

Fostering Social Navigation and Elaboration of Controversial Topics with Preference-Inconsistent Recommendations

Christina Schwind, Jürgen Buder, Friedrich W. Hesse, Knowledge Media Research Center, Konrad-Adenauer-Str. 40, 72072 Tübingen, Germany

Email: c.schwind@iwm-kmrc.de, j.buder@iwm-kmrc.de, f.hesse@iwm-kmrc.de

Abstract: Critical thinking requires knowledge about the diversity of viewpoints on controversial issues. However, the diversity of perspectives often remains unexploited: Learners prefer preference-consistent over preference-inconsistent information, a phenomenon called confirmation bias. Two lab experiments were designed to test whether technologies such as recommender systems can be used to overcome this bias. The role of preference-inconsistent recommendations was explored by comparing their influence to a condition with preference-consistent recommendations and to a control condition without recommendations. In Study 1, preference-inconsistent recommendations led to a reduction of confirmation bias and to an attenuation of preferences. In Study 2, we found that preference-inconsistent recommendations stimulated balanced recall and divergent thinking. Together these studies showed that preference-inconsistent recommendations can foster social navigation and elaboration. In conclusion, future research and practical implications are discussed.

Introduction

Controversies and debates on political or health related issues can be characterized as ongoing deliberations among stakeholders with widely diverse perspectives. On the basis of these perspectives, individuals are able to form an opinion and to back up this opinion with arguments. Thus, learning is a central part of opinion formation and can help the individual to make an informed decision. The WWW is a perfect backdrop for this kind of learning as a multitude of opinions is publicly available: Whether it is through information portals on controversial issues, or through the exchange on forums, social networks, or other channels, information spaces can be characterized by an accumulation of a vast amount of differing opinions.

Why Information Search May Be Biased

However, the availability of different opinions remains unexploited: When learners only have a vague idea about a controversial issue, they inform themselves about the facts, arguments, or explanations. When doing so, they often fail to take dissenting information into account which is referred to as selective exposure (Knobloch-Westerwick & Meng, 2010) or confirmation bias (Jonas, Schulz-Hardt, Frey, & Thelen, 2001). Festinger's (1957) dissonance theory provides the basis for this effect: Individuals try to avoid dissonance and therefore prefer information which supports their own position. Consequently, knowledge acquisition is typically biased in favor of the learner's previously held expectations. This biased knowledge acquisition leads to learners adhering to their position, even though considering others and their perspectives is a necessary first step for critical thinking (Stanovich & West, 1997). Therefore confirmation bias is likely to be a hindrance to critical thinking (West, Toplak, & Stanovich, 2008).

Why We Can Use Technology to Overcome Confirmation Bias

The question arises if and how we can use technology to overcome this bias. One possible solution is to emphasize preference-inconsistent information by the use of recommender systems, as they are optimized for making specific information salient. Recommender systems can be classified as a collaborative technology for filtering information: Users express social judgments explicitly by rating stimuli or implicitly by their navigational behavior. Out of these social judgments, each user receives personalized recommendations that are matched to the user's profile stored by the system (Konstan & Riedl, 2003). Community-generated recommendations may act as an information signpost influencing individual navigation and item selection. If this is the case, it is called social navigation (Dieberger, Dourish, Höök, Resnick, & Wexelblat, 2000).

In many ways, the principles of recommender systems are very much in line with principles that play an important role in the learning sciences. First, constructivist approaches often stress the importance of moving from teacher-centered to learner-centered education (Bransford, Brown, & Cocking, 1999). Recommender systems fit into this philosophy, as the recommendations do originate from the collective of other peers. Second, aptitude-treatment interaction expresses the idea of adapting information to the needs and abilities of learners (Cronbach & Snow, 1977). This is addressed by personalized recommender systems in which recommendations are specifically tailored to the learner. Finally, learners need some form of scaffolding (Vygotsky, 1978). Recommender systems provide information to learners on how to allocate their cognitive capacity. They can help to identify the resources that really matter and thereby create a zone of proximal development.

