Beyond the Filter Bubble: Interactive Effects of Perceived Threat and Topic Involvement on Selective Exposure to Information

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ABSTRACT
We investigated participants' preferential selection of information and their attitude moderation in an online environment. Results showed that even when opposing views were presented side-to-side, people would still preferentially select information that reinforced their existing attitudes. Preferential selection of information was, however, influenced by both situational (e.g., perceived threat) and personal (e.g., topic involvement) factors. Specifically, perceived threat induced selective exposure to attitude consistent information for topics that participants had low involvement. Participants had a higher tendency to select peer user opinions in topics that they had low than high involvement, but only when there was no perception of threat. Overall, participants' attitudes were moderated after being exposed to diverse views, although high topic involvement led to higher resistance to such moderation. Perceived threat also weakened attitude moderation, especially for low involvement topics. Results have important implication to the potential effects of "information bubble" – selective exposure can be induced by situational and personal factors even when competing views are presented side-by-side.

Author Keywords
Information Seeking; Filter bubble; Attitude Change; Perceived Threat; Topic Involvement; Peer Opinions.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors.

INTRODUCTION

Internet has provided a rich and diverse information environment to modern societies. It has, however, also conveniently encouraged selective exposure to information – defined as a tendency to be exposed to information that supports one's own beliefs or attitudes [8]. The selective exposure phenomenon has made many to believe that the Internet is leading to increasing social fragmentation and ideology polarization, as personalized web algorithms that present information based on interests of individual users may eventually lead users to find only information that agrees with their viewpoints and separates them from other viewpoints. In addition, like-minded people may share their views within "echo chambers" on the Internet to reinforce their viewpoints [23]. Premised on this "filter bubble" concern, new technology (typically in the form of information aggregator) has been developed to promote exposure to diverse perspectives in various domains such as politics [15,18,20], healthcare [13], science [5], and consumer reviews [26] to avoid the potential negative effects of the filter bubble [19].

Research has begun to investigate how to design information systems that optimally present diverse information to avoid the filter bubble [10, 25]. Information seekers' preference for diversity may, however, *also* be influenced by situational and personal factors such as personality, knowledge, information search context, and personal involvement (see reviews in [2, 6, 8, 11]). Our goal is to supplement this growing body of research by systematically investigating the influence of two major factors – perceived threat and topic involvement – which arise in a wide range of information search contexts on information seekers' selective exposure and attitude change. To preview our results, we found that even in the absence of external information filter – i.e., when opposing views are presented side-by-side to promote consumption of diverse information (e.g., [13, 15, 18]), selective exposure to information may still exist.

Situational Factor – Perceived Threat

Information seeking under perceived threat is pervasive. In everyday life, people are constantly facing the need to search for wide ranging assortments of opinions for tackling troubling situations or making critical decision that are either personal, such as those regarding security, health, finance, or societal, such as crime, terrorism, economic crisis. Surprisingly, given the risk of vital loss, people are often biased in seeking information. For example, it is commonly observed by physicians that patients are not

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well-motivated to seek balanced information about treatment or diagnosis methods that they assume will bring adverse effects [2]. Bankers and investors' ignorance of warnings given by other experts was believed to have led to the financial crisis. Studies on political anxiety showed that, following major social or political crisis, such as 911 or Iraq war, anxious citizens could be biased in knowledge acquisition about such events [7].

From a design perspective, it is important to understand users' behavior in an information diverse environment under threatening circumstances to inform the design of adaptive, or domain specific information system. For example, an intelligent news aggregator may be able to foresee the potential change of information seeking patterns induced by political or social anxiety in the public atmosphere; or, by sensing the increased level of anxiety in the individual, and adapt its selection and presentation of information to mitigate potential biases in judgment and decisions. The same applies to various user posting systems, decision support systems, or search engines when employed for topics that are sensitive to perception of threat or anxiety, such as healthcare, politics, finance, etc.

Personal Factor – Topic Involvement

Topic involvement is often studied together with information seeking and attitude change as a critical moderator (e.g. [21]). For high involvement topics, users often have a relatively high motivation to extensively seek information to learn more about the topic, even for information that is inconsistent with their existing views. For low involvement topics, users may be less motivated to seek information and therefore possibly more selective in their information consumption.

Another interesting practical question is whether there is selective exposure to different types of information. The Internet environment is rich in formal, factual knowledge as well as "word-of-mouth" knowledge contributed by peer users, the later of which has become increasingly prevalent by virtue of "social technologies". There is substantial evidence supporting the fact that Internet users seek both factual knowledge and peer opinions. The question, however, is in what kind of situation, and for what kind of users, should the system provides more factual knowledge, or more peer users opinions that support or challenge users' existing attitude.

In summary, the current research is centered around the following research questions:

1. How does perceived threat influence users' selective exposure to attitude consistent and inconsistent information? How does such potential change in information seeking process impact attitude change?
2. How does topic involvement moderate the impact of perceived threat on selective exposure, as well as attitude change?
3. How do perceived threat and topic involvement influence users' preference for factual arguments and peer opinions that convey competing views?
4. How does selective exposure to diverse information influence attitude changes?

