response would be highest when the first core response dominates the decoy (decoy-1 condition) and lowest when the second core response dominates the decoy (decoy-2 condition). The proportion of participants selecting the first core response when there is no decoy (control condition) should be between these two extremes.

Table 1. Questions and responses used in Experiment 1

Q#	Which of the following …	Core 1	Core 2	Decoy 1	Decoy 2
1	… has the most number of calories?	20 oz of Sprite	20 oz of Coca-Cola	16 oz of Sprite	16 oz of Coca-Cola
2	… musicians have sold the most records in the USA?	Madonna	Led Zeppelin	Kylie Minogue	Deep Purple
3	… sports events is most likely to happen?	The New England Patriots win at least one of the next three Super Bowls	The Green Bay Packers win at least one of the next three Super Bowls	The New England Patriots win at least one of the next two Super Bowls	The Green Bay Packers win at least one of the next two Super Bowls
4	… has the most number of calories?	McDonald's Big Mac	Three slices of Domino's Medium Hand Tossed Cheese Pizza	McDonald's Hamburger	Two slices of Domino's Medium Hand Tossed Cheese Pizza
5	… takes the longest amount of time?	Driving from Boston to Washington D.C.	Flying from Los Angeles to Miami	Driving from Boston to New York	Flying from Los Angeles to San Francisco
6	… has the largest population?	Texas	California	Houston	Los Angeles
7	… is the largest in terms of distance?	The height of Mount Everest	The length of Manhattan island	The height of Mount McKinley	The width of Manhattan island

Note that Decoy 1 is dominated by Core 1 and Decoy 2 is dominated by Core 2, for every question.

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Table 2. Percentage of participants choosing the first core response in Experiment 1

Q#	Decoy-1 condition	Decoy-2 condition	Control condition
1	24.39	8.47	18.60
2	79.55	67.34	78.72
3	73.81	58.82	70.73
4	58.70	48.00	42.22
5	50.00	29.79	44.68
6	14.58	6.67	12.50
7	77.55	68.18	60.87
Average	54.08	41.04	46.90

Results and discussion

As predicted, the response probability of the first core response was highest when it dominated the decoy response and lowest when the second core response dominated the decoy response. On average, the first core response was chosen 54% of the time when it dominated the decoy response (decoy-1 condition), 41% of the time when the second core response dominated the decoy response (decoy-2 condition), and 47% of the time when decoy responses were not provided to decision makers (control condition). Note that these choice proportions can change based on which of the responses is considered the "first core response" and that the proportions presented here correspond to the responses listed in Table 1. Also, note that a total of 27 responses (out of a total of 1001 responses) involved the selection of a dominated option. These responses are excluded from all analysis in this section.[2]

For each of the seven questions in consideration, we found that the first core response was always more likely to be selected when it dominated the decoy (decoy-1 condition), compared with when the second core response dominated the decoy (decoy-2 condition). Additionally, for five of the seven questions, we found that the choice proportion for the first core response in the absence of a decoy (control condition) was lower than when the decoy was dominated by the first core response (decoy-1 condition) and higher than when the decoy was dominated by the second core response (decoy-2 condition). These results match the predictions of the proposed theory. In the remaining two questions, we found that the choice proportion of the first core response in the absence of a decoy (control condition) was higher than this choice proportion when the second core response dominated the decoy (decoy-2 condition), contradicting the predictions of the proposed theory. Choice proportions for all seven questions are provided in Table 2.

We pooled choices for all questions across all participants together, to test whether the first core response was statistically more likely to be selected when it dominated the decoy compared with when the second core response dominated the decoy or when there was no decoy. Particularly, we ran a logistic regression, with dummy independent variables for the decoy-1 condition and decoy-2 condition, and a dependent variable for the choice of the first core response (first core response chosen = 1; second core response chosen = 0). This regression also included fixed effects on the question level and random effects on the participant level. Our regression indicated that the choice probability of the first core response was significantly higher in the decoy-1 condition, in which the first core response dominated the decoy, compared with the control condition ($\beta = 0.38$, $z = 2.06$, $p < .05$). This regression also indicated that the choice probability of the first core response was marginally lower in the decoy-2 condition, in which the second core response dominated the decoy, compared with the control condition ($\beta = -0.31$, $z = -1.75$, $p < .10$). We also ran a second logistic regression comparing only the decoy-1 and decoy-2 conditions. This had a dummy independent variable for the decoy-1 condition and a dependent variable for the choice of the first core response (first core response chosen = 1; second core response chosen = 0), and indicated that the choice probability of the first core response was significantly higher in the decoy-1 condition compared with the decoy-2 condition ($\beta = 0.71$, $z = 3.76$, $p < .01$). These results further demonstrate the robustness of the asymmetric dominance effect in inference and set the stage for further experiments testing the psychological mechanisms underlying this effect.

