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Confirmation Bias in Sequential Information Search After Preliminary Decisions: An Expansion of Dissonance Theoretical Research on Selective Exposure to Information

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Research on selective exposure to information consistently shows that, after having made a decision, people prefer supporting over conflicting information. However, in all of these experiments participants were given an overview of all available pieces of information, selected them simultaneously, and did not process the requested information during the selection phase. In the present research the authors show that an even stronger preference for supporting information arises if information is presented and processed sequentially instead of simultaneously (Experiment 1), and they demonstrate that this stronger confirmation bias is due to sequential presentation and not to sequential processing of information (Experiment 2). The authors provide evidence that the increase in confirmation bias under sequential presentation is caused by heightened commitment due to the participants' increased focusing on their decision (Experiments 3 and 4).

When people seek new information, these information search processes are often biased in favor of the information seeker's previously held beliefs, expectations, or desired conclusions. For example, people have been shown to favor information that supports their social stereotypes (Johnston, 1996), attitudes (Lundgren & Prislin, 1998), expectations in negotiations (Pinkley, Griffith, & Northcraft, 1995), and self-serving conclusions (Frey, 1981a; Holton & Pyszczynski, 1989). These biased information search processes lead to the maintenance of the information seeker's position, even if this position is not justified on the basis of all available information (Johnston, 1996; Pinkley et al., 1995).

Such processes are of particular relevance in nonroutine decision making. According to authors like Janis (1982) or Nemeth and Rogers (1996), an information search that is clearly biased in favor of a preferred alternative may be dangerous, because potential risks and warning signals may be overlooked and, thus, decision fiascoes may be the consequence. If the decision maker fails to consider disconfirming pieces of information, it is difficult for him or her to correct a faulty decision and thereby avoid loss escalations (Brockner & Rubin, 1985). Although biased information seeking undoubtedly also has significant functional aspects (cf. Beckmann & Kuhl, 1984; Wicklund & Frey, 1981), a strong bias in favor of the preferred or already chosen alternative may, at least in contexts in which high risks are at stake and the advantages and disadvantages of the different alternatives are almost fixed and foreseeable, increase the likelihood of bad outcomes (Schulz-Hardt, 1997; von Haeften, 1999). It is thus of theoretical as well as practical relevance to determine how widespread this bias is in information seeking during decision making.

Empirical studies on biased information search in decision making have been predominantly carried out within the framework of dissonance theory (Festinger, 1957). According to this theory, once committed to an alternative, people prefer supportive (consonant) information compared with opposing (dissonant) information to avoid or reduce postdecisional conflicts. This effect has been labeled *selective exposure to information.* However, because predominantly seeking dissonant information would also be a kind of selectivity, the term is somehow misleading. In this article, we therefore refer to the preference for supporting as opposed to conflicting information as *confirmation bias.*[1]

Meanwhile, a large number of empirical studies (for overviews, see Frey, 1986; Frey, Schulz-Hardt, & Stahlberg, 1996) has shown

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[1] In this context, the term *confirmation bias* has a slightly different meaning than in the context of hypothesis testing, in which it is also often used (e.g., Snyder & White, 1981). In the latter, *confirmatory hypothesis testing* or *confirmation bias* means asking questions that are consistent with the hypothesis that is being tested. However, as Klayman and Ha (1987) pointed out, this way of gathering evidence should be labeled *positive hypothesis testing* rather than confirmatory information seeking or confirmation bias because this way of asking questions does not imply that the person will be confirmed in his or her hypothesis. In the research on decision making to which we are referring, confirmation bias means requesting information that supports a preselected alternative, thus the decision maker using this strategy knows that he or she will get the confirmation sought. Therefore, in our case the use of this term is justified.

that, under conditions of free choice and commitment, people in fact show the predicted preference for supporting information. Recent studies have also demonstrated that such a confirmation bias is not restricted to situations in which a final decision has been made; a similar bias arises after preliminary decisions (preference judgments) if the decision maker feels committed to the preferred alternative (Schulz-Hardt, 1997). Furthermore, this confirmatory information search can also be observed in group decision making (Schulz-Hardt, Frey, Lüthgens, & Moscovici, 2000). All in all, these results seem to suggest that biased searching for supportive information is a widespread phenomenon in decision making.

However, it is not yet clear whether these results can be generalized to and thus have implications for real-world decision making, for example, in politics or business. This generalizability depends inter alia on two questions: Do decision makers in these settings differ from typical student samples when confronted with research paradigms on biased information search? And are these research paradigms typical for information seeking in real decision contexts?

Concerning the first question, one of our recent experiments provided confirmatory evidence. In Experiment 2 of the studies by Schulz-Hardt, Frey, et al. (2000), groups of managers from banks and industrial companies showed a confirmation bias in the context of a financial investment decision that was at least as strong as the confirmation bias of student groups in the other two experiments. Although these results have to be replicated and extended in further research, they speak for a generalizability of the findings on selective exposure to information. Therefore, the second question becomes critical: Even if decision makers from real settings show a confirmation bias in the dissonance theory research paradigm, this would hardly have any practical relevance if the information search procedure in this paradigm bore little resemblance to the information search procedure in real-life settings.

The typical information search procedure in the dissonance theory research paradigm can be outlined as follows (see, e.g., Frey, 1981b): The participants are confronted with a decision case—for example, whether a company should invest in a particular developing country, whether the contract of a manager should be renewed, or choosing between different consumer products—and are asked to reach a preliminary or a final decision. After that, participants are offered additional pieces of information that they can select. In most experiments, these additional pieces of information are presented in the form of commentaries by experts or by former participants.

The participants are given a list of the topics of these articles. From these statements, it is apparent whether the articles in question are consonant or dissonant to the previous decision. Half of the articles are consonant, the other half are dissonant. The participants are asked to mark those articles that they wish to read. The requested articles are not handed out until the selection phase is finished, or they are not handed out at all (because the experiment is over after the selection). We refer to this procedure as *simultaneous information search.*

As this research paradigm was primarily developed for theory testing, less emphasis was placed on whether it captured the critical features of information seeking in real-life decision making. Thus, a critical objection concerning the generalizability of findings on selective exposure to information can be raised: In, for example, business or political contexts, the decision maker seldom has an overview of the information available before he or she starts the information search because new information that could be useful is always cropping up (Vertzberger, 1990). In other words, information is retrieved, then read and processed before further information is retrieved. This sequence is repeated until the need for information is stilled or a decision has been made. When information is sought in this way, it is not possible to determine in advance how many pieces of consonant or dissonant information one will request or to delay processing the information until the selection phase is over. Instead, each time a new piece of information comes to one's attention, a decision must be made whether to heed or ignore this information. Once the selected piece of information has been processed, the information search phase continues. We refer to this as *sequential information seeking.*

Although, as mentioned above, information search in real-life decisions is carried out almost always sequentially, such sequential information-seeking processes have largely escaped attention in empirical studies on biased information search in decision making. The topic has indirectly been approached in some field studies on selective exposure (Diab, 1979; Sweeney & Gruber, 1984), in which the participants were retrospectively asked about their actual information-seeking behavior, and this behavior was, for example, put in relation to their political views. The information-seeking processes reported can be categorized as sequential in that these persons, for instance, decided daily which newspaper to read or TV program to watch for information. Because of the research method (retrospective questions), selective information seeking could only be demonstrated in retrospect and, therefore, systematic memory distortion cannot be ruled out as an alternative explanation for the findings.

In addition, the studies on sequential information processing by Geller and Pitz (1968), Godden (1976), Grabitz and Haisch (1972), Peterson and DuCharme (1967), Pitz (1969), and Pitz, Downing, and Reinhold (1967) are of relevance here. Although they were not conceptualized as a genuine examination of the selective exposure hypothesis, they can be categorized as such (Frey, 1986). In these experiments, the participants were confronted with a string of new information in sequence, which either supported or conflicted with their tentative decisions. An overestimation of the diagnostic value of supportive information and an underestimation of the diagnostic value of conflicting information were consistently demonstrated in these studies. Similar results were obtained by Ditto and Lopez (1992) and Edwards and Smith (1996) in experiments on motivated reasoning: In their experiments, participants who were sequentially confronted with information supporting or contradicting a preferred conclusion (Ditto & Lopez, 1992, Experiment 1) or a prior belief (Edwards & Smith, 1996) evaluated discrepant information more critically than supporting information.

