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Abstract

Recommendation agents are deployed to give online consumers advice on products. This study focuses on how two demographic interface characteristics of online recommendation agents – ethnicity and gender – influence the way consumers agree with the product recommendations offered by anthropomorphic (humanoid) recommendation agents. Because consumers may not always straightforwardly self-report their true perceptions about entities that differ from them in their ethnicity and gender, this study applies neuroimaging methods (fMRI) to understand how the design of online recommendation agents can include anthropomorphic interfaces with different ethnicity and gender to enhance the interaction between consumers and agents. Subjects who either fully matched or fully mismatched with the ethnicity and gender of recommendation agents were asked to indicate their *agreement* with the advice provided by the recommendation agents while their brain activities were observed in an fMRI scanner. The results show that there is only activation in brain areas of intense emotion (amygdala) and fear of loss (insular cortex) when subjects *disagree* with a recommendation agent that does not match their ethnicity and gender, while there is no activation for recommendation agents that match their ethnicity and gender. The fMRI results suggest that ethnicity and gender mismatch spawns strong emotional responses in the brain, particularly among women.

Keywords

Online recommendation agents, Ethnicity, Gender, Neuroimaging methods, fMRI, NeuroIS

1. Introduction

Online recommendation agents are increasingly used by commercial websites to give consumers advice about products (Komiak and Benbasat 2006). By eliciting consumers' needs and provide advice to customers about the products that match these needs, recommendation agents improve the effectiveness and efficiency of online shopping and highlight the importance of information technology (IT) in facilitating e-commerce transactions.

Although the design of online recommendation agents has received some attention in the IS literature, the focus has been on the recommendation agents' utilitarian characteristics. However, because demographic characteristics are salient features that affect how people react to anthropomorphic recommendation agents (humanoid avatars) (Qiu and Benbasat 2009), we focus on how the design of recommendation agent interfaces that include ethnicity and gender enhance the quality of the anthropomorphic interface and encourage consumers to use online recommendation agents as decision aids.

Because consumers may not always straightforwardly self-report their true perceptions about entities that differ from them in their ethnicity and gender, this study applies neuroimaging methods (fMRI) (Dimoka, 2010). Consumers whose ethnicity and gender either fully matched or fully mismatched the ethnicity and gender of recommendation agents responded about their *agreement* with these recommendation agents while their brains were scanned in an fMRI scanner.

2. Theory

Three theories - *similarity-attraction*, *homophily*, and *social identity* - have been used to justify the role of ethnicity and gender effects in the adoption and use of online recommendation agents (Qiu and Benbasat, 2009). A consumer's agreement with the advice provided by an online recommendation agent is proposed to affect whether an agent will be used. Because people tend to be more easily persuaded by the same information provided by a similar versus a dissimilar person (Hogg et al. 1990), we predict that the advice offered by recommendation agents that match a subject's ethnicity and gender will be more positively received than the same advice offered by an agent that does not have such a match.

In terms of capturing the brain activity that underlies the self-reported measures of agreement or disagreement with a recommendation agent, we draw upon the cognitive neuroscience literature to link the observed brain activations of these constructs to existing neurological processes. Disagreement with a recommendation agent that does match a subject's ethnicity and gender is proposed to activate brain areas associated with intense negative emotions and fear of loss. Strong negative emotional stimuli have been linked to the *amygdala* (LeDoux 2003), while fear of loss has been linked to the *insular cortex* (Wicker et al. 2003). These findings are consistent with neuroimaging studies where Caucasian subjects who looked at faces of people of a different race exhibited higher activation in the amygdala (Phelps et al. 2000). Thus, we hypothesize:

H1: A user's disagreement with a recommendation agent that does <u>not</u> match her ethnicity *and* gender (mismatch) is associated with higher activation in the (a) *amygdala* and (b) *insular cortex*.

However, we do not expect to see activation when subjects agree with a recommendation agent that match their ethnicity and gender. This is because agreement across recommendation agents is not expected to spawn any differential brain activations, and thus brain activity is expected to cancel out when comparing across "matched" and "mismatched" recommendation agents.

3. Research Methodology

To test the proposed hypothesis, an fMRI experiment was conducted in which the brains of 24 subjects were scanned while responding to a set of stimuli (measurement items) associated with the subjects' agreement with the recommendation agents' advice.

3.1 Experimental Design

The four recommendation agents used were based on recommendation agents for digital cameras (Wang and Benbasat 2007). Each of the four agents had the same exact functionality and reasoning, but had a different humanoid avatar (Figure 1) interface through which the user interacted with the agent: two permutations of ethnicity (Caucasian and Asian) and gender (Male and Female). Accordingly, four groups of *subjects* were recruited whose gender and ethnicity were also permuted to create four categories - ethnicity and gender match or mismatch between the agent and the user All subjects viewed the exact same stimuli (recommendation agents), albeit the full match and mismatch varied across subjects.