LITERATURE REVIEW

Most research on selective exposure was conducted within the framework of cognitive dissonance theory [8]. It asserts that people experience cognitive dissonance when they have to consider the negative implications of their selected choice or pre-existed position. To reduce the unpleasant psychological state, information seekers are motivated to expose themselves to attitude consistent information while avoid or discredit attitude inconsistent information.

Researchers have studied users' selective consumption of diverse, and often competing online information [5, 16, 18]. For example, users' selective exposure to online partisan news or opinions is a frequently studied topic [9, 10, 17,]. Because of the greater availability and reduced access cost for diverse information, researchers have found that although Internet users desire for opinion reinforcing information, they do not necessarily show aversion to opposing opinions [9].

When studying selective exposure, CHI researchers have focused on improving system design to better present diverse information. Frequently they ask questions such as "what is the optimal diversity level and optimal presentation for agreeable and disagreeable items" [5, 17, 18]. Results suggest that there is seldom a universally correct answer to such question, but design decisions often depend on various factors. For example, [17] found that when browsing political news online, some users appear to be diverse-seeking while others are challenge-averse. It appears that the lack of a relatively complete understanding of the underlying factors that influence selective exposure has created obstacles for developing better intelligent and reliable personalization technologies [10].

Recent studies showed that an increase in relevant dimensions of individual's topic involvement such as topical importance, interests, certainty and confidence could promote information seekers' exposure to attitude challenging information [1, 8, 11]. To some extent, the result suggests that, as people become more interested and knowledgeable about a topic, they may as well become more motivated to learn from different opinions to form a better representation of the reality. It is worth pointing out, however, that it does not necessarily mean they are more subject to the persuasive influence of competing views. To the contrary, they may scrutinize the information more deliberatively, thus their attitudes were moderated only when they perceived strong arguments [21, 22].

Meanwhile, people who are less involved in the topic tend to put more weight on factors that are peripheral to the information (e.g., other people's agreement, information

source, etc) [21], therefore may differ from those highly involved in their preference for factual arguments and peer opinions when seeking for diverse information. As an example, in [16], a study on patients using social media to learn alternative disease models showed that when evaluating alternative views, patients who committed to a prior existing model put more weight on factual information while patients started with no clear model tended to rely on other patients' agreement.

Selective exposure is also highly dependent on the social context. Among others, perceived threat, or anxiety it brings, has raised increasing attention recently (see review in [6]). This body of research shows mixed evidence for whether threat reduces or increases selective exposure. Some argued that threatening perspective encourages users to be more vigilant in information seeking, thus carry out more cognitive effort to process unbiased information [24]. In contrast, from a motivational perspective, some argue that the cognitive dissonance theory predicts the increased levels of selective exposure because users have to cope with the increased level of cognitive discomfort and dissonance incurred by threat. These mixed results motivated researchers to attempt to disclose the underlying factors that moderate the effects of threat [6].

METHODOLOGY

Participants

We recruited 28 participants from the Illinois Champaign-Urbana community. They mainly consisted of a mix of college students, faculties and university staff. According to [4], younger people with higher education are most likely to seek political news and participate in political activities online. Although it is possible that people with different social, cultural, and educational backgrounds may exhibit different information seeking behavior, we believe our sample is at least representative of a most active subset of the online user population who are concerned with seeking information about controversial social-political issues.

Participants were randomly assigned to the conditions with (group 2) and without (group 1) the threat manipulation. The demographical information questionnaire showed there is no significant difference ($p>0.10$) in age (M1=26.30, M2=28.78), gender (64.3% in group 1 and 57.1% in group 2 are female) education level (35.7% in group 1 and 42.9% in group 2 are graduate students or have graduate degree), Internet use frequency (M1=1.72, M2=1.53, for scale from 1-less than an hour per day to 5-more than 8 hours per day), political leaning (M1=3.4, M2=3.1, scale from 1-conservative to 5-liberal), and self-reported knowledge about the topics between the two groups.

Materials and Measurements

We first selected 13 candidate topics that are commonly deemed as controversial. To ensure a reasonably balanced distribution of topic involvement level among participants, we selected topics from various domains (e.g., ethics, healthcare, crime, sports) ranging from common focus of public debate (e.g., death penalty) to topics that are less prevalently discussed (e.g., using steroids for sports). We measured participants' attitude on each topic by using a 5-item semantic differential scale, which is often used to derive attitude towards given concept by measuring its connotative meanings [12]. For example, when measuring participants' attitude on the issue of vegetarianism, instead of directly asking whether they held a positive or negative attitude, we asked them to choose their position on a 7-point Likert scale for five pairs of bipolar adjectives: unfavorable-favorable, bad-good, unnecessary-necessary, harmful-beneficial, unhealthy-healthy. We calculated the mean rating of the five items to be the subject's prior attitude on the topic. The Cronbach's alpha reaches 0.87, which is close to excellent internal consistency [3] in measuring the pre-existing attitudes toward each topic.