EXPERIMENT 2

Experiment 1 provides evidence that the asymmetric dominance effect emerges in naturalistic, everyday judgment. It demonstrates this effect for responses involving magnitudes and responses involving probabilities, in a variety of domains. We wish to test for the asymmetric dominance effect in one more setting, one in which cues are presented explicitly to the decision maker. By presenting the cues used in the judgment, such a setting can rigorously control dominance relationships between the available response options. Such a setting is also useful for observing the cue accessibility biases predicted by the proposed confirmatory search mechanism. These biases will be explored in more detail in Experiment 3.

Method

Seventy-four US college students ($M_{age} = 20.75$, $SD_{age} = 1.62$, 47% female) participated for course credit. Participants were required to select which of two or three hypothetical vacation resorts they believed to be the most popular amongst tourists. Each resort was listed with a number of features that made it desirable as a vacation destination. The resorts and their features are presented in Table 3. Half the participants chose only between the target and the competitor resorts (control condition), whereas the other half chose between all three resorts (decoy condition). The order that the resorts and their individual features were listed was randomized across participants. All questions were answered on a computer screen in a laboratory cubicle, and participants were unable to consult external sources to answer these questions.

Note that the target has all the features of the decoy, in addition to other desirable features that the decoy does not have.

[2]The results of this experiment and the other experiments in this paper do not change if dominated responses are included in the statistical analysis.

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Table 3. Response options and component features used in Experiment 2 and Experiment 3

Target resort	Competitor resort	Decoy resort
- Beautiful natural scenery	- Good weather	- Beautiful natural scenery
- Wildlife excursions	- Beaches	- Wildlife excursions
- Activities for the entire family	- Exciting nightlife	- Activities for the entire family
- Great local cuisine	- Casinos	
- Adventure sports facilities	- Famous spa	

Hence, it can be seen as dominating the decoy. In contrast, the competitor does not contain the features of the decoy and thus cannot be seen as dominating the decoy. Subsequently, the asymmetric dominance effect predicts that the proportion of participants selecting the target would be greater when the decoy is included as a response option (decoy condition) compared with when it is not (control condition).

Results and discussion

As predicted, the response probability of the target resort was higher in the decoy condition than in the control condition. Particularly, only 32% of participants selected the target as the most popular resort, when the decoy was not included in the response set. This proportion more than doubled, to 66%, when the decoy was included in the response set.

For our statistical test, we ran a logistic regression for the effect of condition (decoy condition = 1; control condition = 0) on response (target chosen = 1; competitor chosen = 0). Our regression indicated that the effect of the decoy on responses was statistically significant ($\beta = 1.42$, $z = 2.86$, $p < .01$). One of the participants selected the decoy (which cannot reasonably have a higher popularity than the target). This participant was excluded from the aforementioned analysis.

EXPERIMENT 3

In Experiment 3, we wished to test the psychological mechanisms underlying the asymmetric dominance effect in judgment. The confirmatory search mechanism proposed in this paper states that asymmetric dominance effects emerge because of the effect of decoy options on cue recall and attention. As decision makers are more likely to recall cues supporting the available response options, adding an asymmetrically dominated decoy (whose cues also support one, but not the other, core response options) can alter response probabilities.

We can test the confirmatory search account of asymmetric dominance using process-level data for the judgment. Particularly, if a cue-recall task is embedded into the judgment so that participants have to list all remembered cues before providing their response, then we can observe the cues that are used by participants to form their beliefs. The confirmatory search account of asymmetric dominance predicts that the presence of the decoy option should increase the recall of cues supporting the decoy option. These are cues that also support the target option (but do not support the competitor). This biased recall should subsequently predict the strength of the asymmetric dominance effect so that participants that list more cues supporting the decoy option should also be more likely to select the target.