However, some features of recommender systems can be detrimental to learning. Classical recommender systems provide mainly preference-consistent recommendations, as this method appears to be promising in fields of taste and consumption. But in doing so, classical recommender systems violate the educational claim of multiperspectivity and informational diversity (De Wit & Greer, 2008; Spiro & Jehng, 1990). Therefore it would seem to be useful to recommend preference-*inconsistent* arguments for educational purposes.

Why Preference-inconsistent Recommendations May Help

Educational literature states that one of the learning goals is to think decontextualized without the biasing influence of prior preferences and opinions. Learners should elaborate on controversial topics and evaluate arguments regardless of whether they tend towards the advantages or disadvantages of a specific topic. This form of unbiased reasoning is referred to as critical thinking (Stanovich, & West, 1997). Facing preference-inconsistency or disagreement is considered to stimulate critical thinking (e.g., Buchs, Butera, Mugny, & Darnon, 2004; Johnson & Johnson, 2009). The basis of this approach is Piaget's (1950) theorizing that internal conflicts are necessary to stimulate cognitive development. The uncertainty which results from conflicting situations leads to epistemic curiosity (Berlyne, 1960), which is a main trigger for further information search and for an interest in an understanding of other perspectives. Doise and Mugny (1984) stressed that constructive conflicts are best initiated by the direct confrontation with the opinion of others. Further, social psychology hints at other potentials of conflicts, for instance in the literature on the influence of minorities (Nemeth, 2003). Participants confronted with authentic dissent from a minority show increased searching for information, deep elaboration, creative problem solutions, and thus divergent thinking (Nemeth, Connell, Rogers, & Brown, 2001; Nemeth, & Rogers, 1996; Nemeth, & Wachtler, 1983). From research on the influence of minorities, it is known that these effects can lead to informational influence and to changes in attitudes (Wood, Lundgren, Ouellette, Busceme, & Blackstone, 1994).

The question remains whether conflicting information must originate from direct interaction with another person or whether a preference-inconsistent recommendation originating from a computer system may also stimulate conflict and foster deeper elaboration. One indication that computer-based recommendations can be efficient substitutes relates to the notion that human social categories are ascribed to recommender systems (McNee, Riedl, & Konstan, 2006). However, empirical clarification is needed to investigate whether or not the "recommender personality" is sufficient to stimulate socio-cognitive conflict.

The present research attempted to clarify whether preference-inconsistent recommendations can stimulate conflict and thus affect social navigation and elaboration. We did not address the technical specifications of a recommender system, but rather explored the psychological impact of recommendations. In two lab experiments, we manipulated the type of social navigation tool by providing recommendations that were either consistent or inconsistent to the participants' prior preferences. These two conditions were compared to a control condition without any recommendation.

Hypotheses

Conflict can lead to epistemic curiosity and therefore trigger further information search and higher interest in understanding an opposite perspective (Buchs et al., 2004). Preference-inconsistent recommendations are conceptualized as stimulating conflict and therefore motivate learners to search for more inconsistent information resources.

Hypothesis 1. Therefore, it was hypothesized that participants will show natural confirmation bias when no recommendation is given. Preference-consistent recommendations will enhance confirmation bias, whereas preference-inconsistent recommendations will reduce confirmation bias. (Study 1 & Study 2)

Hypothesis 2. It was predicted that the difference in confirmation bias will have its equivalent in the adaptation of subjects' preferences: Participants' preferences will be strengthened in the post-preference when no recommendation is given. Preference-consistent recommendations will also strengthen preferences, whereas preference-inconsistent recommendations will weaken preferences. (Study 1)

Hypothesis 3. It was expected that participants confronted with preference-inconsistent recommendations are more likely to experience dissent. Therefore they will (3a) recall more arguments and (3b) show a more balanced recall than participants confronted with preference-consistent or no recommendation. (Study 2)

Hypothesis 4. Based on the literature on minority dissent, it was also expected that participants confronted with preference-inconsistent recommendations will (4a) generate more arguments in general as well as (4b) more novel arguments than participants confronted with preference-consistent or no recommendation. (Study 2)

Study 1

The first study was conducted as an online experiment and investigated the impact of recommendations on information selection and preference adaptation.