Topic involvement is generally considered a multi-dimensional construct concerned with the topic importance and relevance to an individual. Following [14], we started by measuring two types of topic involvement: 1) *value-relevant involvement*, which measures the extent to which the attitudinal topic is linked to important value. We measured value-relevant involvement by asking participant *a)* how much this topic is related to his/her core value, and *b)* how important it is to him/her to defend his/her point of view on this issue, both of which based on a 1(little) to 7(a lot) scale; 2) *outcome-relevant involvement*, which measures the extent to which one is motivated to process relevant information to correctly understand the topic. We measured outcome-relevant involvement by asking participants *a)* how interested he/she is in learning about the topic, and *b)* how much he/she desires to know the truth about the topic. It turned out the results of two types of involvement measures are highly correlated ($r=0.84$), which echoed the conclusion of previous studies on topic involvement [22]. To simplify the analysis, we combined the two measures by averaging the ratings of the four questions above and created the topic involvement index. The Cronbach's alpha of the four items reaches 0.93, which is considered excellent internal consistency in measuring the same latent variable of topic involvement.

After measuring participants' attitude and topic involvement for each candidate topic, we excluded those topics that were highly imbalanced in the pre-existing attitudes and topic involvement scales. Specifically, we excluded the topics in which the number of people on one side of the attitude or topic involvement scale (higher/lower than neutral) were more than two times the number of people on the other side. This was done to ensure that for each topic there were a balanced number of participants having high or low pre-existing attitudes or involvement in our samples. This left us with 8 topics used in the experiment. Examples include "should euthanasia be legal?" and "should people become vegetarian?" The complete topic list can be found at the appendix.

We selected items of arguments and user opinions on each topic from this website http://*procon.org*. It is developed by a non-profit organization that aims at providing resources for critical thinking for various controversial topics. For each topic the website provides pros and cons arguments by summarizing factual information from multiple formal sources including academic publication, newspaper, government document, etc. For example, a pro argument for video game leading to increasing youth violence is:

"Violent video games desensitize players to real-life violence. It is common for victims in video games to disappear off screen when they are killed or for players to have multiple lives. In a 2005 study, violent video game exposure has been linked to reduced P300 amplitudes in the brain, which is associated with desensitization to violence and increases in aggressive behavior."

The website also allows users to submit their own opinions. An example of pro user opinions for the same topic is:

"Violence influences the mind, brain, and the way we act on what we would've just seen. Those thoughts would still be in our mind even after an hour or so because our mind is still re-playing what we saw on screen. This would then reflect on our actions and how we think for 30-45 minutes. Even I have experienced this."

We randomly selected 8 pros and 8 cons arguments, as well as 5 pros and 5 cons user opinions for each topic. We slightly modified the material to ensure there is no significant difference in length (about 60-90 words) or rigor of arguments between items of each side.

To manipulate perceived relevant threat, we followed the approach used by [6] in their series of studies on threat and selective exposure. During the experiment, participants assigned to the condition with threat were exposed to an image conveying strongly threat-inducing outcomes relevant to the topic. To avoid biasing the choice and comprehension of information, we chose pictures highlighting the negative outcomes related to the topic while remaining neutral in terms of the discussion. For example, for the question "does violent video games contribute to increases of youth violence", a picture depicting a badly injured teenager was presented, which highlighted the threat-inducing aspect of youth violence without suggesting whether violent video game is a cause.

After showing the picture, we asked the participants to imagine how they felt if they themselves, or their beloved ones were involved in such a threatening situation. For example, participants were asked "how much does it make you feel suffering if seeing the scene of youth violence", and "how much will you be worried if your beloved ones are involved in violence scene?" based on a 1 (little) to 5 (a lot) scale. Following [6], the questions were designed to strengthen the manipulation of perceived threat.

Procedure

As described earlier, participants were first asked to complete a survey to measure their prior attitude for all candidate topics, as well as demographic information. After one week the topics were selected, participants were contacted to complete the main experiment. The experiment consisted of eight tasks, each corresponding to one selected topic. For each task, participants assigned to the threat condition were firstly presented with the threat inducing image and questions described in earlier section, while participants in the control condition would skip this step. Then they were presented with the topic, e.g., "should certain performance enhancing drugs be legal?" as the heading on screen. They were then instructed to imagine they were writing an essay on the given topic using the website presenting pros and cons arguments and user opinions on the topic. They were allowed to freely browse the website, and afterwards they would be asked to write a short summary of the essay they planned to write.

The interface is shown in Figure 1. The page presents arguments on top and user opinions at the bottom. Arguments and user opinions were placed in different two-column tables, with all pros arguments or opinions on one side and cons ones on the other. This two-column format is similar to the interface adopted by many systems that present competing viewpoints (e.g., [15,18]), in the purpose of promoting balanced selection of information and avoiding selective exposure to one-sided information.