All in all, the studies mentioned above provide evidence that the same bias in the evaluation of information that was found in simultaneous information seeking or in a simultaneous confrontation with the available information (e.g., Ditto, Scepansky, Munro, Apanovitch, & Lockhardt, 1998; Koehler, 1993; Lord, Ross, & Lepper, 1979) also occurs when information is presented and has to be evaluated sequentially. However, hardly any evidence exists

whether the same holds true for the confirmation bias in information search.[2]

In this article, we report on four experiments that were conducted to investigate this question and thereby test the generalizability of former findings on confirmatory information search. In Experiment 1, simultaneous and sequential information seeking are compared with regard to the confirmation bias. Following Experiment 1, we discuss possible explanations for the central finding of this experiment. These possible explanations are directly tested in the subsequent experiments.

Experiment 1

In the first experiment, sequential information seeking was compared with simultaneous information seeking to investigate whether a confirmation bias can be demonstrated for both procedures and, if so, whether the strength of this bias differs for both procedures. Therefore, in one of the two experimental conditions the typical procedure from former experiments on selective exposure to information was replicated (simultaneous presentation of all pieces of information, selection of information, and reading the selected pieces of information after the selection phase). In the other condition, information was presented and selected sequentially, and the selected article was read before a new sequence began.

Method

Participants and design. Thirty-six students (22 female and 14 male; ages ranging from 19 to 45 years) from the University of Munich, Munich, Germany, participated in this experiment. They were recruited in the university cafeteria by asking whether they would be willing to participate in a study on decision making at the nearby Institute of Psychology. The experiment is based on a 2×2 (information search mode: simultaneous vs. sequential; type of information: supporting vs. conflicting) factorial design with repeated measures on the second factor.

Material. In all four experiments a paradigm with high relevance for our participants was used, namely, health policy. The continuous increase in health insurance contributions, the increased cuts in payments by health insurance companies, and the discussion among politicians about necessary reforms in health policy have led to an increased public awareness about this topic in Germany. At a time when alternative healing methods are booming in Germany, a battle for principles has arisen between the proponents of alternative healing methods and the defenders of traditional medicine. Ultimately, it is the foundation of scientific thought and those principles that are generally understood as being scientific that are being called into question. In our paradigm, the participants have to decide between two alternatives: whether health insurance should also cover alternative healing methods or whether health insurance should only cover traditional medical treatments.

Procedure. The experiment was conducted simultaneously in two separate rooms. Participants were randomly assigned to one of the two experimental conditions. The experiment consisted of answering a questionnaire with three parts. The first part was an introduction to the topic, including the rising costs in the public health sector, the measures being taken by the policymakers, the boom in alternative healing methods, and the question whether alternative healing methods should be covered by health insurance. Participants were informed that, at the moment, this question is settled by a provisional paragraph passed by the German parliament but that a definite decision is absolutely necessary. The participants' first task was to make a preliminary decision between the two alternatives mentioned above; they were informed that the final decision would be made later on.

In the second part of the questionnaire, the participants were informed that additional information concerning the decision at hand was available. This additional information consisted of 16 one-page statements written by experts on this topic. Each statement was summarized by a main thesis (two sentences). The main theses referred to either traditional medicine or alternative methods and contained either decidedly positive or decidedly negative arguments. Thus, after reading a particular main thesis, participants knew whether the corresponding article would support or conflict (i.e., be consonant or dissonant) with the preliminary decision they had previously made. Supporting pieces of information were those that were in favor of the chosen alternative or against the rejected alternative and vice versa for conflicting pieces of information. Reference books, magazines, and articles were used as the basis for the arguments in the main theses. Credibility and persuasiveness of the arguments had been shown in a pretest, especially with regard to the fact that arguments from both sides had comparable strength.

An example of a main thesis from an article in favor of the payment of alternative methods is: "The success of alternative healing methods cannot be ignored. Therefore, alternative treatments should also be paid by health insurance." An example of a main thesis from an article against the payment of alternative methods is: "In the absence of an unequivocal explanation of how certain methods work, it would be irresponsible to call such a method therapeutic. Thus, alternative treatments should not be paid by health insurance." An example of a main thesis from an article in favor of the exclusive payment of traditional medical practices is: "Traditional practices are convincing because of a long history of benefits and successes. Therefore, it makes sense and suffices when only these methods are paid by health insurance." Finally, an example of a main thesis from an article against the exclusive payment of traditional methods is: "Traditional medicine uses aggressive methods when not called for and uses medicines with side effects not proportional to what is needed. Therefore, the exclusive payment of traditional methods is unjustified."

The experimental manipulations took place in the following way. In the sequential information search condition, the participants received two main theses per sequence, one supporting and one conflicting with their prior preliminary decision. The information-seeking phase contained eight of these sequences; the participants had been informed of this beforehand. In each sequence the participants could choose one, both, or none of the presented articles. After the participant had made his or her choice, the experimenter handed out the chosen article or articles. When the participant had read the article or articles, the next sequence followed.

In the simultaneous information search condition, the procedure was similar to former experiments on selective exposure to information: The participants received a list with all 16 main theses. They were asked to mark the titles of those articles that they would like to read to prepare for the final decision. After they had finished their information selection, they received the requested articles.

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[2] Studies using the information display board (IDB) technique (Dukerich & Nichols, 1991; Payne, 1976) somehow represent a mixture of simultaneous and sequential information search. Here the participants are shown all the available information on cards pinned on a board; to get the requested information they must turn over the corresponding card. Under these conditions, the participants have an overview of the available information and can decide immediately how many pieces of information they want to request concerning each alternative. Additionally, they have an overview of which pieces of information they have already requested. Although the latter features can be classed as simultaneous owing to our definition, the fact that the selected pieces of information are processed during the selection phase represents an element that belongs to our definition of sequential information search. However, studies using the IDB technique have yet not been used to investigate the confirmation bias.

The third part of the experiment was identical for both conditions and consisted of making a final decision between the two alternatives. After that, the participants had the opportunity to ask questions about the experiment and were informed about the experimental aims. The whole experiment took about 0.5 hr. As a small token of our gratitude, the participants were given a chocolate bar. They were thanked for their participation and then dismissed.

Results

Check for possible interfering effects. Of the 36 participants, only 5 decided in favor of the exclusive payment of traditional medicine. With regard to the confirmation bias ($M = 0.20$, $SD = 0.84$ for the difference between the number of selected supporting and conflicting articles), they did not significantly differ from those participants who were in favor of insurance coverage for alternative health practices ($M = 1.77$, $SD = 2.47$), $t(34) = 1.40$, $p > .15$. In addition, information seeking did not depend on participants' age or gender.

Information search. Cell means and standard deviations for the number of chosen supporting and conflicting articles as well as for the difference values (confirmation bias) are shown in Table 1. An analysis of variance (ANOVA) revealed a significant main effect for type of information, $F(1, 34) = 16.91$, $p < .001$, indicating that on average more supporting ($M = 4.22$, $SD = 2.10$) than conflicting articles ($M = 2.67$, $SD = 1.77$) were chosen; that is, overall a significant confirmation bias occurred. Separate analyses showed that this confirmation bias was significant for the simultaneous search condition ($M = 0.78$, $SD = 1.56$), $t(17) = 2.12$, $p < .05$, as well as for the sequential information search condition ($M = 2.33$, $SD = 2.81$), $t(17) = 3.53$, $p < .01$.

The most important finding, however, was that, as indicated by a significant interaction of information search mode and type of information, $F(1, 34) = 4.23$, $p < .05$, the confirmation bias was significantly stronger in the sequential condition ($M = 2.33$) than in the simultaneous condition ($M = 0.78$). Simple effects analyses showed that this effect was due to the supporting articles: Whereas no significant differences were obtained with regard to the conflicting articles ($M = 2.94$, $SD = 1.76$ for sequential search, $M = 2.39$, $SD = 1.79$ for simultaneous search), $|t(34)| < 1$, participants in the sequential search condition requested significantly more supporting articles ($M = 5.28$, $SD = 1.78$) than participants in the simultaneous search condition ($M = 3.17$, $SD = 1.89$), $t(34) = 3.46$, $p < .01$. As a consequence, the overall number of chosen articles was also higher in sequential information search ($M = 8.22$, $SD = 2.16$) compared with simultaneous information search ($M = 5.56$, $SD = 3.33$), $F(1, 34) = 8.13$, $p < .01$.

A further inspection of the sequential condition revealed that no systematic pattern could be discerned for the changes in information requests over the course of the eight sequences; therefore, no such results are documented here.