Method

Participants

One hundred twenty-five subjects participated in the experiment. They were recruited via an academic e-mail-list and compensated by the participation in a lottery. Based on manipulation check data, four subjects were excluded from the analysis. Ultimately, data of 121 subjects ($M = 25.28$, $SD = 6.05$; 92 female) were included in the analysis. In order to prevent high levels of prior knowledge, students of medicine or pharmacy were excluded from participation. The majority of participants (90.8%) judged their prior knowledge of the subject matter to be very poor, poor, or average.

Materials

The materials of the online study comprised a number of screens. One screen contained a short introductory text about the controversial topic of neuro-enhancement, referring to the facilitation of cognitive abilities through training or through medication. The main screen of the experiment consisted of a bogus list of Web search results. The list was composed of eight written arguments, four of them supporting and four of them opposing neuro-enhancement. The arguments consisted of a headline followed by two explanatory sentences. An example of an argument supporting neuro-enhancement is: “Minimizing risks at the workplace: Neuro-enhancement should be embraced particularly in professional fields in which human failure is likely to lead to detrimental outcomes (e.g. air traffic controllers, surgeons, or military personnel).” An example of an argument opposing neuro-enhancement is: “Striving for undesirable perfectionism: The era of lovable little quirks might be over quite soon. Research is looking for ways to make us perfect. We don't need that.” The arguments were tested in an online survey ($N = 48$) to balance them for credibility, persuasiveness, comprehensibility, originality, and strength. Although the headlines were marked as hyperlinks, participants could not access additional information. One of the arguments was highlighted by an orange-colored frame surrounding the text. This argument represented the recommendation. The caption above the frame stated: “The following information is recommended to you.” (see Figure 1). The order of the arguments and the serial position of the recommendation were randomized across participants in order to minimize content and order effects.

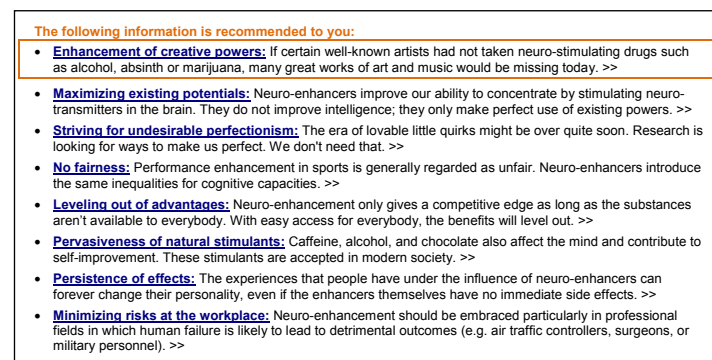


Figure 1. Screenshot of the Experimental Conditions with Recommendation (Translated from German).

Design

The experiment is based on a one factorial design with three conditions (control condition vs. preference-consistent vs. preference-inconsistent). In the control condition (CC), no argument was recommended to the participants. In the first experimental condition (EC_{con}), an argument was recommended that was consistent with the participant's pre-preference for or against neuro-enhancement. In the second experimental condition (EC_{inc}), an argument was recommended that was inconsistent with the participant's preference. The preference data showed that 70.2 % of the participants were against neuro-enhancement. This preference ratio was equally distributed over the three conditions ($F(2,118) < 1$, $p = .727$, $\eta^2 = .00$).

Procedure

The scenario was adapted from Jonas et al. (2001) and structured into three phases: First, subjects read the introductory passage on neuro-enhancement, and subsequently indicated their pre-preference on neuro-enhancement. In the second phase, the list of eight arguments was presented with four arguments in favor of and

four arguments against neuro-enhancement. This phase varied depending on the condition, mimicking the personalization part of recommender systems. In the control condition, no recommendation was given. In the consistent experimental condition, subjects received a preference-consistent recommendation, and in the inconsistent experimental condition, subjects received a preference-inconsistent recommendation. Subjects were asked to select exactly one of the eight arguments that they would like to read more about by clicking on an adjacent box. In the third phase, participants were asked to indicate their post-preference. The preference adaptation scales contained one item on a 6-point bipolar continuum. The preference indication was represented by a word pair ranging from opposing (-2.5) to endorsing (+2.5) neuro-enhancement. Afterwards, participants were asked to fill out two items for the manipulation check and to provide demographic details (age, gender).

Measures

In the first study, we focused on information selection and preference adaptation.