For each topic the participants were shown 8 pros and cons arguments, and 5 pros and cons user opinions, respectively. Every user opinion was shown with a pseudo user name. The order of arguments and user opinions were randomized in each table. For each argument or opinion, only a snippet of the first sentence was shown, which we specifically rewrote to give participants a general idea of the item. Participant could choose to click on "read more" if he or she wanted to continue reading. A popup window would show the complete argument or opinion, where participants were also asked to rate their agreement with the particular argument or user opinion based on a 5-point Likert scale.

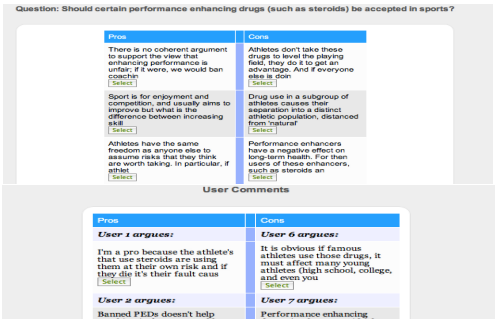

Figure 1. Screenshot of experiment interface: factual argument (top) and user opinions (bottom)

Participants were told to freely read any numbers of items in any order, and there was no time limit for reading them. The system automatically recorded their clicks on different items. After they felt confident to write the essay they could proceed to the next page, where they would be asked to write down the main points in their essays. In the end of

each task they were asked to finish a questionnaire to measure their attitude on the topic again, which was the same scale used in the pre-experiment survey.

RESULTS

First, we conducted manipulation check on participants' ratings on how they felt suffered/worried after the threat inducing scenarios. The ratings (M=4.70, SD=0.60) were significantly higher ($t(111)=29.96$, $p<0.01$) than neutral (rating=3), confirming the manipulation was successful.

To differentiate topics that participant had low or high involvement, we performed median splits on the topic involvement index of the eight topics for each participant. As a result, each participant had 4 high-involvement and 4 low-involvement topics. The mean value of the medians for all participants was 3.75 (SD=0.60), and there was no outlier (more than +/- 3 SD of the mean). Therefore the distribution of topic involvement across participants was well distributed in our samples.

We also recoded participants' prior attitude as positive or negative according to whether the mean score of the five semantic differential items was more or less than neutral (rating=4), which was also the median of the overall attitude ratings from all participants. For the 6 out of 224 cases participants gave rating 4 we randomly assigned them to either side. There was no significant difference of the proportion of tasks for which participants had positive prior attitude between the two experiment (threat and no-threat) groups ($c^2(1,224)=0.18$, $p=0.89$). Prior attitudes between the two groups therefore did not significantly differ.

In this study, our focus was not on features of information seekers' prior attitude, therefore we did not control for magnitude of prior attitude bias but conducted random sampling, which resulted in reasonably uniformly distributed prior attitudes in our samples. On the other hand, since we did not intend to infer the general attitude distribution in the population, we believe the current sample size was sufficient for our research questions. To exclude the influence of attitude related factor on interpreting the potential effect of topic involvement, we examined in our sample whether there was correlation between topic involvement index and attitude extremity, defined as the absolute deviation of prior attitude rating from neutral (rating=4), and found no significant correlation($r=-0.06$).

On average, participants checked 8.28 items (SD=4.93), in which they clicked on average 6.12 (SD=3.64) arguments and 2.16 (SD=2.16) opinions, and they spent M=33.98 (SD=30.39) seconds reading each item. There was no significant difference between the groups with and without threat in all the four measures described above ($p>0.10$), suggesting that the general participation level was about the same between the two groups.

Information Selection

To examine participants' exposure to attitude consistent and inconsistent information, we created an index: *selectivity count*, by calculating the difference of the number of attitude-consistent and attitude-inconsistent items clicked for each topic. Here whether an item is attitude consistent or not was decided by whether the attitude conveyed by the message was consistent with the coded prior attitude index (positive/negative) as described above. E.g., if a participant held a positive prior attitude towards the topic, then a pro argument or user opinion was considered attitude consistent while a con argument or user opinion was considered attitude inconsistent. The *selectivity count* was calculated to capture the tendency of selective exposure, such that a higher magnitude of the index indicated a stronger bias to select more attitude-consistent (or attitude-inconsistent) than attitude-inconsistent (or attitude-consistent) information if the index was positive (or negative).

We first performed an ANOVA on *selectivity count* with prior attitudes extremity (rating <3 or >5 as high, others low) as independent variable, but the effect was not significant. Given the lack of effect on *selectivity count* (as well as other variables we examined in later sections) and the fact that the current focus was not on effects of prior attitudes, we did not analyze the effects of prior attitudes in the rest of the analysis. However, we will discuss our results in relation to prior attitudes in the discussion section.