Discussion

First, the results of the simultaneous condition in Experiment 1 replicate the findings of former experiments on selective exposure to information (cf. Frey, 1986; Frey et al., 1996; Schulz-Hardt, 1997): After having made a (in this case preliminary) decision for an alternative, participants showed a preference for supporting information. More importantly, Experiment 1 clearly supported the thesis that this biased information search phenomenon extends to situations in which information is requested and processed sequentially. Not only did a clear confirmation bias emerge in the condition featuring sequential information seeking, but this confirmation bias was also significantly stronger than the bias in the simultaneous condition.

This latter finding, assuming that it can be replicated, would have important theoretical and practical implications. As we have already outlined, when people make decisions in real life, the typical information search process is sequential and not simultaneous. If we now find out that sequential information bias exaggerates the confirmation bias, then this obviously implies that former studies on this topic have largely underestimated the degree to which people exhibit a confirmatory information search pattern. Thus, the first question for the following experiments is whether we can replicate this effect of the sequential information search mode.

Assuming that the answer to this first question is yes, a second question becomes important, namely, what mechanism causes a stronger confirmation bias under conditions of sequential information search? To find this psychological mediator, one must first locate the effect more precisely. Because sequential information search differs from simultaneous information search on two different structural aspects, either of the two aspects could be the source of the effect. The first aspect is the presentation mode: In simultaneous information search, all information titles are presented together; thus, the decision maker always has an overview of the available pieces of information as well as his or her prior

Table 1
Means and Standard Deviations for Information Search Dependent on Information Search Procedure in Experiment 1

	Information				Confirmation bias[b]	
	Supporting		Conflicting			
Search procedure[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Simultaneous information search	3.17	1.89	2.39	1.79	0.78	1.56
Sequential information search	5.28	1.78	2.94	1.76	2.33	2.81

[a] $n = 18$ in each condition. [b] The confirmation bias corresponds to the difference between the number of chosen supporting and the number of chosen conflicting articles.

information choices. In sequential information search, on the contrary, no such overview exists; the decision maker has to make separate choices for each item (or, in the case of Experiment 1, for each pair of items). The second aspect is the processing mode: Whereas in simultaneous search the requested articles are read and processed after the complete selection is over, sequential information seeking involves processing during the selection phase. Once a piece of information has been requested, this information is processed and its implications are evaluated. A choice about requesting or not requesting a further piece of information is not made until this processing is finished.

Both aspects involve different psychological processes that could be responsible for the stronger confirmation bias in sequential compared with simultaneous information seeking. The presentation mode, on the one hand, could influence how much the participants focus on their prior decision. As research from cognitive psychology has demonstrated, sequentially presenting items implies that each single item is compared with the person's prior belief, whereas under simultaneous presentation the different items are first compared and then (if possible) integrated (Hogarth & Einhorn, 1992). Thus, participants under conditions of sequential search could focus more heavily on their decision, whereas in simultaneous search the focus is more on the evaluation and comparison of the available articles and less on the prior decision. Because focusing on the prior decision increases the confirmation bias (Jonas et al., in press), this mechanism could be responsible for the effect in Experiment 1. Another possible explanation based on the processing mode is that normally people try not to be too biased in their search for information because they feel that a balanced search for information is more appropriate to find out the best alternative (Jonas, 2000, Experiment 1). In other words, they may try to counteract a confirmation bias (see also Kunda, 1990). This, however, is only possible if they have an overview of the available and the already chosen pieces of information; if they lose this overview (which can easily happen in sequential information search), these attempts may fail.

On the other hand, the different modes of information processing in simultaneous versus sequential search also give rise to different psychological mechanisms that could explain the results of Experiment 1. For example, processing the requested articles during the selection phase could increase cognitive load. If people feel a high cognitive load, this may induce a need for structure (Kruglanski, 1989), that is, a tendency to freeze a particular alternative as the supposedly best one (see also Ford & Kruglanski, 1995). A biased search for supporting information helps to generate this structure (Kruglanski & Mayseless, 1987). To mention just one additional possible mechanism, processing the articles during the selection phase could gradually increase the participants' conviction of "being on the right side" and thereby polarize their belief. As experiments by, for example, Ditto and Lopez (1992), Ditto et al. (1998), Edwards and Smith (1996), and Lord et al. (1979) have shown, the usual reaction to reading supportive information is to generate proarguments to that information, whereas the usual reaction to information conflicting with one's view is to generate counterarguments. As a consequence, the participants with sequential processing could have learned that reading the supporting articles is more worth the effort than reading the conflicting articles.

However, elaborating such processes in more detail only makes sense after a replication of the effect in Experiment 1 has been successful, and after we have been able to locate whether presentation mode or processing mode or both are responsible for the differences between simultaneous and sequential information search. This is the aim of Experiment 2. Later, in Experiments 3 and 4, we try to clarify the underlying psychological processes.

Experiment 2

As outlined earlier, Experiment 2 deals with two questions: (a) Can the stronger confirmation bias in sequential compared with simultaneous information search be replicated? (b) If the answer to the first question is yes, is this effect due to different information presentation or due to different information processing in sequential versus simultaneous search?

To answer these questions, we orthogonally manipulated presentation mode and processing mode. Participants were either given (simultaneous presentation) or not given (sequential presentation) a sheet of paper with an overview of all available articles on which all articles were listed and the requests had to be marked, and either they read each requested article immediately after they had marked it (sequential processing) or all requested articles were handed out at the end (simultaneous processing). To answer the first question, we tested the condition with sequential presentation and processing against the condition with simultaneous presentation and processing. To provide an answer to the second question, we calculated the main effects and the interaction of the two experimental factors.

Method

Participants and design. Sixty students (19 male and 41 female, ages from 19 to 38 years) from the University of Munich participated in this experiment. The experiment is based on a 2 × 2 × 2 (presentation mode: simultaneous vs. sequential; processing mode: simultaneous vs. sequential; type of information: supporting vs. conflicting) factorial design with repeated measures on the third factor.

Procedure. The procedure was identical to Experiment 1 with the exception that participants under sequential presentation were given one title at a time (this allowed an even stronger test of the presentation mode compared with Experiment 1 when two titles were given in each sequence) and had to decide whether they wanted to read the corresponding article. Supporting and conflicting articles were alternated under sequential presentation. Simultaneous presentation was identical to Experiment 1 with the exception that the participants, after reading all titles, had to start the search phase by indicating whether they wanted to read the first article on the overview sheet, then move to the second article, and so on. This was done to guarantee complete comparability between simultaneous and sequential presentation with regard to choice order of the titles.[3]

In the sequential processing condition, each requested article was handed out to the participants immediately and had to be read before the next selection took place. If this was done under simultaneous presentation of the titles, then this meant that the participants were not allowed to mark another article before the previously selected article had been read. The experimenter took care that no violations of this procedure occurred. Under sequential presentation, this was easy to control because a new sheet of

[3] In a pretest, we checked whether this small change in the procedure had an influence on the confirmation bias. The pretest's results showed no influence.

paper with the title of the next article was handed out for each new sequence.

Results

Check for interfering effects. Of the 60 participants, only 4 voted against a payment of alternative healing methods. Whereas these 4 participants showed a preference for conflicting over supporting information ($M = -3.50$, $SD = 1.73$ for the confirmation bias), those participants who chose the payment of alternative healing methods clearly displayed a confirmation bias ($M = 2.29$, $SD = 2.63$). The difference between these two groups was significant, $F(1, 58) = 18.57$, $p < .001$. However, this effect did not influence the results of the experimental design.

Also, in relation to gender, an effect was found: The 41 female participants exhibited a significantly stronger confirmation bias ($M = 2.44$, $SD = 2.74$) than the 19 male participants ($M = 0.74$, $SD = 3.14$), $F(1, 58) = 4.57$, $p < .04$. But again the results of the experimental design did not change if gender was entered as an additional factor. Participants' age did not influence the confirmation bias.