Method

One hundred and twenty-two participants ($M_{age} = 33.25$, $SD_{age} = 12.99$, 43% female) were recruited from Amazon's Mechanical Turk system and paid \$0.15 for their participation. Participants were presented with the hypothetical vacation resorts used in Experiment 2 and were asked to consider which of these they believed was the most popular amongst tourists (Table 2). Also, as in Experiment 2, half of the participants were only given the target and the competitor resorts (control condition), whereas half were given all three resorts (decoy condition). The asymmetric dominance effect predicts that the proportion of participants selecting the target would be greater when the decoy is included as a response option (decoy condition) compared with when it is not (control condition).

There were two crucial differences between Experiment 3 and Experiment 2. Firstly, participants were not allowed to indicate their response on the screen listing the vacation resorts and their accompanying features. Instead, they were told that they had to consider all the resorts and then give their response on a subsequent screen. After viewing the question, the resorts, and the features of the resorts, participants were taken to a screen in which they were asked to list as many of the features present in the target and competitor (in the control condition) or in the target, competitor, and decoy (in the decoy condition) as they could recall. Participants were required only to list the features that they could remember. They were not required to list which resorts these features belonged to. After completing the recall task, participants were taken to a new screen in which they indicated which of the vacation resorts they believed was the most popular. The features of the available response options were not presented to participants on this screen, and they had to make their judgments based only on their memory of these features.

A second difference between Experiment 3 and Experiment 2 pertained to the display of the response options. In Experiment 2, each resort was presented alongside the features that it possessed. The features that were absent from the resort were not listed alongside the resort. While this does not pose any problems for establishing the existence of the asymmetric dominance effect, it can lead to some confounds when examining whether memory mechanisms are involved in this effect. Particularly, the display in Experiment 2 led to the features of the target resort being listed more frequently in the decoy condition compared with the control condition. This could generate a recall bias due to mere presentation and not only due to confirmatory search.

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In Experiment 3, we modified the display of the three response options so that each resort was listed with every feature involved in the experiment. The features that were contained in the resort were indicated with a check mark. This ensured that each feature was listed the same number of times in the two conditions, thereby controlling for recall effects due to mere presentation. An example of this display for the competitor resort is presented in Figure 1. All resorts were presented sequentially on the same screen, and the order that the resorts were presented in and in which the features were listed was randomized across participants.

Results

Recall

We first tested for the effect of the decoy option on recalled features. Five participants did not list any features and are excluded from the analysis in this section. Additionally, four participants selected the dominated resort. These participants are also excluded from the analysis in this section.

Both conditions have the same total features, and thus, if the decoy option does not affect memory processes, we should not observe differences in recalled features across the two conditions. In contrast, if the decoy option does alter memory, as predicted by the confirmatory search account, features belonging to the decoy option (which also belong to the target) should be more likely to be mentioned in the presence of the decoy than in the absence of the decoy. To test this formally, we defined the variable Relative Recall Bias (RRB), which was equal to the total number of mentioned decoy features over the total number of mentioned features. RRB can range between zero and one, with a value of RRB closer to one indicating that the participant mentioned primarily decoy features and a value of RRB closer to zero indicating that the participant mentioned primarily unique target features and competitor features. As predicted, RRB was significantly higher in the presence of the decoy, with a mean value of 0.34 in the decoy condition compared with a mean value of 0.27 in the control condition ($\beta = 0.07$, $t = 2.58$, $p < .05$). Note that the absolute number of mentioned decoy features was also significantly higher in the presence of the decoy compared with the control condition, with a mean value of 2.00 in the decoy condition and a mean value of 1.46 in the control condition ($d = 0.61$, $t = 3.22$, $p < .01$).

	Resort 1
Casinos	✓
Famous spa	✓
Adventure sport facilities	
Beaches	✓
Wildlife excursions	
Exciting nightlife	✓
Good weather	✓
Activities for the entire family	
Beautiful natural scenery	
Great local cuisine	

Figure 1. Sample presentation of the competitor response option, in Experiment 3. Note that the competitor resort in this example was presented first and is thus referred to as Resort 1. Overall, the order that the resorts were presented in was randomized across participants

Beliefs

As in Experiment 2, we observed the emergence of the asymmetric dominance effect. Particularly, 38% of participants selected the target as the most popular resort, when the decoy was not included in the response set. This proportion increased to 62%, when the decoy was included in the response set. This effect was significant ($\beta = 0.97$, $z = 2.51$, $p < .05$) using a logistic regression for the effect of condition (decoy condition = 1; control condition = 0) on response (target chosen = 1; competitor chosen = 0).