We performed a two-way repeated measure ANOVA on *selectivity count* with condition (without/with threat) as between-subjects variable and involvement (low/high) as within-subjects variable. The result showed that the main effect of threat was significant ($F(1,26)=9.61$, $p<0.01$, $\eta^2=0.27$), and the two-way interaction between condition and involvement was significant ($F(1,26)=4.91$, $p=0.04$, $\eta^2=0.16$). Figure 2 plotted the mean value of selectivity count for topics with high and low involvement separately. The figure shows that this interaction was caused by the very different effects of threat to participants with low and high involvement with the topics: When relevant threat was presented to low-involvement participants, they became more selective by reading significantly more attitude-consistent than inconsistent information ($F(1,26)=10.46$, $p<0.01$, $\eta^2=0.29$). In contrast, threat had little effect on high-involvement participants as they behaved consistently by seeking balanced information with or without threat ($F(1,26)=0.02$,$p=0.90$, $\eta^2<0.01$).

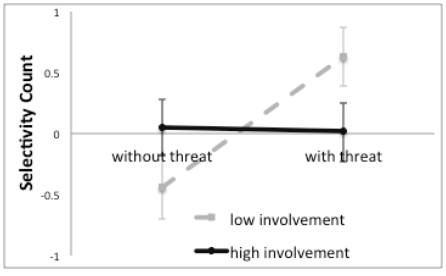

Figure 2. Mean selectivity count for topics one had low/high involvement with absence/presence of threat

In addition, we performed one sample t-tests to compare each participant' average *selectivity count* to zero (balanced in selecting both sides) with each of the four combinations of with/without threat and high/low topic involvement. The result showed that none of them were significantly different from zero, *except* when participants were presented with threat in low involvement topics, the *selectivity count* was significantly higher than 0 ($t(13)=2.57$, $p=0.02$). The above results showed that *when participants were presented with contextually relevant threat, they exhibited pronounced selective exposure for attitude-consistent information, but only in topics that they had low involvement.*

In summary, by comparing participants' selection of attitude consistent and attitude inconsistent information, we found that the presence of contextually relevant threat induced selective exposure for topics that participants had low involvement, but there was no effect for topics that they had high involvement. While previous research (e.g.,[6]) found that contextually relevant threat increases information seekers' tendency of being preferentially exposed to attitude consistent information, our results suggested that there is an additional underlying factor: topic involvement, to moderate this tendency. When seeking information for topics that one has high involvement, users seem to be able to maintain balanced information search even when facing relevant threats. In other words, contrary to common beliefs, not all users exhibit selective exposure to information and lead to the "echo chamber" effect. Our results suggest that the combination of threat and low involvement will more likely induce selecting exposure to attitude-consistent information.

Information judgment

Users' attitude change, after being exposed to information diverse environment, is likely not only influenced by their selection of information but also their self-evaluated agreement with the information they read. To analyze participants' self-evaluated agreement with attitude consistent and attitude inconsistent information, we created another variable: *selective rating*, by calculating the difference between the average rating given to attitude consistent and that of attitude inconsistent items for each topic. A positive *selective rating* indicated that attitude consistent information was evaluated more favorably, and a higher magnitude would indicate that this preference was stronger.

We performed a two-way repeated measure ANOVA on *selective rating* with condition (with/without threat) as between-subjects variable and involvement (high/low) as within-subjects variable. We found that the main effect of topic involvement was significant ($F(1,28)=4.24$ $p=0.05$, $\eta^2=0.14$). No effect of condition or interaction between the two was observed. As illustrated in Figure 3, it suggested that participants' high involvement with the topic was a reliable predictor of how much they evaluated attitude consistent information more preferentially than attitude inconsistent one, regardless of the presence of contextual threat. The result echoed conclusion of previous studies suggesting that high topic involvement promotes the tendency of critically scrutinizing the attitude inconsistent information [21, 22].

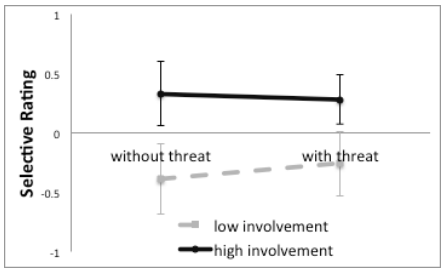

Figure 3. Mean selective ratings for high/low involvement topics in conditions with and without perceived threat

Attitude change

In this study, we are interested in whether being exposed to diverse views in the online environment could prevent attitude polarization. Therefore, when examining attitude change, we conceptually distinguished situations where attitude was moderated, i.e., moved to the opposite direction of one's prior attitude, and attitude became more extreme, i.e., moved further along the same direction of prior attitude. Given the prior and post attitude measurement we used was based on a 1 (negative) to 7 (positive) scale, we created a variable, *attitude moderation* by: 1) if the participant held a positive prior attitude, *attitude moderation* was calculated by prior attitude index minus post attitude index; 2) if the participant held a negative prior attitude, *attitude moderation* was calculated by the post attitude index minus prior attitude index. Hence a positive *attitude moderation* value would indicate that the participant's attitude was moderated, while a negative value would indicate that it became more extreme, and the magnitude of the index indicates the extent of attitude change to either direction. In our experiment both for topics with high ($t(29)=7.15.$, $p<0.01$) and low involvement ($t(29)=7.89$, $p<0.01$), participants' average *attitude moderation* were significantly higher than zero (no change), suggesting that for both types of topics individual's attitudes were moderated after being exposed to a system presenting diverse information.