Information search. Cell means and standard deviations for chosen supporting and conflicting articles as well as for the confirmation bias are shown in Table 2. First, we compared the confirmation bias in the condition with sequential presentation and processing during selection ($M = 3.33$, $SD = 2.79$) with the confirmation bias in the condition with simultaneous presentation and processing after selection ($M = 1.13$, $SD = 3.40$) to check whether the central result of Experiment 1 was replicated. The corresponding contrast, using the error mean square from the analyses of the factorial design outlined below, became significant, $t(56) = 2.10$, $p < .05$. Thus, a stronger confirmation bias in sequential compared with simultaneous information search was shown. Separate analyses demonstrate that this effect, as in Experiment 1, was due to a higher number of chosen supporting articles in sequential ($M = 6.13$, $SD = 1.64$) compared with simultaneous search ($M = 3.47$, $SD = 2.07$), $t(56) = 3.59$, $p < .01$, whereas no significant difference was obtained for the conflicting articles (sequential search: $M = 2.80$, $SD = 1.78$; simultaneous search: $M = 2.33$, $SD = 1.80$), $|t(56)| < 1$. Next we turn to the results of the factorial design.

In the $2 \times 2 \times 2$ factorial ANOVA with repeated measures on the third factor, a significant main effect for type of information was found, $F(1, 56) = 26.35$, $p < .001$, indicating that, on average, more supporting ($M = 4.47$, $SD = 2.31$) than conflicting articles ($M = 2.57$, $SD = 2.05$) were requested. Additional t tests against zero reveal that a significant confirmation bias emerged in each condition: $M = 1.13$, $SD = 3.40$, $t(14) = 3.91$, $p < .01$ for simultaneous presentation/simultaneous processing; $M = 0.93$, $SD = 1.22$, $t(14) = 2.95$, $p < .02$ for simultaneous presentation/sequential processing; $M = 2.20$, $SD = 3.47$, $t(14) = 2.46$, $p < .04$ for sequential presentation/simultaneous processing; and $M = 3.33$, $SD = 2.79$, $t(14) = 4.62$, $p < .001$, for sequential presentation/sequential processing.

The main effect for the repeated measures factor was qualified by an ordinal interaction with presentation mode, $F(1, 56) = 5.48$, $p < .03$. Those participants to whom the information titles were presented sequentially had a stronger confirmation bias ($M = 2.77$, $SD = 3.15$) than those to whom all titles were presented simultaneously ($M = 1.03$, $SD = 2.51$). A simple effects analysis shows that this effect was due to the higher number of supporting articles chosen under sequential presentation ($M = 5.57$, $SD = 2.01$) compared with simultaneous presentation ($M = 3.37$, $SD = 2.08$), $F(1, 56) = 17.49$, $p < .001$, whereas no significant difference was observed with regard to the number of chosen conflicting articles ($M = 2.80$, $SD = 2.07$ for sequential presentation, $M = 2.33$, $SD = 2.02$ for simultaneous presentation), $F(1, 56) < 1$. As a consequence, the total number of articles chosen was also significantly higher under sequential information presentation ($M = 8.37$, $SD = 2.61$) than under simultaneous information presentation ($M = 5.70$, $SD = 3.24$), $F(1, 56) = 12.16$, $p < .01$.

On the contrary, no significant effect resulted for processing mode, neither with regard to the confirmation bias nor with regard to the total number of articles requested (both Fs < 1). An inspection of the cell means in Table 2 seems to imply that under conditions of sequential information presentation, the confirmation bias was increased by sequential compared with simultaneous processing ($M = 3.33$, $SD = 2.79$ vs. $M = 2.20$, $SD = 3.47$), whereas processing mode had no effect under conditions of simultaneous presentation ($M = 0.93$, $SD = 1.22$ vs. $M = 1.13$, $SD = 3.40$). However, the corresponding interaction of presenta-

Table 2
Means and Standard Deviations for Information Search Dependent on Experimental Condition in Experiment 2

	Information				Confirmation bias[b]	
	Supporting		Conflicting			
Experimental condition[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Simultaneous presentation						
Simultaneous processing	3.47	2.07	2.33	1.80	1.13	3.40
Sequential processing	3.27	2.15	2.33	2.29	0.93	1.22
Sequential presentation						
Simultaneous processing	5.00	2.24	2.80	2.40	2.20	3.47
Sequential processing	6.13	1.64	2.80	1.78	3.33	2.79

[a] $n = 15$ in each condition. [b] The confirmation bias corresponds to the difference between the number of chosen supporting and the number of chosen conflicting articles.

tion mode and processing mode was far from reaching statistical significance, $F(1, 56) < 1$.

As in Experiment 1, no systematic pattern could be discerned for the development of the confirmation bias over the course of time in this experiment.

Discussion

In Experiment 2 we replicated the finding from Experiment 1 that the confirmation bias is stronger when the information search is carried out sequentially instead of simultaneously. In addition, as in Experiment 1, this effect was caused by a higher number of supporting articles requested in sequential information search. Thus, the answer to the first of the two questions ("Can the central findings of Experiment 1 be replicated?") that led to this experiment is yes. We were also able to provide an answer to the second question, namely, whether these differences are due to presentation mode or processing mode. We found clear evidence that the difference between sequential and simultaneous information seeking can be traced back to the different modes of information *presentation.* Independent of the processing mode, the confirmation bias was shown to be stronger if the information titles were given sequentially instead of simultaneously. On the contrary, we did not find support for the hypothesis that the different processing mode in sequential compared with simultaneous information search affects the confirmation bias; the confirmation bias was not shown to be stronger under sequential processing than under simultaneous processing. Thus, suggestions that a need for structure induced by cognitive load (Ford & Kruglanski, 1995) or belief polarization due to a biased evaluation of the requested articles (e.g., Ditto & Lopez, 1992; Edwards & Smith, 1996) could be responsible for the heightened confirmation bias in sequential information search were not validated.

Now that we have identified the presentation mode as the crucial aspect of sequential information seeking with regard to the confirmation bias, we can elaborate possible psychological processes underlying this effect in more detail. In the discussion of Experiment 1, we already outlined those two mechanism that, in our view, are most likely to mediate the effect of presentation mode. The first one is based on the idea that people try not to be too biased in their search for information; therefore, we subsequently refer to this as the *biasedness restriction* hypothesis. This hypothesis can be derived from the *motivated reasoning* concept that has been formulated by Kunda (1990). Similar to dissonance theory (and other motivational approaches), Kunda's motivated reasoning concept works with the assumption that people strive to defend positions to which they feel committed; this is conceptualized as a directional goal in the inference process. Although in Kunda's model the means of defending a particular position is the selective use of heuristics and inferential rules that lead to the desired conclusion, this can easily be applied to information seeking: People selectively seek supporting information to reach a decision for the favored alternative. But, at the same time, the model proposes that people will show such distortions only to the extent that they still feel that the decision has a rational basis. In terms of Pyszczynski and Greenberg (1987), they want to maintain an illusion of objectivity.

As Jonas (1999) demonstrated in two studies, exclusively seeking supporting information and ignoring conflicting aspects is not a rational way of deciding for most people. Therefore, it is plausible to assume that people try not to be too biased in their selection and evaluation of information (see also Boiney, Kennedy, & Nye, 1997). This biasedness restriction could explain the stronger confirmation bias in sequential information seeking. In the simultaneous condition, participants had an overview of all the available supporting and conflicting articles and marked their information requests on that sheet of paper. As a consequence, being too biased in information selection would become quite obvious to the participants. In the sequential condition, this overview was lacking, which might have made their preference for supporting information less obvious to the participants and thereby might have fostered the confirmation bias. We directly test this hypothesis in Experiment 3.

However, there is another psychological mechanism that could explain why sequential information presentation strengthens the confirmation bias. Research from cognitive psychology has shown that different cognitive processes are involved when people are confronted with arguments or items sequentially versus simultaneously (Hogarth & Einhorn, 1992). Sequential presentation implies that each new item is immediately compared with one's prior belief (see also Edwards & Smith, 1996), and the implications of this item for one's prior belief are assessed. Thus, in our case, for each information title that is presented and for which a decision about reading or not reading the corresponding article has to be made, the participants' previous decision will be automatically activated, and they ask themselves, "What implications does that information have for my decision?" As a consequence, the sequential presentation should lead to a strong focus on the prior decision.

On the contrary, under simultaneous presentation the focus should be more on the information and less on the prior decision. The dominant reaction to a simultaneous presentation mode is to first compare the different items, to evaluate them, and to try to integrate them[4]—only in a second step is the comparison with one's prior belief made (Hogarth & Einhorn, 1992). In our case, this means that the dominant reaction to the simultaneous presentation mode is to compare the different information titles and to evaluate them with regard to the expected quality of the information. Only on the basis of the complete information (as far as it is given in the titles) do the participants ask themselves what implications this evidence has for their prior decision. As a consequence, the participants' attention should be less focused on this prior decision than in the sequential condition.