Manipulation check. Manipulation check consisted of two questions. Participants had to decide if the recommended argument was for or against neuro-enhancement on a dichotomous item and they were asked to indicate on a 5-point Likert scale whether the recommended argument matched their own position *absolutely* (+2) or *not at all* (-2).

Information selection. Information selection was measured for testing the impact of the recommendations on confirmation bias. The measurement expressed the likelihood of selecting a preference-consistent over a preference-inconsistent argument.

Preference adaptation. The adaptation of preferences was calculated as the difference between the absolute value of the post-preference and the absolute value of the pre-preference. In this way, it was possible to differentiate whether subjects' preferences were weakened or strengthened.

Results

Information selection was tested with χ^2 -tests, whereas preference adaptation was analyzed using analysis of variance (ANOVA).

Manipulation check. The first question asked whether the recommended argument was for or against neuro-enhancement. For the second question, EC_{con} subjects were excluded if they indicated that the recommended argument did not match their pre-preference (i.e. a value less than or equal to zero). Contrary, EC_{inc} subjects were excluded if they indicated that the recommended argument did match their pre-preference (i.e. a value greater than or equal to zero). Participants were included in the analysis only if the answers to both questions were correct. Following this rule, the analysis comprised 40 CC subjects, 41 EC_{con} subjects, and 40 EC_{inc} subjects.

Information selection. In Hypothesis 1, a confirmation bias was predicted in the control condition, an enhancement of confirmation bias in the preference-consistent condition, and a reduction of confirmation bias in the preference-inconsistent condition. To test this prediction, we computed an overall χ^2 -test with the factors condition (CC vs. EC_{con} vs. EC_{inc}) and information selection (consistent vs. inconsistent). The analysis revealed a marginally significant effect, $\chi^2_{0.95(2)} = 3.51$, $p = .087$, $d = 0.35$. By testing the three conditions separately, a significant effect occurred for CC ($\chi^2_{0.95(1)} = 8.10$, $p = .002$, $d = 1.01$) as well as for EC_{con} ($\chi^2_{0.95(1)} = 10.76$, $p < .001$, $d = 1.19$). For EC_{inc}, no confirmation bias could be detected ($\chi^2_{0.95(1)} < 1$, $p = .343$, $d = 0.30$); see Figure 2. This effect occurred although the acceptance rates of the recommendations (the likelihood that the recommended argument was selected) differed between the two experimental conditions: preference-consistent recommendations were accepted by 42 % of subjects, whereas preference-inconsistent recommendations were accepted by 20 % of subjects.

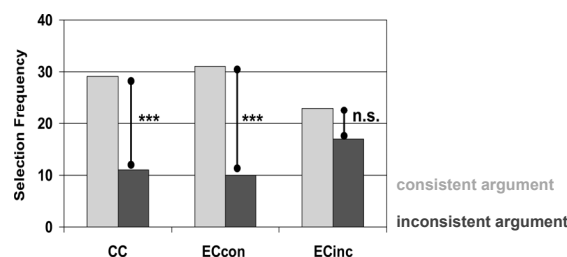


Figure 2. Selection Frequencies in the Three Conditions (Study 1).

Preference adaptation. We expected a weakening of post-preference vs. pre-preference in the condition with preference-inconsistent recommendation and a strengthening in the other two conditions (Hypothesis 2). The analysis of the adaptation of participants' preferences for the three conditions yielded the expected main effect, $F(2,118) = 3.66$, $p = .029$, $\eta^2 = .06$. Participants in the condition with preference-inconsistent recommendation indicated a more moderate view; their preference became weaker ($M = -0.30$, $SD = 0.65$).

Participants in the control condition ($M = 0.00$, $SD = 0.59$) as well as those in the condition with preference-consistent recommendations ($M = 0.05$, $SD = 0.64$) did not change their preference. Pairwise comparisons using simple contrasts revealed that EC_{inc} subjects had stronger preference weakening compared to CC subjects ($p = .014$), while there was no effect for EC_{con} subjects compared to CC subjects ($p = .720$).