We first performed a two-way repeated measure ANOVA on *attitude moderation* with condition (with/without threat) as between-subjects variable and topic involvement as within-subjects variable. We found that the main effect of involvement was significant ($F(1,26)=12.82$, $p<0.01$, $\eta^2=0.27$), and the main effect of presence of threat was marginally significant ($F(1,26)=3.09$, $p=0.09$, $\eta^2=0.11$). It suggested that, as shown in Figure 4, in general participants' attitudes were less moderated for topics they had high than low involvement, while the presence of threat also led to slightly less moderation of attitude.

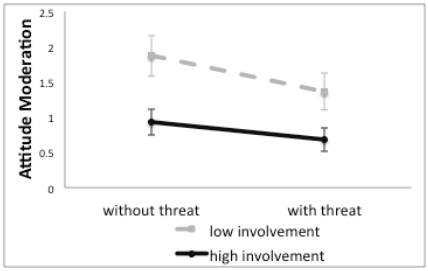

Figure 4. Mean attitude moderation score for topics one had high/low involvement with and without threat

In addition to attitude moderation, we also examined the number of topics in which participants' attitude flipped (i.e., shifted to the other side over the neutral point). The findings were generally consistent with the results of analysis on *attitude moderation:* the main effect of topic involvement was significant ($F(1,26)=28.26$, $p<0.01$, $\eta^2=0.52$), and the main effect of threat was marginally significant ($F(1,26)= 3.44$, $p=0.08$, $\eta^2=0.12$). We also found the two-way interaction between threat and topic involvement was marginally significant ($F(1,26)=3.14$, $p=0.09$, $\eta^2=0.11$), suggesting that the presence of threat had higher impact on reducing the tendency of attitude flip for topics participants had low than high involvement.

In summary, both the presence of threat and topic involvement influenced how attitude changed after being exposed to the information diverse environment. In general, all participants' attitudes were moderated, although they were less subject to change if they had high than low involvement with the topic. The current results can be combined with the results on selective ratings, in which participants who had high topic involvement agreed with attitude-consistent information significantly more than attitude inconsistent information (see Figure 3), and thus were less moderated by the persuasive effects of attitude-inconsistent information. Meanwhile, the presented threat also made participants less likely to change attitude, especially for topics that they had low involvement. We could understand this finding by combining the results to those in the analysis of information selectivity presented earlier (see Figure 2): when seeking information under perceived thread for low involvement topics, participants became significantly more selective in processing attitude-consistent information over inconsistent n. Therefore, overall they were exposed to less attitude inconsistent information that could moderate their attitude in the presence of perceived threat.

Selection of User Opinions versus Factual Arguments

When facing competing views, people may seek factual argument, as well as peer opinions to solicit different views. From a design perspective, it is important to understand users' preferential selection of these two types of information under different situational and individual factors. To this end, we examined the overall preferential seeking of peer opinions versus factual arguments, as well as participants' selective exposure to these two types of information that conveyed competing views.

First, we calculated the percentage of user opinions selected as compared to the total number of selected items for each topic. We performed a two-way repeated measure ANOVA on this percentage value by using condition (with/without threat) as between-subjects variable and topic involvement (high/low) as within-subjects variable. Interestingly, we found a significant two-way interaction between condition and topic involvement ($F(1,28)=6.07$, $p=0.02$, $\eta^2=0.17$). We illustrated this interaction in Figure 5: participants checked on more user opinions for low than high involvement topics without perceived threat ($F(1,13)=16.4$, $p=0.01$, $\eta^2=0.56$). This difference, however, disappeared when they perceived threat ($F(1,13)=0.02$, $p=0.90$, $\eta^2<0.01$).

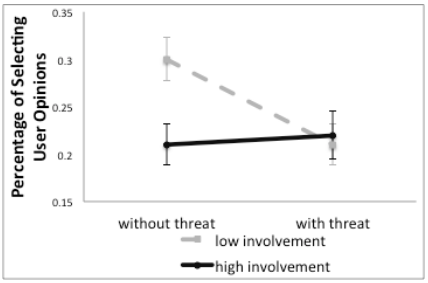

Figure 5. Mean percentages of the selection of user opinions for high/low involvement topics in with and without threat

To further understand participants' differential preference for user opinions that convey competing views, we divided user opinions into attitude consistent and inconsistent to analyze if there was selective exposure between them. We calculated the same *selectivity count* index by including only selection of user opinions (i.e.,the difference between the frequencies of selection of attitude consistent and inconsistent user opinions). We performed the same two-way repeated ANOVA on user opinions *selectivity count* with condition and perceived threat. We found that the two-way interaction between topic involvement and presence of threat was marginally significant ($F(1,28)=3.31$, $p=0.08$, $\eta^2=0.11$). Figure 6 showed that it was caused by the differential effects of perceived threat on inducing the tendency of preferentially selecting more attitude consistent user opinions under threat for low involvement topics ($F(1,13)=3.76$, $p=0.06$, $\eta^2=0.13$), but not for high involvement ones ($F(1,13)=0.32$, $p=0.58$, $\eta^2=0.01$).