All in all, according to this mechanism, sequential presentation induces repeated thinking about one's prior decision; we thus refer to it as a *decision focus effect.* This decision focus, in turn, can increase the confirmation bias. As previous research has shown, repeated thinking about a hypothesis increases one's confidence in the correctness of this hypothesis as well as one's commitment to this hypothesis (for overviews, see Koehler, 1991; Tesser, Martin,

[4] It has to be emphasized that, according to Hogarth and Einhorn (1992), this so-called averaging strategy is only used if the items are not too complex and if no capacity constraints hinder the person from doing so. However, neither of these two restrictions should have been present in our experiments. Observations by the experimenters also confirm that in the simultaneous presentation mode the participants concentrated on comparing and evaluating the information titles.

& Mendolia, 1995). Thus, if the participants in the sequential condition repeatedly think about their previous decision, this could increase their conviction of already having found the best alternative as well as their commitment to this prior decision. Both mechanisms lead to a stronger confirmation bias because in the former case the person feels that there is hardly any need to test the decision critically (Schulz-Hardt, Frey, et al., 2000; Schulz-Hardt, Jochims, & Frey, 2000), whereas in the latter case the person feels a stronger need to defend this prior decision (Jonas et al., in press; Schulz-Hardt, Frey, et al., 2000; Schwarz, Frey, & Kumpf, 1980). We test this decision focus hypothesis in Experiment 4.

Experiment 3

As we outlined above, Experiment 3 was designed as a direct test of the biasedness restriction hypothesis. A straightforward way of testing this hypothesis is as follows: If generally people are trying not to be too biased, and if the stronger confirmation bias in sequential information search is due to the fact that the sequential presentation mode makes it difficult for them to realize how biased their search already is, then the confirmation bias should be reduced if people are given the opportunity to realize and counteract their bias. In other words, if people first seek information in the sequential presentation mode, if they are subsequently presented with a summary of their requests and then undergo a second information search phase in which the articles are presented simultaneously, they should use this second phase to counteract their bias from the first phase.

Therefore, in Experiment 3 the information search is divided into two different phases. The first eight information titles are presented sequentially. After that, the participants receive an overview sheet of these eight articles; on this overview sheet the requested articles are marked by the experimenter. Afterward, they receive a second overview sheet with eight new information titles, that is, the second information search phase is conducted simultaneously. If the biasedness restriction hypothesis is true, the confirmation bias should be clearly stronger in the first phase than in the second phase because after the first phase they realize their bias and try to counteract it in the second phase. This could even lead to a preference for conflicting information in the second phase. If, however, the decision focus hypothesis is true, we would not expect any difference between the two phases: The effect of repeatedly thinking about the prior decision that occurred in the first phase should still be active in the second phase.

Method

Participants and design. Seventeen students (5 male and 12 female, ages from 20 to 27 years) from the University of Munich participated in this experiment. The experiment is based on a 2 × 2 factorial (type of information: supporting vs. conflicting; search phase: first [sequential] vs. second [simultaneous]) factorial design with repeated measures on both factors.

Procedure. The procedure for the participants was similar to the sequential conditions in Experiments 1 and 2, with the following exception. After having made a preliminary decision concerning the health case and having been presented the first eight information titles sequentially (one title at a time; the participants had to decide whether they wanted to read the corresponding article), each participant received an overview sheet with these eight information titles. On this overview sheet the experimenter had marked the participant's information requests. In addition, the participant received a second overview sheet with another eight information titles and was informed that these articles were also available for further information. Thus, the second information search phase was identical to the simultaneous condition in Experiment 1. All requested articles were handed out after the second information selection phase was finished. As in the previous experiments, the participants were then asked to make their final decision. Afterward, they were informed about the experimental aims, thanked for their participation, and offered a chocolate bar as a token of our gratitude.

Results

Check for interfering effects. Of the 17 participants, only 2 voted against a payment of alternative healing methods. With regard to the confirmation bias ($M = 1.00$, $SD = 1.41$), they did not significantly differ from those participants who were in favor of insurance coverage of alternative health practices ($M = 2.20$, $SD = 3.23$), $|t(15)| < 1$. There were no effects of gender or age on the confirmation bias.

Information search. Cell means and standard deviations for chosen supporting and conflicting articles over the two phases of information search as well as for the confirmation bias are shown in Table 3. First, the analysis revealed a significant main effect for type of information, $F(1, 16) = 7.64$, $p < .02$, indicating that, on average, more supporting ($M = 4.29$, $SD = 2.34$) than conflicting

Table 3
Means and Standard Deviations for Information Search Dependent on Experimental Condition in Experiment 3

	Information				Confirmation bias[b]	
	Supporting		Conflicting			
Experimental condition[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall	4.29	2.34	2.24	1.92	2.06	3.07
Separated into the two phases						
First phase: sequential presentation	2.29	1.26	1.35	1.00	0.94	1.60
Second phase: simultaneous presentation	2.00	1.22	0.88	1.11	1.12	1.76

[a] $n = 17$. [b] The confirmation bias corresponds to the difference between the number of chosen supporting and the number of chosen conflicting articles.

articles ($M = 2.24$, $SD = 1.92$) were requested. More importantly, we found no difference in the confirmation bias between the two search phases: In the first (sequential) phase, the average confirmation bias is $M = 0.94$ ($SD = 1.60$); this bias significantly differed from zero, $t(16) = 2.43$, $p < .03$. However, in the second (simultaneous) phase, this bias was $M = 1.12$ ($SD = 1.76$), which also became significant if tested against zero, $t(16) = 2.61$, $p < .02$. All in all, the confirmation bias in the second phase was at least as strong as in the first phase; the corresponding interaction of search phase and type of information was insignificant, $F(1, 16) < 1$.[5]

Discussion

The results of Experiment 3 clearly contradict the biasedness restriction hypothesis. As in the first two experiments, during the sequential phase a strong confirmation bias emerged (because this bias is based on 8 instead of 16 articles, one has to multiply the confirmation bias by two to make it comparable with the first two experiments). However, even after the participants were given the opportunity to realize this bias and to counteract it in a second (simultaneous) phase, no such correction took place. If biasedness restriction were the driving force behind the differences between simultaneous and sequential information seeking, we should have found a significantly weaker confirmation bias or even a disconfirmation bias in the second phase.[6]

This result also helps rule out additional alternative explanations that might be suggested for the differences between sequential and simultaneous presentation. For example, one could suppose that people use a "diversification heuristic" if they are confronted with combined choices (simultaneous presentation), as has been observed in consumer decision making (Read & Loewenstein, 1995). Or it could be suggested that seeing that 50% of the articles support one's prior decision, as is the case in simultaneous presentation, reduces postdecisional dissonance compared with the sequential situation in which one can never be sure how much further support will come. However, both explanations would have predicted that the confirmation bias would decrease in the second (simultaneous) phase in Experiment 3, which obviously was not the case. In other words, the decision focus hypothesis is, from our point of view, the only one that can explain why the confirmation bias in simultaneous search is not lowered when this phase follows a sequential presentation phase: If the sequential presentation mode induced a decision focus and thereby heightened participants' confidence in or commitment to their prior decision, this effect should have endured during the simultaneous phase.

However, although this result contradicts several alternative explanations and is compatible with the decision focus hypothesis, it does not provide conclusive evidence for the correctness of this hypothesis. Therefore, the decision focus hypothesis is directly tested in Experiment 4.

Experiment 4

The decision focus hypothesis can be tested in two different ways. First, one could try to induce a decision focus in the simultaneous condition and see whether the resulting confirmation bias becomes as strong as in the sequential condition. One possibility to realize this would be to explicitly instruct the participants in the simultaneous condition to think about their prior decision before they read each information title. However, we felt that this could appear somewhat artificial to the participants; therefore, we decided on the second way of testing the decision focus hypothesis: Instead of inducing a decision focus in simultaneous information search, one could also try to remove (or at least reduce) the decision focus in the sequential condition and see whether the confirmation bias in sequential information search decreases to the level of the simultaneous search condition.

In Experiment 4 we tried to realize this by inducing a so-called *information focus*. If we suppose that the simultaneous presentation mode leads people to concentrate on the information, to compare and evaluate the different pieces of information, and, thereby, not to focus on their prior decision, the differences between simultaneous and sequential search should disappear if we induce this process in the sequential condition. This is done by explicitly asking the participants to evaluate each piece of information (to the extent that it becomes apparent for them from the main thesis) with regard to how credible an article is expected to be, how competent the author seems to be, and how persuasive the main argument is expected to be. These evaluations are made prior to deciding whether one wants to read the corresponding article.