The four humanoid avatars (Figure 1) were selected after several pretests that showed that *all* of the participants correctly identified the character's ethnicity and gender, and they were no significant differences among them (Qiu and Benbasat 2009).

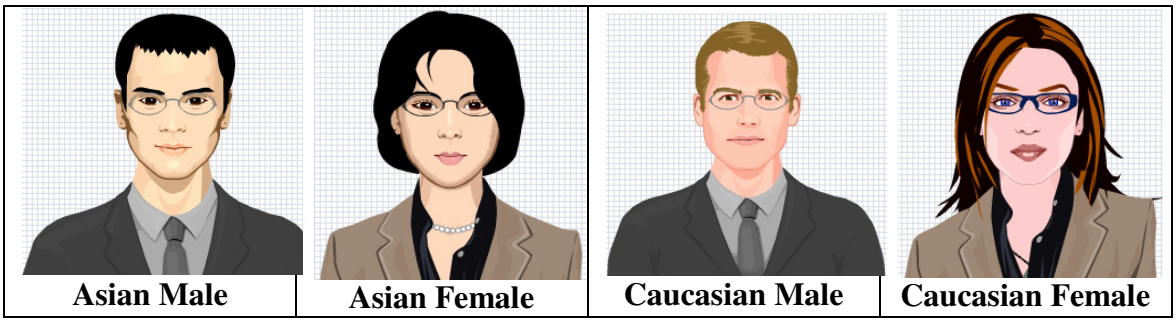

Figure 1: The Four Avatars Used in the fMRI Study

24 right-handed subjects (6 Caucasian males, 6 Asian males, 6 Caucasian females, 6 Asian females) participated in the study. The number of subjects (n=6) was chosen to ensure adequate power of analysis (80%) for statistically-significant brain activations ($p<.05$).

3.1.1 Before fMRI Session

All subjects were asked to work with the four recommendation agents to get information about a digital camera. The subjects were told to provide their preferences about a digital camera by answering a set of 10 questions posed by the agents. Subjects simultaneously viewed all four agents who *jointly* asked them these questions about digital cameras. Subjects were told that each of the four agents would *separately* present to them a best choice camera recommendation.

To minimize any differences across the recommendation agents (besides ethnicity and gender), the advice from all four agents was *virtually identical* in terms of basic camera characteristics (e.g., price, resolution, zoom). We slightly modified the camera picture and model number to create the impression that the four camera recommendations presented by the agents were different.

3.1.2 During fMRI Session

Subjects entered the fMRI scanner lying comfortably on their back. Visual stimuli were projected to them through fiber-optic goggles connected to a computer. To spawn activation in the brain areas associated with the subject's agreement with an agent, measurement items in the form of Likert-type scales were developed for this study. First, one randomly-selected recommendation agent was shown together with a randomly-selected measurement item for a randomly-selected construct for the same focal agent. Each stimulus was shown for 5 seconds without the scale, which was shown to be ample time for subjects to read and process (Dimoka, 2010). Then, the 7-point Likert-type scale appeared, and the subjects selected their choice by depressing one of the seven buttons using a fiber-optic mouse they held with their right hand. After clicking on their choice, they were shown a new randomly-selected agent followed by a randomly-selected measurement item. This procedure was repeated for all recommendation agents, measurement items, and control items (Figure 2).

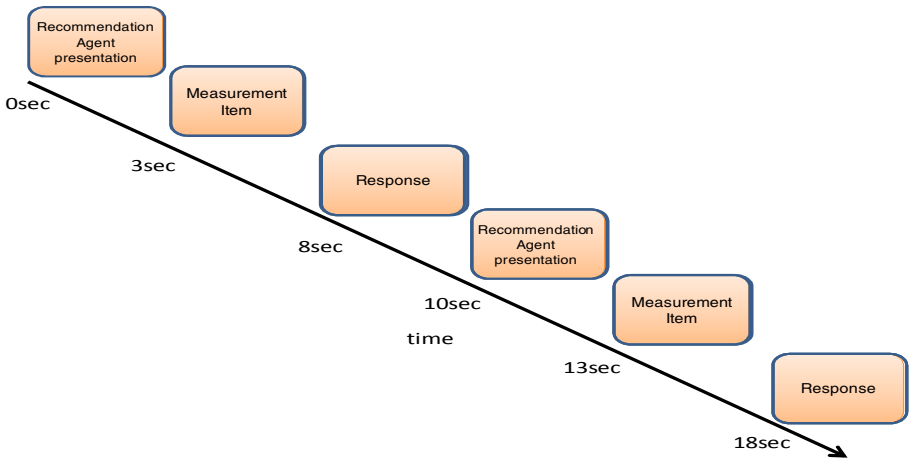

Figure 2: Graphical Description of the fMRI Study and Stimuli

3.2 Results

ANOVA was first used on the behavioral data to examine whether ethnicity- and gender-match affect the subjects' agreement with the recommendation provided by the agent. While ethnicity-match and gender-match did not have significant effects across subjects, for the analysis by subject's gender, there were significant *ethnicity-match* effects for women ($t=4.77$, $p<.01$), but not men. Taynor and Deaux (1973) explained that gender effects are comparatively weak relative to ethnicity effects.