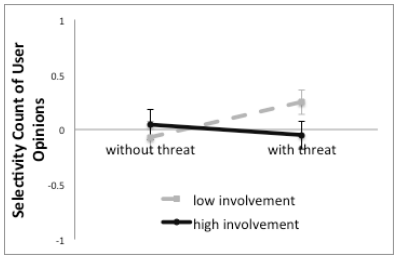

Figure 6. Mean user opinions selectivity count for high/low involvement topics in conditions with and without threat

We then analyzed the selective exposure for only factual arguments. We calculated the *selectivity count* among factual arguments in the same manner as for user opinion and conducted the same two-way repeated measure ANOVA. It showed the main effect of threat was significant ($F(1,26)=5.04$, $p=0.03$, $\eta^2=0.16$) and the two-way interaction between threat and topic involvement was marginally significant ($F(1,28)=3.15$, $p=0.08$, $\eta^2=0.11$). Figure 7 illustrated that this interaction was again caused by the differential effect of threat on low and high involvement topics: perceived threat induced selective exposure towards attitude consistent factual arguments for low involvement topics ($F(1,28)=7.31$, $p=0.01$, $\eta^2=0.22$), but not for high involvement topics ($F(1,28)<0.01$, $p=0.95$, $\eta^2<0.01$).

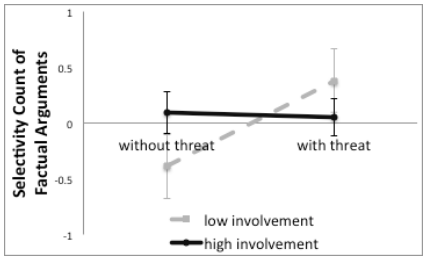

Figure 7. Mean factual argument selectivity count for topics one had high/low involvement with absence/presence of threat

In summary, the analysis on the selection of user opinions and factual argument shows that for low involvement topics, there was a higher tendency to check on user opinions, however this tendency decreased with contextually relevant threat. This change could possibly be explained by the fact that when threat was perceived people became more vigilant in the information seeking process [24], and thus might treat the issue as more "serious". As a result, they put more weight on factual arguments than user opinions as they did for topics they had high involvement. Our analysis on selective exposure revealed that contextually relevant threat induced higher selective exposure to both factual arguments and user opinions, which implied that participants preferentially selected both attitude consistent factual arguments and attitude consistent peer opinions to cope with cognitive dissonance.

In general, we found that participants' information selection was more sensitive to the influence of contextual factor when they had low involvement with the topic. In comparison, for topics users have high involvement, balanced and consistent information seeking strategy for attitude consistent and inconsistent information was adopted across different situational context and for different types of information, with a higher general preference for factual information. It was consistent with conclusions from previous research, which stated that increased level of topic involvement often leads to an "open minded" information seeking strategy towards competing views and a lower reliance on other people's opinions [1, 8].

DISCUSSION

Our study showed that, even when opposing views were presented side-by-side, information seeking under perceived relevant threat led to more pronounced selective exposure to attitude consistent information. This increased level of selective exposure also leads to less attitude change due to the overall less reception of attitude challenging information. However, high topic involvement can override this tendency such that people seek relatively balanced exposure to attitude consistent and inconsistent information. Nonetheless, high involvement with the topic results in more preferential evaluation of attitude consistent information over attitude inconsistent one, and largely increases the resistance to attitude change.

According to Frey [7], when facing cognitive dissonance brought by attitude-challenging information, the consistency of the cognitive system is maintained by either avoiding attitude-inconsistent information, or by counter arguing attitude-inconsistent information in order to find flaws in it. For topics that people have low involvement, in which people may have less knowledge and thus fewer defending arguments available, they may feel higher level of uncertainty and less motivated to counter-argue attitude-challenging information. While they may be interested in discovering attitude-challenging information otherwise, perceived threat may increase the motivation to avert themselves from confronting attitude challenging information. From a motivational account, it is also possible that for topics that people have high involvement, they have a higher motivation to learn about the truth about the topic regardless of their own position. According to [1,24], this kind of accuracy motive is able to mitigate the tendency of selective exposure. As a result, people may be able to retain higher level of accuracy motive for topics that they have high involvement regardless of the situation.

These findings suggest that selective exposure is sensitive to situational variables if they are less involved with the topic. For example, a newly diagnosed patient, who is likely to feel increasing level of anxiety, may have a higher tendency to expose himself to information about a treatment he or she prefers and fails to pay attention to different perspectives to better inform the medical decision. In this kind of situation, the system (e.g., search engine, recommendation system) should provide adequate information about their preferred choice while encourage the exposure to high quality information about the alternatives [10]. On the other hand, the system should provide a balanced mix of alternative or competing views if it recognizes that the user is knowledgeable or frequently exposed to the domain or topic.