Mediational analysis

If these memory processes do not affect final responses, then even if there are differences in recalled features across conditions, these differences should be independent of observed response probabilities across conditions. In contrast, if the proposed confirmatory search mechanism is responsible for the asymmetric dominance effect, then the observed recall bias should influence the probability of selecting the target, with a higher selection probability for participants that list more features of the decoy. This prediction was confirmed in the data. Particularly, a logistic regression for the effect of RRB on response (target chosen = 1; competitor chosen = 0) yielded a significant positive effect ($\beta = 3.42$, $z = 2.48$, $p < .05$).

We can more formally test the impact of recall on the asymmetric dominance effect using a mediation analysis. To perform this analysis, we set choice of the target (target chosen = 1, competitor chosen = 0) as the dependent variable, the condition (decoy condition = 1, control condition = 0) as the independent variable, and RRB as the mediator. When the mediator was included in the (logistic) regression analysis testing the relationship between the condition and the choice of the target, the total effect of condition on choice ($\beta = 0.97$, $z = 2.51$) reduced ($\beta = 0.81$, $z = 2.03$). Although the effect of condition on the choice of target was still significant in the presence of RRB in the regression, the reduction in β and the z score indicates mediation. To test whether this mediation was significant, we used bootstrapping methods recommended by Preacher and Hayes (2008). This analysis revealed a 95% bias-corrected and accelerated bootstrap confidence interval of 0.02 to 0.59 for RRB, indicating that attention to the features of the decoy option was a significant mediator of the asymmetric dominance effect.

Discussion

While Experiments 1 and 2 show that the asymmetric dominance effect emerges in a variety of everyday judgments, Experiment 3 shows that confirmatory search is at play in this effect. It demonstrates this by embedding a recall task into the judgment: participants were required to list as many of the

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features of the available options as they could recall, prior to indicating their response. Experiment 3 found that participants were significantly more likely to list the features present in the decoy (that were also present in the target but not in the competitor) when the decoy was included in the response set, compared with when it was not included in the response set. This was shown to mediate the strength of the asymmetric dominance effect.

EXPERIMENT 4

The results of Experiment 3 provide strong evidence that confirmatory search can generate changes to stated belief when novel response options are added to the response set. However, its results are only correlational. Although the recall task in Experiment 3 preceded the choice task, it may be the case that participants made their choice implicitly prior to the recall task. If this were the case, then the increased recall of decoy features could be due to a post-choice justification process, rather than the confirmatory search mechanism suggested in this paper. We can more rigorously test confirmatory search as a viable mechanism if we experimentally manipulate memory. Particularly, if decoy options affect choice probabilities by biasing recall, then we should be able to eradicate the asymmetric dominance effect by manipulating the cues that are most accessible to the participant in the judgment task.

Method

Three hundred and sixteen participants ($M_{age} = 34.52$, $SD_{age} = 12.28$, 51% female) were recruited from Amazon's Mechanical Turk system and paid \$0.15 for their participation. Participants were presented with the second question used in Experiment 1, which asked participants which of two or three musicians had sold the most records in the USA. For simplicity, this question only utilized the first decoy response (Kylie Minogue). Thus, the first core response (Madonna) served as the target, whereas the second core response (Led Zeppelin) served as the competitor.[3]

Participants were randomly assigned into four conditions. The first condition (control) offered them the target and competitor responses, and the second condition (decoy-unbiased) offered them all three responses. The third (decoy-enhanced) and the fourth (decoy-eliminated) conditions also offered participants all three responses; however, these conditions included an additional question that was presented prior to the main judgment. In this additional question, participants were required either to list two reasons why pop musicians are popular in the USA (decoy-enhanced condition) or to list two reasons why rock musicians are popular in the USA (decoy-eliminated condition). The additional question in conditions three and four served to experimentally bias cue accessibility in the three option set, with increased cue accessibility in favor of the target option in the decoy-enhanced condition and increased cue accessibility in favor of the competitor option in the decoy-eliminated condition. The proposed confirmatory search account of asymmetric dominance predicts that the decoy-unbiased condition should have a higher response probability for the target, compared with the control condition. Additionally, this difference should be sustained when the decoy-enhanced condition is compared with the control condition but removed when the decoy-eliminated condition is compared with the control condition. Note that there were four filler questions regarding unrelated music trivia in between the initial question that biased cue accessibility and the final question of interest. These filler questions ensured that any experimenter-demand effects would be minimized. All participants (including those in the control and decoy-unbiased questions) were presented with the four filler questions.