The information focus factor was orthogonally crossed with presentation mode; that is, we induced this information focus in simultaneous as well as in sequential information search. However, for simultaneous presentation we did not expect any effects of information focus because, even without explicit instructions to focus on the information, this is what participants "normally" do (according to the decision focus hypothesis). On the contrary, if the decision focus hypothesis is correct, information focus should lead to a reduction of the confirmation bias in sequential information search, and that reduction should almost be to the level of the simultaneous conditions. In other words, the effect of presentation mode from Experiments 1 and 2 should only be replicated if no information focus is induced; for the information focus conditions, no effect of presentation mode should be observed.

In addition, if the decision focus hypothesis is true, this interaction effect should be mediated by commitment, confidence, or both. Repeatedly thinking about the prior decision should either increase one's confidence in the correctness of the prior decision or heighten one's commitment to this decision (Koehler, 1991), or both processes should be at work. Each of these processes would be capable of increasing the confirmation bias (e.g., Schulz-Hardt, Frey, et al., 2000). Thus, we measured both confidence and commitment to show mediation and thereby clarify the effect.

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[5] In addition, we found a significant main effect for information presentation, $F(1, 16) = 9.32$, $p < .01$, indicating that participants under sequential information presentation (first phase) requested more articles ($M = 3.65$, $SD = 1.62$) than under simultaneous information presentation (second phase, $M = 2.88$, $SD = 1.54$). We do not discuss this effect further because it is not of relevance for the central aims of this experiment.

[6] Data from an additional experiment that we do not report here also speak against the biasedness restriction hypothesis: If, subsequent to the sequential information search but before reading the requested articles, the participants are asked how many supporting and conflicting articles they have marked, they do not underestimate their own confirmation bias. The biasedness restriction hypothesis, on the contrary, only works if people fail to realize their bias during sequential presentation.

Table 4
Means and Standard Deviations for Information Search Dependent on Experimental Condition in Experiment 4

	Information				Confirmation bias[b]	
	Supporting		Conflicting			
Experimental condition[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Simultaneous presentation						
Control	2.33	2.69	1.27	1.87	1.07	2.28
Information focus	3.13	2.98	1.73	2.29	1.40	2.20
Sequential presentation						
Control	5.13	2.09	2.07	2.05	3.07	2.81
Information focus	2.60	2.47	1.53	1.88	1.07	1.39

[a] $n = 15$ in each condition. [b] The confirmation bias corresponds to the difference between the number of chosen supporting and the number of chosen conflicting articles.

Method

Participants and design. Sixty students (24 male and 36 female, from ages 17 to 42 years) from the University of Munich participated in this experiment. The experiment is based on a 2 × 2 × 2 (presentation mode: simultaneous vs. sequential; information focus: not given vs. given; type of information: supporting vs. conflicting) factorial design with repeated measures on the third factor.

Procedure. The procedure for the participants without information focus was identical to Experiment 2; for all participants the requested articles were handed out after the complete search phase was finished. In the information focus conditions, the participants had to evaluate each article (on the basis of the information titles) with regard to three aspects: credibility of the article, competence of the author, and persuasiveness of the article. To make sure that this evaluation took place, for each aspect, we used a scale ranging from 1 to 10 on which the evaluation was marked. In the sequential condition, each information title was written on a separate page; the questions and answering scales were written below the title and above the small box where the participants made their cross if they wanted to read the article. In the simultaneous condition, the participants received two separate sheets, one with the information titles and the boxes for the information requests, the other one with the evaluation questions and the answering scales. The experimenter took care that the participants first completed these scales before they marked whether they wanted to read the corresponding article.

After the participants had finished the information search phase, they indicated their degree of confidence about having found the better alternative as well as their degree of commitment to that alternative. Both questions were answered on scales from 1 to 10. Afterward, the participants had the opportunity to read the requested articles and to ask questions about the experiment, and they were informed about the experimental aims. As in the previous experiments, they were given a chocolate bar and thanked for their participation.

Results

Check for interfering effects. Of the 60 participants, only 5 voted against a payment of alternative healing methods. Whereas these 5 participants showed a preference for conflicting over supporting information ($M = -1.20$, $SD = 0.45$ for the confirmation bias), those participants in favor of the payment of alternative healing methods clearly displayed a preference for supporting over conflicting information ($M = 1.91$, $SD = 2.25$ for the confirmation bias).[7] The difference between these two groups was significant, $t(31.42) = 8.54$, $p < .001$.[8] However, this effect did not influence the results of the experimental design. Participants' age or gender had no effects on information search.

Information search. Cell means and standard deviations for chosen supporting and conflicting articles as well as for the confirmation bias are shown in Table 4. As in the former experiments, a significant main effect for type of information emerged, $F(1, 56) = 32.86$, $p < .001$, indicating that, on average, more supporting ($M = 3.30$, $SD = 2.78$) than conflicting articles ($M = 1.65$, $SD = 2.02$) were requested. Additional t tests against zero revealed that a significant confirmation bias emerged in the following conditions: simultaneous presentation/information focus: $M = 1.40$, $SD = 2.20$, $t(14) = 2.47$, $p < .03$; sequential presentation/no information focus: $M = 3.07$, $SD = 2.81$, $t(14) = 4.22$, $p < .002$; and sequential presentation/information focus: $M = 1.07$, $SD = 1.39$, $t(14) = 2.98$, $p < .02$. In the condition simultaneous presentation/no information focus, the effect was only marginal: $M = 1.07$, $SD = 2.28$, $t(14) = 1.81$, $p < .1$.

The main effect for the repeated measures factor was qualified by a significant three-way interaction with presentation mode and information focus, $F(1, 56) = 4.11$, $p < .05$. Simple effects analyses revealed that the pattern of results was exactly the one predicted by the decision focus hypothesis. If no information focus was given, the presentation mode led to a significant effect,

[7] In all four experiments, those participants who voted for the payment of alternative healing methods displayed a stronger confirmation bias than those who voted against this payment. For two of the four experiments, this difference reached significance. In addition, participants voting against the payment of alternative healing methods were clearly in the minority and, on average, showed no clear confirmation bias at all. We can only speculate about the reasons for this difference. One possibility is that both alternatives are not psychologically equivalent with regard to their implications. A person who votes for the payment of alternative healing methods does, by doing so, not automatically vote against traditional medicine. People choosing the other alternative, on the contrary, vote for traditional medicine and against alternative methods. Explicitly voting against a particular alternative may induce a norm to be fair and to hear arguments from both sides.

[8] Because of inhomogeneous variances, the separate variance estimate was used here; this caused the broken number of degrees of freedom.

$t(56) = 2.46$, $p < .02$; as in Experiments 1 and 2 the confirmation bias was stronger in sequential ($M = 3.07$, $SD = 2.81$) compared with simultaneous information search ($M = 1.07$, $SD = 2.28$). Again, as in Experiments 1 and 2, this difference was caused by the fact that more supporting articles were chosen in sequential ($M = 5.13$, $SD = 2.09$) than in simultaneous search ($M = 2.33$, $SD = 2.69$), $t(56) = 2.93$, $p < .01$, whereas no significant differences were obtained for the number of chosen conflicting articles (for sequential search: $M = 2.07$, $SD = 2.05$; for simultaneous search: $M = 1.27$, $SD = 1.87$), $t(56) = 1.07$, $p > .25$.

If, on the contrary, an information focus was induced, no effect of presentation mode was obtained, $|t(56)| < 1$. In this case, the confirmation bias in the sequential condition ($M = 1.07$, $SD = 1.39$) was reduced to the level of the corresponding simultaneous condition with information focus ($M = 1.40$, $SD = 2.20$). All in all, as predicted by the decision focus hypothesis, inducing an information focus made the effect of the sequential presentation mode disappear.[9] We now try to find out whether confidence in the correctness of the decision, commitment to the decision, or both processes mediate the effect we obtained.

Mediation analyses. Both hypothetical mediators are analyzed according to mediation criteria set forth by Baron and Kenny (1986). These criteria are as follows: (a) The independent variable must influence the mediator; (b) the mediator must influence the dependent variable; and (c) controlling for the influence of the mediator, the influence of the independent variable on the dependent variable must be substantially lowered.