Discussion

Study 1 provides first evidence for the impact of recommendations on information selection and preference adaptation. As expected in Hypothesis 1, CC subjects showed confirmation bias by choosing preference-consistent over preference-inconsistent arguments. In EC_{con} , the confirmation bias was also present; however, we could not find the expected enhancement of the bias. In EC_{inc} , the expected reduction of confirmation bias occurred. These effects in information selection had their equivalent in preference adaptation (Hypothesis 2): CC subjects as well as EC_{con} subjects did not adapt their preferences. However, EC_{inc} led to a more moderate view of the controversial topic of neuro-enhancement. Based on Study 1, it is not clear whether or not these changes in information selection and preference adaptation were accompanied by deeper elaboration. In order to measure the impact of recommendations on elaboration, we conducted the follow-up Study 2.

Study 2

The second study was conducted as a lab experiment. Two goals were pursued in this study: First, we wanted to replicate our findings concerning the impact of recommendations on information selection. Second, we investigated the impact of recommendations on free recall and on the generation of opinion statements.

Method

Participants

One hundred one students from a German university participated in the experiment. They were recruited via an academic e-mail-list and compensated by either payment or course credit. Twelve subjects were excluded from the analysis either because of failing the experimental manipulation check or because of their medical related field of study. Therefore, data of 89 subjects ($M = 23.15$, $SD = 3.11$; 62 female) were included in the analysis. The majority of participants (84.3 %) judged their prior knowledge about the subject matter to be very poor, poor, or average.

Material

The simulated website with search results used in the first study as well as the application domain of neuro-enhancement remained the same.

Design

The experiment again was based on a one factorial design with the three conditions (CC vs. EC_{con} vs. EC_{inc}). The pre-preference data showed that 82 % of the participants were against neuro-enhancement. This preference ratio was equally distributed over the three conditions ($F(2,86) < 1$, $p = .781$, $\eta^2 = .00$).

Procedure

The procedure remained the same as in Study 1 except for the third phase including measuring the dependent variables. As in the first study, subjects were asked to select exactly one argument that they would like to read more about by clicking on an adjacent box. In the third phase, participants were asked for free recall of the eight arguments on the simulated website. This free recall test was followed by an opinion statement: participants were asked to state their opinion and to justify it by writing an essay. They were explicitly instructed that they did not have to use all information they could remember (in contrast to the free recall task) and that they could use new and self-created arguments respectively. Afterwards, participants were asked to fill out two items for the manipulation check and to provide demographic details (age, gender).

Measures

In the second study, we focused on free recall and on the generation of opinion statements. The measures for manipulation check and information selection remained the same as in the first study (see above). Therefore we will describe here only the new measures for elaboration, namely, free recall and generation of opinion statements.

Free recall. First, we counted the overall number of arguments recalled. Second, we calculated a balancing index $[(\text{arguments}_{\text{consistent}} \text{ recalled} / \text{arguments}_{\text{inconsistent}} \text{ recalled}) - 1]$ to find out *which* arguments were recalled. A score around zero indicated a balanced recall which means that participants recalled an equal number of preference-consistent and preference-inconsistent arguments. A score above zero indicated a biased

recall for preference-consistent arguments, and a score below zero indicated a biased recall in favor of preference-inconsistent arguments.

Opinion statement. For opinion statement, the overall number of arguments generated per participant was counted. Further, we were interested in the percentage of novel arguments generated in the essay. For the analyses, a coding schema suggested by Cacioppo, Harkins, and Petty (1981) was used. Accordingly, arguments were coded as 0 = “external” when they were part of the arguments on the search result website, or as 1 = “internal” when the arguments were not mentioned before and thus generated by the participants. All 89 essays were coded by two raters. The interrater reliability Cohen’s Kappa was $K = .88$ which indicates an almost perfect strength of agreement.

Results

Information selection was tested with χ^2 -tests, whereas elaboration measures were analyzed using ANOVAs.

Manipulation check. Following a criterion set for the first study (inclusion into the analysis only if both answers were correct), the analysis comprised 30 CC subjects, 29 EC_{con} subjects, and 30 EC_{inc} subjects.