Results

We observed the asymmetric dominance effect. Only 65% of participants selected the target in the control condition. This proportion, however, increased to 80% in the decoy-unbiased condition. Additionally, 83% of participants selected the target in the decoy-enhanced condition, and only 62% of participants selected the target in the decoy-eliminated condition. A logistic regression was used to perform a contrast test between the three decoy conditions and the control condition. This regression had three independent dummy variables for the decoy-unbiased, decoy-enhanced, and decoy-eliminated conditions, and had choice of the target (target chosen = 1; competitor chosen = 0) as the dependent variable. This regression showed that target response probabilities in the decoy-unbiased and decoy-enhanced conditions were significantly higher than in the control condition ($\beta = 0.76$, $z = 2.08$, $p < .05$ for decoy-unbiased and $\beta = 0.95$, $z = 2.48$, $p < .05$ for decoy-enhanced). Also, as predicted, this test did not find significant differences in target response probabilities between the decoy-eliminated condition and the control condition ($\beta = -0.15$, $z = -0.45$, $p = .65$).

A similar logistic regression was used to compare response probabilities in the decoy-enhanced and decoy-eliminated conditions against response probabilities in the decoy-unbiased conditions. This regression included all responses except for those in the control condition, had two independent dummy variables for the decoy-enhanced and decoy-eliminated conditions, and had choice of the target (target chosen = 1; competitor chosen = 0) as the dependent variable. This regression showed that target response probabilities in the decoy-eliminated condition were significantly lower than in the decoy-unbiased condition ($\beta = -0.91$, $z = -2.50$, $p < .05$) but that there was no significant difference between target response probabilities in the decoy-enhanced condition and the decoy-unbiased condition ($\beta = 0.19$, $z = 0.47$, $p = .64$).

Discussion

Experiment 4 shows that biasing cue accessibility in a judgment task eliminates the asymmetric dominance effect when cues supporting the non-dominant option are made more salient but not when the cues supporting the dominant option

[3]This question was used because pre-trials (whose results were included in earlier drafts of this paper) showed that it generated a strong and robust asymmetric dominance effect with the Amazon Mechanical Turk population.

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are made more salient. This matches the predictions of the proposed confirmatory search account of the asymmetric dominance effect: changes to response probabilities are caused by biased memory, and experimentally altering memory can affect these changes.

GENERAL DISCUSSION

This paper has shown that the asymmetric dominance effect emerges in judgment tasks. Particularly, altering the response set for a question by adding a novel response, whose supporting cues also support one (but not the other) of the initial, core responses, can change the relative selection probabilities for the core responses. In Experiment 1, we demonstrated this effect for judgments of magnitude and probability in a large number of naturalistic settings, and in Experiment 2, we demonstrated this effect in a setting where the cues available to the decision maker (and the dominance structures that they generate) were controlled experimentally.

These changes in belief can be explained by confirmatory search processes. Decision makers are likely to focus on information that supports the responses in consideration. Adding a novel dominated response increases the salience of the cues that support this novel response (which also support the dominating core response), thereby altering the information that is attended to in the decision task and biasing judgments in favor of the dominating core response. We found evidence for the confirmatory search account of the asymmetric dominance effect in Experiment 3 of this paper, which used a recall task to observe the memory biases underlying judgment. Experiment 3 found that increased attention towards the decoy option's supporting cues mediated the strength of the asymmetric dominance effect. We also showed that the asymmetric dominance effect could be eradicated by altering the memory processes underlying judgment. Particularly, Experiment 4 found that experimentally increasing the accessibility of cues supporting the nondominant option removed the asymmetric dominance effect. In contrast, experimentally increasing the accessibility of cues supporting the dominant option did not alter this effect.