Thus, in the first step we have to find out whether the same interaction effect that was found for the confirmation bias also occurs for confidence and commitment. If confidence is a mediator, then the sequential presentation mode should lead to higher confidence compared with the simultaneous presentation mode only if no information focus is induced, because only in the former condition should the repeated thinking about one's prior decision cause an increase in confidence and, as a consequence, an increase in the confirmation bias. The same logic applies to commitment.

However, for confidence, neither this interaction effect nor any other significant effect was found (all Fs < 1). The average confidence ratings were almost the same for all four conditions: $M = 8.60$, $SD = 1.45$ for simultaneous presentation/no information focus; $M = 8.60$, $SD = 2.38$ for sequential presentation/no information focus; $M = 8.79$, $SD = 1.19$ for simultaneous presentation/information focus; and $M = 8.47$, $SD = 1.92$ for sequential presentation/information focus. On the contrary, for commitment, we obtained the predicted interaction, $F(1, 56) = 4.04$, $p < .05$. The simple effects were in line with the considerations outlined above: If no information focus was induced, commitment to the decision was stronger after sequential presentation ($M = 8.40$, $SD = 2.47$) than after simultaneous presentation ($M = 6.33$, $SD = 2.66$), $t(56) = 2.32$, $p < .03$. In the information focus conditions, however, no significant difference between sequential ($M = 7.47$, $SD = 2.59$) and simultaneous presentation ($M = 7.93$, $SD = 1.98$) was obtained, $|t(56)| < 1$. Thus, only commitment is further tested for mediation.

Examining the second condition, we calculated a regression analysis in which commitment was the predictor and the confirmation bias was the criterion. This analysis revealed a significant positive regression weight for commitment, $\beta = .46$, $t(58) = 4.03$, $p < .001$, indicating that higher levels of commitment are associated with a stronger confirmation bias.

In the final step, it has to be examined whether the statistical control for commitment reduces the predictive power of the interaction term for the confirmation bias. Using the confirmation bias as the criterion and the two experimental conditions as well as the interaction term as predictors in a hierarchical regression analysis, we found that the standardized regression weight for the interaction term is $\beta = .44$, $t(56) = 2.03$, $p < .05$. If the influence of commitment on the confirmation bias was controlled for, the regression weight for the interaction term was no longer significant, $\beta = .26$, $t(55) = 1.26$, $p > .20$, whereas commitment still was a significant predictor for the confirmation bias, $\beta = .40$, $t(55) = 3.34$, $p < .01$. In sum, commitment mediates the effect of the interaction term on the confirmation bias, although, since β has not been reduced to zero, no full mediation has been shown.

Discussion

The results of Experiment 4 clearly support the decision focus hypothesis. If we induce an information focus in the sequential condition—a focus that, according to the decision focus hypothesis, should be usual for people under simultaneous presentation but quite unusual under sequential presentation because the latter mode should lead to a decision focus—the effect of presentation mode disappears. Whereas without information focus induction we replicated the central finding from Experiments 1 and 2, namely that the confirmation bias is stronger under sequential compared with simultaneous presentation, inducing an information focus kept the bias in the sequential condition at the same (low) level as that in the simultaneous condition. Thus, Experiment 4 gives us good reason to believe that "normally" sequential information presentation leads to repeatedly thinking about the decision—each new piece of information is compared with one's prior decision (Hogarth & Einhorn, 1992)—and only if this decision focus effect is blocked by inducing a contrary focus does the effect of presentation mode disappear.

The mediation analyses also provided evidence that this effect of decision versus information focus is mediated by commitment: If people repeatedly think about their prior decision, this leads to an increase in commitment compared with people who focus less on their decision (cf. Koehler, 1991; Tesser et al., 1995). This higher commitment, in turn, induces a stronger motivation to defend one's position (e.g., Chaiken, Liberman, & Eagly, 1989; Festinger, 1964; Frey, 1986; Kruglanski, 1989), thereby inducing a strong bias toward supporting pieces of information (Schulz-Hardt, Frey, et al., 2000; Schwarz et al., 1980). This converges with the results from prior studies on sequential information eval-

[9] In both information focus conditions, the supporting articles, on the basis of the main theses, were evaluated as being more credible ($M = 6.54$, $SD = 1.63$), more persuasive ($M = 6.33$, $SD = 1.86$), and written by a more competent author ($M = 5.99$, $SD = 1.92$) than the conflicting articles (credibility: $M = 4.26$, $SD = 1.50$; persuasiveness: $M = 3.10$, $SD = 1.24$; competence: $M = 3.79$, $SD = 1.32$). This evaluation bias was significant for all three attributes: $F(1, 28) = 23.74$, $p < .001$ for credibility; $F(1, 28) = 62.18$, $p < .001$ for persuasiveness; and $F(1, 28) = 25.32$, $p < .001$ for competence. However, no significant differences between sequential and simultaneous presentation were obtained (all Fs < 2, all ps $> .15$).

uation (e.g., Geller & Pitz, 1968; Godden, 1976; Pitz, 1969), in which commitment has been found to be a mediator for the fact that people often fail to revise a hypothesis in accordance with subsequent evidence. As our results imply, not only may they fail to revise their preliminary decision, but they may even actively try to bolster this decision if they focus on it and, thus, feel committed to it.

Confidence, which has previously also been shown to increase when a position is made salient (Koehler, 1991; Tesser et al., 1995), did not play a mediating role in this effect. If we take into account that in all four experiments the stronger confirmation bias under sequential compared with simultaneous presentation was due to the fact that participants under sequential presentation chose more supporting (and not less conflicting) articles than participants under simultaneous presentation, commitment also seems to be the more plausible mediator. If a defense motivation is induced (commitment), then it is reasonable to look for as much supporting information as possible. If, however, the participants with the sequential presentation mode felt comparably more confident about having found the superior alternative, then this confidence should reduce their need to critically test this alternative; that is, they should request less conflicting articles. Searching for more information if one feels more confident seems to make less sense.

However, at least three limitations of these latter findings have to be taken into account. First, for both possible mediators, only one-item measures were taken. Thus, the failure to find effects for confidence could also be due to insufficient reliability. Second, because of the experimental procedure, we were only able to measure both mediators after the participants had made all their information requests (but, of course, before they read the requested articles). Because, in the sequential conditions, being presented an item and deciding whether to request the corresponding article were done in the same step, it was not possible to measure the mediator prior to the information choices. Thus, it would be useful to modify our procedure and separate information presentation and information choice in further experiments.

Finally, even if the decision focus effect is mediated by commitment and not by confidence—and the fact that no full mediation was shown still leaves open the possibility of additional mediators—this could also be dependent on the case study we used in our experiments. To achieve strong involvement on the part of the participants, we used a topic that is of high political relevance in Germany at the moment. However, the topic of whether alternative healing methods should be covered by health insurance is a theme that often leads to discussions that are (also) carried out on an emotional level, and it is a theme on which most people (at least most students) hold comparably strong convictions (as the high confidence ratings in all conditions indicate). Both features could have worked against a confidence effect and in favor of a commitment effect, so it would be best to try to replicate these findings with different case studies.

General Discussion

We started the research reported here by asking whether findings concerning dissonance theory's selective exposure hypothesis (Frey, 1986) can be generalized to situations in which new information is sought sequentially instead of in the traditional simultaneous "one-shot" manner. In all four experiments, we found consistent support for the assumption that this generalization is valid; in each experiment participants performing sequential information search showed a significant confirmation bias—they preferred articles that supported their previous tentative decision compared with articles that contradicted this decision. To our knowledge, this is the first test ever done to show that this generalization can be made. As we have pointed out, sequential information seeking seems to be more typical of decision processes in real settings than the typical procedure from selective exposure research because decision makers in applied settings hardly ever possess an overview of the available pieces of information when they are confronted with a decision problem (Vertzberger, 1990). Additionally, they can hardly ever delay processing the requested pieces of information until all information requests have been made. We thus can conclude that there is no reason to believe that a confirmation bias disappears if the research procedure captures more typical features of decision making in the field.