The analysis of the fMRI data was performed with SPM5. We identified the neural correlates of the subjects' agreement with an agent when comparing between the "matched" and "mismatched" agents (and vice versa) (Figure 3). The analysis was undertaken by contrasting

the brain activations of each construct for the "matched" relative to the "mismatched" agents.[1]

Disagreement with a "mismatched" versus a "matched" recommendation agent was proposed to activate the amygdala and insular cortex (H1). The analysis across subjects showed significant activation in the amygdala (z-value=3.27, p<.05) and insular cortex (z-value=2.45, p<.05), thereby supporting H1.

The analysis by gender showed significantly stronger (p<.01) activation for women in the amygdala (z-value=3.21, p<.01) than men (z-value=2.22, p<.05), but no different activation in the insular cortex (z-value=2.46, p<.05 for women; z-value=2.60, p<.05 for men). These fMRI results correspond to the ANOVA results that showed that women are more likely to agree with an agent that matches their ethnicity.

Finally, as expected, there was no significant brain activation when subjects agreed with recommendation agents that matched their ethnicity and gender compared to dissimilar recommendation agents.

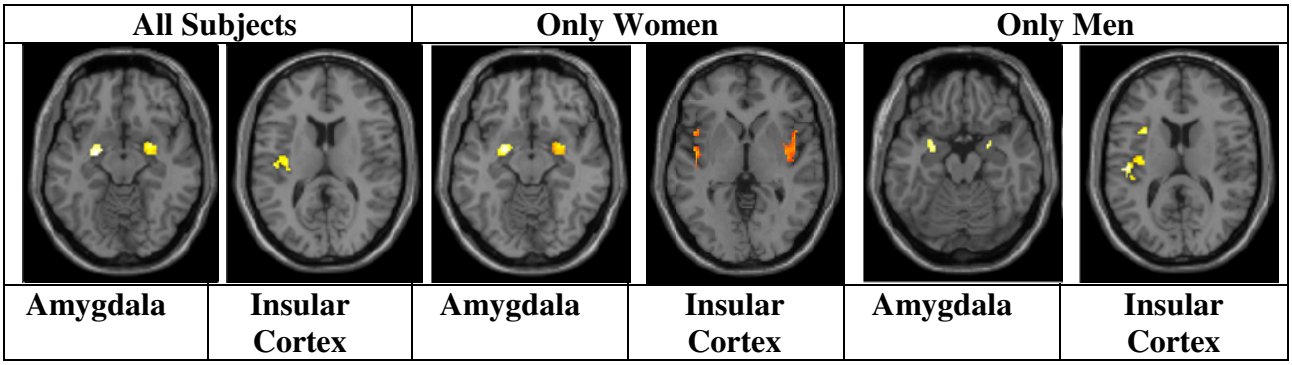

Figure 3: fMRI Results for Agreement with Agent (Mismatch Versus Match)

4. Conclusions

The results show that there was activation in brain areas of intense emotion (amygdala) and fear of loss (insular cortex) when subjects disagreed with a recommendation agent that did not match their ethnicity and gender (particularly among women), while there was no activation when subjects agreed with the recommendation agents that match their ethnicity and gender.

For researchers, besides specifying the neurological origins of what drives consumers' agreement with an agent's advice, the results imply that ethnicity and gender *mismatch* spawns strong emotional responses in the brain. This study contributes to our understanding of how ethnicity and gender differences influence the adoption of recommendation agents by spawning strong emotional brain responses that cannot be captured by the subject's self-reported measures.

[1] The contrast between the 'match' and the 'mismatch' image reflects the *difference* in brain activation due to the measurement item when responding about a recommendation agent that matches versus the agent that does not match the subject's ethnicity and gender. Because it is not possible to observe negative brain activation when subtracting the two brain images and we can only observe positive activation that exceeds a certain statistical threshold, the contrast between match and mismatch can be starkly different from the contrast between mismatch and match.

The results provide prescriptions to designers of online recommendation agents to consider the provision to especially female consumers an anthropomorphic agent that matches their ethnicity and gender in order to improve their evaluations of recommendation agents.

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