The ability of confirmatory search to predict the emergence of the asymmetric dominance effect is not surprising. Confirmatory search has been used to explain a large range of behaviors involving hypothesis testing, information search and interpretation, and formal reasoning (Klayman & Ha, 1987; Koriat et al., 1980; Wason, 1960). Beyond this, confirmatory search provides an explanation for the anchoring effect, the endowment effect, and bidirectional effects in judgment: in all these domains, biases in final responses are explained by the dependence of information accessibility on the responses offered initially to the decision maker (Bhatia, 2013; Carmon & Ariely, 2000; Chapman & Johnson, 1994, 1999; Glöckner et al., 2010; Holyoak & Simon, 1999; Johnson et al., 2007; Russo et al., 2006; Simon et al., 2004; Strack & Mussweiler, 1997). Task-dependent biases in cue accessibility are also considered responsible for behaviors as diverse as priming effects (Mandel & Johnson, 2002), response mode effects (Tversky, Sattath, & Slovic, 1988), biases in probability judgment (Tversky & Kahneman, 1973), and the use of heuristic decision strategies (Kahneman & Frederick, 2002).

While Experiments 3 and 4 support the notion that the asymmetric dominance effect in judgment can be explained using a confirmatory search mechanism, confirmatory search is not the only mechanism capable of generating this effect. A phenomenon as robust as the asymmetric dominance effect is likely to have multiple causes. Indeed, there are a number of alternate theories, designed primarily to explain this effect in multi-attribute choice, that predict its emergence in judgment as well. Decision field theory (Busemeyer & Townsend, 1993; Roe et al., 2001), for example, assumes that choice options that are similar to each other inhibit each other's preferences, generating a contrast effect. This contrast effect is stronger for the decoy and the target (which are very similar to each other), compared with the decoy and competitor. This leads to an overall preference for the target in the presence of the decoy and generates the asymmetric dominance effect. Other approaches also explain the asymmetric dominance effect through contrast (Dhar & Glazer, 1996; Pettibone & Wedell, 2000; Wedell & Pettibone, 1996), although here contrast affects attribute valuation and depends on differences between the choice options on the different attributes. Note that the proposed confirmatory search theory is unable to explain findings on contrast documented in this work.

Yet, another mechanism has been proposed by Huber et al. (1982) and Wedell (1991). This mechanism relies on range effects, according to which extending the range of values on one attribute dimension reduces perceived differences on that attribute, reducing the attribute's weight in the decision task (see also Wedell & Pettibone, 1996, and Pettibone & Wedell, 2007). Alternatively, Trueblood et al. (in press) have proposed the multi-attribute linear ballistic accumulator (MLBA) model as an explanation for these effects. In MLBA, attribute weights depend on the similarity between pairs of objects on different attributes. Subsequently, differences between the target and the decoy on the various attributes are overweighted because of the similarity between the target and the decoy, generating the asymmetric dominance effect.[4]

Perhaps, the model most similar to the proposed confirmatory search mechanism is Bhatia's (2013) associative accumulation model (AAM). According to AAM, attention in a multi-attribute decision task is biased towards attributes strongly associated with the choice options that are offered to the decision maker. Associations are, for simplicity, defined in terms of attribute amounts so that attributes highly present in the available choice options are seen as being strongly associated with these options and are subsequently predicted to be more accessible and to receive higher weights compared with other attributes. As increased attention to the attributes of a choice option generally leads to an increased choice probability for the option, the AAM model can be seen

[4]In addition to these theories, a popular explanation for the asymmetric dominance effect relies on loss aversion (Tversky & Simonson, 1993; Usher & McClelland, 2004). While loss aversion may be a feasible explanation for this effect in multi-attribute choice, it is unlikely that it is also at play in everyday judgment (see e.g. Trueblood, 2012; Trueblood et al., 2013, for a discussion).

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as presenting a formal computational model of the confirmatory search process.[5] Correspondingly, confirmatory search can be seen as generating the asymmetric dominance effect in choice, as well as other multi-attribute choice effects, such as the compromise effect, alignability effects, and reference point effects, captured by AAM. The results of Experiments 3 and 4 in this paper provide empirical evidence that confirmatory search is involved in the asymmetric dominance effect for judgment. Further work should examine whether this mechanism is at play for the asymmetric dominance effect—and related context effects—in multi-attribute choice.

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[5]Indeed, as AAM also permits continuous attribute or cue values and can also make decision time predictions, it may in fact be more suitable for model fitting and other quantitative tests of the proposed theory.

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