Information selection. In this study, we attempted to replicate the findings of the first experiment concerning information selection (Hypothesis 1). Therefore, we computed an overall χ^2 -test with the factors condition (CC vs. EC_{con} vs. EC_{inc}) and information selection (consistent vs. inconsistent). The analysis yielded the expected effect, $\chi^2_{0.95(2)} = 3.99$, $p = .068$, $d = 0.43$. We also found the same pattern as in the first experiment for the three conditions separately: a significant effect occurred for CC ($\chi^2_{0.95(1)} = 6.53$, $p = .011$, $d = 1.06$) as well as for EC_{con} ($\chi^2_{0.95(1)} = 4.17$, $p = .041$, $d = 0.82$). For EC_{inc}, no such effect occurred ($\chi^2_{0.95(1)} < 1$, $p = .999$, $d = 0.00$); see Figure 3. This effect occurred although the acceptance rates of the recommendations differed between the two experimental conditions: Preference-consistent recommendations were selected for further information from 24 % of subjects, whereas preference-inconsistent recommendations were selected for further information from 10 % of subjects.

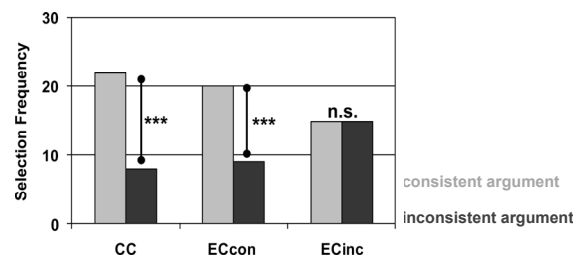


Figure 3. Selection Frequencies in the Three Conditions (Study 2).

It was predicted that information selection is related to information processing such that less confirmation bias results in deeper elaboration. Therefore, we expected free recall (Hypothesis 3a and 3b) and opinion statement (Hypotheses 4a and 4b) to be best in EC_{inc}. In order to test the hypotheses, one-factorial ANOVAs with condition (CC vs. EC_{con} vs. EC_{inc}) as the independent variable and different elaboration measures as dependent variables were conducted.

Free recall. The analysis of number of arguments recalled revealed no difference between the three conditions ($F(2,86) < 1$, $p = .623$, $\eta^2 = .00$). CC subjects recalled $M = 4.33$ ($SD = 1.09$) arguments, EC_{con} subjects $M = 4.00$ ($SD = 1.75$) arguments, and EC_{inc} subjects $M = 4.03$ ($SD = 1.45$) arguments. The analysis of the recall balancing index yielded the expected highly significant main effect, $F(2,81) = 5.03$, $p = .009$, $\eta^2 = .04$: Subjects in the control condition ($M = 0.61$, $SD = 1.07$) as well as those in the condition with consistent recommendation ($M = 0.26$, $SD = 0.64$) recalled the arguments biased towards preference-consistency, whereas subjects in the condition with inconsistent recommendation showed a balanced recall ($M = -0.06$, $SD = 0.67$). Pairwise comparisons using simple contrasts revealed that EC_{inc} subjects showed stronger recall balancing compared to CC subjects ($p = .002$), while there was no significant effect for EC_{con} subjects compared to CC subjects ($p = .128$).

Opinion statement. The analysis of number of arguments generated revealed a significant effect between the three conditions ($F(2,86) = 3.13$, $p = .049$, $\eta^2 = .01$). CC subjects generated $M = 2.97$ ($SD = 1.19$) arguments, EC_{con} subjects $M = 2.97$ ($SD = 1.40$) arguments, and EC_{inc} subjects $M = 3.77$ ($SD = 1.66$) arguments. The analysis of the source of arguments yielded the expected highly significant main effect, $F(2,86) = 7.11$, $p = .001$, $\eta^2 = .06$: Participants in the control condition ($M = 1.10$, $SD = 0.92$) as well as those in the condition with consistent recommendation ($M = 1.34$, $SD = 1.17$) showed less internal argument generation compared to the condition with inconsistent recommendation ($M = 2.30$, $SD = 1.69$). Pairwise comparisons using simple contrasts revealed that EC_{inc} subjects showed stronger internal argument generation compared to CC subjects ($p = .001$), while there was no significant effect for EC_{con} subjects compared to CC subjects ($p = .472$).