Our results not only highlight the practical relevance of biased information seeking by showing a significant confirmation bias under conditions of sequential information search but also reveal an increase in the confirmation bias when the information search was run sequentially instead of simultaneously. As Experiment 2 showed, this stronger confirmation bias is due to sequential presentation of the available information and not due to sequential processing of the requested articles during the selection phase. We could thus rule out that need for structure (Kruglanski, 1989) caused by cognitive load (Ford & Kruglanski, 1995) or belief polarization due to biased processing of the requested articles (Edwards & Smith, 1996; Lord et al., 1979) was responsible for this effect of sequential search. Experiment 3 further ruled out that the higher confirmation bias in sequential presentation is caused by the fact that people, as can be derived from Kunda's (1990) motivated reasoning concept, try to maintain an *illusion of objectivity* (Pyszczynski & Greenberg, 1987) by trying not to be too biased and that this attempt fails under sequential conditions because of the lack of an overview.

The only approach that was able to explain why, on the one hand, sequential presentation leads to a stronger confirmation bias than simultaneous presentation (Experiments 1 and 2) but, on the other hand, no such difference occurs if simultaneous search follows a sequential search phase (Experiment 3), was the so-called decision focus hypothesis. According to this hypothesis, and in line with research from cognitive psychology (Hogarth & Einhorn, 1992), being sequentially confronted with new pieces of information makes one's prior decision salient because each new information title is compared with this decision. Thus, as a result of the sequential presentation, the prior decision repeatedly comes into mind. This focusing on the decision increases commitment to one's own standpoint (cf. Tesser et al., 1995) compared with persons to whom the information is presented simultaneously: In this case, people concentrate on comparing, evaluating, and integrating the new pieces of information, and only after that process are the implications for the prior decision assessed (Hogarth & Einhorn, 1992). As a consequence, the focus is more on the information and less on the prior decision.

In a direct test of this hypothesis, Experiment 4 revealed that introducing an information focus (which, as outlined above, should be typical for simultaneous search) in sequential information seeking made the effect of processing mode disappear. In other words,

if people in the sequential presentation condition are instructed to use the same focus as those with simultaneous presentation, the former also show the same information search pattern as the latter. This evidence for the decision focus hypothesis is even stronger if we further take into account that commitment has been shown to (partially) mediate the effect in Experiment 4. Thus, to summarize our findings, sequential information presentation makes the prior decision salient, thereby increases commitment to that decision and, as a consequence, leads to a stronger confirmation bias compared with simultaneous presentation.

Dissonance Theory and Biased Information Search

The results we obtained in the four experiments reported here are almost in line with the dissonance theory view of selective exposure to information (cf. Festinger, 1957, 1964; Frey, 1986). Prior dissonance research on this topic has consistently shown that increased commitment to a position leads to a stronger confirmation bias in information search (e.g., Schwarz et al., 1980; see also Schulz-Hardt, Frey, et al., 2000). In addition, a consistent pattern in these dissonance studies was that manipulations of relevant antecedent conditions (e.g., free choice, commitment, and intensity of dissonance) influenced the search for supporting information, whereas the search for conflicting information was hardly ever affected (Frey, 1986). Both processes were clearly observable in our experiments. From a dissonance theory view, they can be explained by assuming that the more one feels committed to a decision, the more dissonance one experiences if this decision is threatened (and half of the articles in fact are threatening for the decision). However, simply avoiding dissonant information would not reduce any experienced dissonance; thus, seeking additional supporting information is a more effective strategy.

However, saying that the results we obtained are in line with dissonance theory does not imply that one would have easily predicted these results on a dissonance theory basis. Obviously, dissonance theory does not predict that consecutive information choices will lead to a focus on the decision and thereby increase commitment to that decision. The dissonance approach to biased information seeking has always been a somehow stationary one: People make a (preliminary or final) decision, feel a certain degree of commitment to that decision, and, in a second step, show a confirmation bias in information search depending on how large this commitment is (Frey, 1986). However, in real life, making a decision and seeking new information are ongoing, interactive processes that cannot easily be separated. As our experiments show, specific features of the information search process may increase (or decrease) people's commitment to their decision and, thereby, have repercussions on the kind of information that is preferred.

In another example of this interplay, Jonas and Frey (2000) showed that being forced to choose a certain number of articles induces a stronger confirmation bias than being free to choose as many articles as one likes. This applied to the classical simultaneous information search procedure as well as to the (more realistic) sequential procedure used in the experiments described in this article. Being forced to choose between supporting and conflicting information may make the act of choosing more salient, thereby enhancing the focus on the prior decision and, as in the experiments reported here, increasing commitment to that decision. If, however, people have to justify their information choices, their confirmation bias is reduced or even turns into a disconfirmation bias (Jonas & Frey, 2000). Against the background of the results from the experiments reported above, being forced to justify why a particular piece of information is chosen or not chosen should induce an information focus instead of a decision focus, thereby debiasing information search. Thus, predicting the occurrence and the strength of confirmatory information search in real-life decision making calls for an approach that captures this dynamic interplay of characteristics of the information search and decision characteristics (such as commitment, confidence, etc.). Whether this can be more successfully achieved by reformulating and extending the dissonance framework from a decision-process perspective or by integrating variables like commitment and defensive motivation into process theories of decision making (e.g., Montgomery, 1989; Svenson, 1996) is an open question for further theoretical and empirical research.

Practical Implications

As we outlined in the beginning, information search in real-life settings is carried out more or less sequentially. Thus, a direct implication of our results is that prior studies on biased information search that used a simultaneous search procedure have underestimated the degree to which people exhibit a preference for supporting information in "real" decision making. The more natural setting of sequential information search leads to a stronger confirmation bias.

Does this, in turn, imply that people are more irrational under these conditions, and therefore their need for debiasing techniques is greater? In our opinion, there is no clear-cut answer to this question. As our results show, people with sequential information search do not become ignorant to conflicting information; in none of the experiments did the sequential mode lead to a decrease in the number of requested conflicting articles. On average, the participants selected about two conflicting articles in our experiments. Thus, they definitely tried to pay attention to conflicting opinions and arguments. Instead, what they did if they developed a strong commitment as a result of sequential information presentation and choices was to request additional supporting articles for their decision.

Now, if we realize that, when making decisions, people experience conflict between avoiding a mistake (or avoiding adopting a position that is not justified by the evidence) and preventing indecisiveness (Beckmann & Kuhl, 1984; Wicklund & Frey, 1981), the participants in the sequential conditions seem to have made a good compromise: They paid attention to both kinds of information but, at the same time, the predominance of requested supporting articles helps them bolster the position to which they feel committed. Results from studies on motivated reasoning that deal with information evaluation instead of information seeking support this notion: People are more ready to accept arguments supporting their position, but if conflicting arguments are strong and valid, they are accepted and incorporated rather than dismissed (Ditto & Lopez, 1992; Ditto et al., 1998).

However, although the information search pattern in the sequential conditions may be functional in many contexts, under specific conditions it may be undesirable for the decision maker to predominantly seek supporting information. For example, we would

expect a medical doctor to avoid any premature commitment to a specific diagnosis and, even if the doctor feels committed to a diagnosis, would like him or her to pay attention to information that speaks for alternative diagnoses. Or, to give another example, if a supervisor evaluates the performance of an employee, we expect the supervisor to be fair and not to prefer information that supports his or her prior impression of this employee. In situations like these, it can be important to recognize that the sequential nature of information search may lead to a reinforcement of one's prior position and, thereby, induce a strong preference for supporting information.

If one is aware of this possibility, how can one prevent mechanisms like these? Obviously, knowing that simultaneous search will lead to a smaller bias hardly helps because it is difficult to restructure the information search in a given situation: Doing so is only possible if a priori an overview of all relevant information is available, and this will seldom be the case. The results of Experiment 4 suggest that one possibility is to focus on aspects of the information such as expected persuasiveness, credibility, and source competence, thereby trying to pay less attention to one's prior decision. Although not making the confirmation bias disappear, focusing on the information at least diminished this bias.

However, as this effect was completely due to a reduction in the requests for supporting information and not due to increased interest in conflicting information, this "intervention" may not be completely satisfying. Thus, a better solution could be based on the above-mentioned manipulation by Jonas and Frey (2000), who induced a need to justify the information choices in two of their experiments. In these experiments, having to justify one's information search increased the number of chosen conflicting articles. This converges with results from other areas of decision-making research showing that accountability for the decision process, contrary to accountability for decision outcomes, makes decision processes more accurate and unbiased (e.g., Doney & Armstrong, 1996; Siegel-Jacobs & Yates, 1996; Simonson & Staw, 1992). Thus, inducing accountability for the decision process (e.g., by evaluating how the decision maker conducted his or her search for information) may be an effective means of counteracting a confirmatory information search pattern that, as our experiments show, is particularly strong in settings that involve sequential confrontation with new pieces of information.

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