While the study in [17] concluded that system designers should be aware that there exists both "diverse-seeking" users and "challenge-averse" users, our findings seem to complement their finding in suggesting that these tendencies are not fixed for each individual but are sensitive

to situational factors and dependent on the domain or topic. A person who is highly passionate about politics may seek diverse information when browsing political news. However, he may become challenge-averse when it comes to information seeking for a health related decisions. Although it is a highly challenging task to accurately predict users' preference for the level of diversity based on the complex interactions among personal, topic-related, and situational factors, our study provides preliminary evidence that, to design for personalized presentation of diverse information, it is helpful to take into account users' overall involvement with the domain/topic and the situation of the information seeking process, such as whether it is for acute information needs (e.g., learning about ongoing events, making time sensitive decisions), or whether it is about an anxiety sensitive topic (e.g., politics, finance, health).

By analyzing the selection of factual arguments and user opinions separately, we found that users may have a higher tendency to seek peer users' opinions if they are studying a topic that they consider less involved. However, if they are facing a threatening situation, they may turn to factual arguments more often and increase their tendency of preferentially seeking both attitude consistent factual arguments and attitude consistent user opinions. These findings have interesting implications for designing systems that aggregate and present diverse information. For example, the system may provide more peer users' opinions as well as competing views for topics that are relatively casual (e.g., entertainment), but highlight attitude supporting information and high quality factual arguments for topics that may potentially induce threat and anxiety.

Our study also suggested, to a certain extent, that information seekers' attitude could be moderated by exposure to diverse viewpoints, even for topics that one already had a certain level of involvement. In general, it supported the validity of promoting personal deliberation and preventing attitude extremity by exposing people to diverse opinions enabled by technology intervention as suggested by previous researchers [10, 15, 20]. Our finding provided further evidence that attitude moderation for low involvement topics tended to be more effective, suggesting that the exposure to diverse information may have a larger impact for low-involvement topics, as such experiences may encourage knowledge acquisition and attitude construction for these topics.

During preliminary data analysis, we explored the effects of attitude extremity by comparing cases where participants had more extreme prior attitude rating (<3 or >5) to those who were more neutral. However, we did not find any significant effect on either information selection or attitude change ($p>0.10$). At first glance, it may seem somewhat counterintuitive, as people with more extreme attitude may be less likely to change. However, we observed that in our sample, there were cases where participants who held extreme attitudes actually shifted their attitude in a relatively large magnitude. Interestingly, most of these cases were regarding topics participants had low involvement, which again underscored the interactive effects of pre-existing attitude and personal involvement on attitude moderation.

Given that our experiment used 8 controversial topics that covered a wide variety of domains that varied in their prevalence, it is unlikely that participants would have mature attitudes in all topics. This could be one reason why we found the dominating effects of topic involvement, rather than attitude extremity, on attitude change. In the experiment, the system provided 13 different aspects on either side (pro/con), which could serve as an intensive educating platform that led to discoveries of new knowledge and (re)construction of attitude. It was possible that, for topics that one had low involvement, the processing of the larger amount of information that was new to the participants resulted in higher attitude change as they acquire more knowledge about the topics. This inference was at least partially supported by the fact that our topic involvement measure had a high correlation with participants' self claimed topical knowledge ($r=0.77$). Another related finding was the low correlation between attitude extremity (measured by absolute difference between prior attitude rating and neutral rating 4) and topic involvement ($r=-0.06$), which calls attention to an important and potentially dangerous phenomenon: people could express a relatively extreme attitude even when they have neither adequate knowledge nor motivation to learn about the topic. The attitude is therefore likely to be an uninformed or even biased one. An information aggregation system that presents well-organized high quality information on multiple facets of the topic can be effective and efficient for the purpose of educating without bias. These results imply that information interfaces may need to adapt to both the levels of knowledge or familiarity of the topic and personal involvement of the users to encourage a more balanced processing of multiple viewpoints.

Lastly, we should point out that the interface we used in the experiment was already an optimized design in presenting diverse information. Presenting equal numbers of pros and cons items in a well-defined layout was often considered an effective means to encourage users to check on both sides of the issues [18]. Although in the experiment, selective exposure was salient only in the condition of low topic involvement with threat, selective exposure may be even more pronounced in a loosely organized online information environment, in which users follow hyperlinks, or use simple interfaces commonly designed for many information retrieval or aggregation systems for everyday information needs. Our results provided strong support that information bubble can emerge from the interactions of multiple factors *in addition to* that created by personalization Web algorithms. How technology interacts with multiple personal and social factors to impact effectiveness of balanced civic discourse through the online information

environment clearly demands more research and attention from both information engineers and HCI researchers.

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APPENDIX: TOPICS USED IN THE EXPERIMENT

1. Should certain performance enhancing drugs (such as steroids) be accepted for sports?
2. Should death penalty be allowed?
3. Should prescription drugs be advertised directly to consumers?
4. Should euthanasia be legal?
5. Do violent video games contribute to the increase of youth violence?
6. Should people become vegetarian?
7. Should the US have sent troops to Iraq?
8. Should social security be privatized?