Discussion

In Study 2, it was possible to replicate our findings for the impact of a recommendation on confirmation bias and to extend them in several ways. In line with Hypothesis 1, both studies demonstrated that CC subjects showed a confirmation bias. Confirmation bias remained stable for EC_{con} subjects and was reduced or even prevented for EC_{inc} subjects. It is worth noting that both studies revealed the same effect pattern concerning information selection, although the data collection (online and lab) as well as subjects' compensation (lottery and payment) differed. As the effect occurred in both studies, albeit in different contextual settings, it appears to be a robust finding. Study 2 found that EC_{inc} stimulated balanced recall, whereas CC and EC_{con} resulted in biased recall towards preference-consistent arguments (Hypothesis 3b). However, the overall number of arguments recalled revealed no difference between the three conditions (Hypothesis 3a). In addition, Study 2 demonstrated that EC_{inc} stimulated increased argument generation compared to CC and EC_{con} (Hypothesis 4a). Furthermore, EC_{inc} subjects generated more novel arguments compared to CC and EC_{con} subjects (Hypothesis 4b). This internal argument generation can be interpreted as divergent thinking processes stimulated by EC_{inc}.

General Discussion

The current research demonstrated that preference-inconsistent recommendations can foster social navigation and elaboration of controversial topics. Both studies showed that preference-inconsistent recommendations have an effect on information selection and thus can help to overcome confirmation bias. This effect was not associated with a high acceptance rate of preference-inconsistent recommendations: Participants did not select the recommended argument; they selected a different argument from the recommended perspective instead. This rejection could have resulted from psychological reactance (Miron & Brehm, 2006), as reactance is known to stimulate resistance when people perceive their freedom of choice to be restricted. Alternatively, the design of the recommendation used in the studies could have led to banner blindness (Benway & Lane, 1998), a phenomenon in which emphasized information is ignored. Further research is needed to ascertain which factors contribute to the low acceptance rate of recommendations and how an enhancement could be achieved. Furthermore, we could not find empirical evidence for our hypothesis that classical, preference-consistent recommendations lead to an enhanced confirmation bias. Therefore, the implementation of recommender systems for learning does not appear to have debilitating effects on informational diversity above natural confirmation bias. Consequently, it might be worthwhile to strive for wider application of recommender systems in educational contexts.

This claim is supported by our findings on further points. Study 1 demonstrated that preference-inconsistent recommendations weaken participants' preferences; participants formed a more moderate view on the controversial topic. Study 2 demonstrated the impact of preference-inconsistent recommendation on elaboration. Participants showed a balanced recall by remembering arguments from both perspectives and divergent thinking by generating more novel arguments. This difference between preference-consistent vs. preference-inconsistent recommendations might result from the difference in the perceived recommender personality. Taking the research of minority dissent into account, participants might have assumed that preference-inconsistent recommendations stemmed from a minority and thus leading to divergent thinking. Further studies should include an investigation of the perceived "humanization" of a recommender system.

Although our studies were conducted in a non-collaborative context, we believe that they have implications for CSSL. For instance, exposure to preference-inconsistent opinions is regarded as an important element of collaborative learning. Our findings implicate that exposure to dissenting information might not be enough to stimulate unbiased reasoning and critical thinking. This can be concluded from the fact that in all three conditions preference-inconsistent arguments were available to the learners. However, only when a preference-inconsistent argument was made salient, did the corresponding opinion have the persuasive power to influence navigation and elaboration. Whether visual salience suffices or whether learners attribute some authority to a recommendation requires further empirical investigation. However, it appears evident that without computer-supported salience, preference-inconsistent arguments can hardly unfold their beneficial effects.

Another relevant dimension for further research is the difference between debate and controversy (Johnson & Johnson, 1979). Preference-consistent recommendations highlight arguments which match the learners' preferences. Therefore consistent recommendations might trigger a debate mode of processing and lead to differentiation processes. On the other hand, preference-inconsistent recommendations highlight arguments which do not match the learners' preferences, but since they are denoted as a recommendation, they might be viewed more positively. This might trigger a controversy mode of processing and lead to integration processes.

This paper provides experimental evidence that in opinion formation contexts learners will only accept a challenge when the challenging information is recommended. In this regard, it can be said that preference-inconsistent recommender systems create a zone of proximal development. If properly implemented, recommender systems have the potential to become powerful tools supporting learners on their way to becoming critical thinkers and informed decision makers.

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