The Neural Correlates of Ethnic and Gender Similarity and Dissimilarity with Avatars in Online Shopping Environments

ABSTRACT

Virtual sales assistants with human-like interfaces ("avatars") help consumers make better choices with less cognitive effort in online shopping environments. Following similarity-attraction theory, such avatars must be similar to consumers' ethnicity and gender to be liked and used. In contrast, dissimilarity-repulsion theory posits that dissimilarity causes consumers to avoid avatars that mismatch their ethnicity and gender. This study tests these two competing theories by identifying the neural correlates of similarity/dissimilarity using functional Magnetic Resonance Imaging (fMRI) while consumers assess their similarity/dissimilarity with avatars who vary in their ethnicity and gender to match/mismatch the consumers' ethnicity and gender. The fMRI results show activation in a brain area associated with utility (caudate nucleus) for similarity, only in men and mainly due to *ethnic* similarity. In contrast, dissimilarity spawns activity in brain areas linked to negative emotions (amygdala, insular cortex) and social prejudice (Broadmann Areas 9 and 32), only in women and mainly due to *gender* dissimilarity. While both men and women ultimately choose "matched" avatars, men do so because of utility derived from ethnic similarity, while women because they perceive emotionally-charged social anxiety from gender dissimilarity.

Keywords: Avatars, Virtual Salespeople, Similarity, Ethnicity, Gender, fMRI, Neural Correlates, Neuromarketing, Cognitive Neuroscience.

1. INTRODUCTION

Virtual sales assistants with human-like interfaces (avatars) are valuable in impersonal online shopping environments by offering personalized product information and advice in a personable way, thus helping consumers make better choices and expend less effort (Haubl and Trifts 2000). An avatar is a software-based pictorial interface that represents a virtual sales assistant that offers personalized recommendations to consumers, thus helping them make better shopping decisions (e.g., Alba et al. 1997; Holzwarth, Janiszewski, and Neumann 2006; Senecal and Nantel 2004). Because online shopping environments are inhibited by lack of physical and social interaction, consumers prefer websites with human-like interfaces or avatars (Cyr, Head, Larios, and Pan 2009) and research has shown that avatars with a human-like interface are preferred by consumers over plain decision aids (e.g., Barlow, Siddiqui, and Mannion 2004). This is because human-like avatars help make the otherwise impersonal nature of online shopping more interpersonal and enjoyable for consumers (Burke 2002). Accordingly shopping avatars have assumed many of the traditional roles of human sales assistants, and they are increasingly used by commercial websites to help consumers reduce cognitive overload, enhance decision-making, and facilitate shopping decisions (e.g., Haubl and Trifts 2000; Holzwarth et al. 2006; Redmond 2002; Xiao and Benbasat 2007). Still, the adoption and use of shopping avatars is still at its infancy (Qiu and Benbasat 2010), and consumers are still reluctant to rely on avatars to make shopping decisions (Holzwarth et al. 2006).

Literature on human sales assistants indicates that their social affiliation with consumers is a major driver of their success (Westbrook and Black 1985). Effective salespeople who build social relationships with consumers are perceived to be more credible and trustworthy, and they are able to enhance their consumers' satisfaction and loyalty (Reynolds and Beatty 1999). The literature has specified that salespeople who match their consumers' ethnicity and gender are able to build social relationships and facilitate purchases (Jones, Moore, Stanaland, and Wyatt 1998).

Ethnicity and gender are the most salient demographic cues consumers use when assessing another person (e.g, Ng et al. 2006; Taylor et al. 1978), and consumers often use ethnicity and gender similarity to build social affiliation with salespeople (Churchill, Collins and Strang 1975). Extending the literature from human sales assistants to human-like avatars and drawing upon the "Computers are Social Actors" theory (Reeves and Nass 1996), consumers perceive a human-like, social, and inter-personal communication when interacting with avatars (Qiu and Benbasat 2009). Thus, the demographic attributes of avatars become very important issues in the design of avatars (Baylor and Ryu 2003; Cowell and Stanney 2005; Moon 2000; Nass et al. 1995). While people like those who are similar to them (Byrne 1971) and dislike dissimilar ones (Rosenbaum 1986), and consumers prefer salespeople avatars that are similar to them in terms of ethnicity and gender (Jones et al. 1998; Qiu and Benbasat 2010), the underlying reason for this behavior is still elusive. Because the avatar's social demographics may affect consumer behavior, it is important to better understand how and why consumers assess avatars that are similar or dissimilar to them. There are two theories that offer competing explanations – *similarity-attraction* and *dissimilarity-repulsion*.[1]

First, similarity attraction theory (e.g., Byrne 1971; Newcomb 1956; Pennington 1986) posits that a person's perceived similarity with another results in interpersonal attraction. This draws upon homophily theory (Lazarsfeld and Merton 1954) that states that a person has better interactions with similar others. It also relates to social identity theory that stresses in-group similarities and exacerbates out-of-group differences (Tajfel and Turner 1986). The basic premise of this theory is that people will make more favorable assessments of referent others who are similar to them. Similarity-attraction theory has been validated for traditional salespeople (Jones et al. 1998), human-computer interactions (Nass et al. 2000), decision-making aids (Al-Natour, Benbasat, and

[11] According to both similarity-attraction and dissimilarity-repulsion theories, it is not the other person's actual demographic ethnicity or gender, per se, that matters but rather one's *perceived* similarity.

Cenfetelli 2008), and online recommendation agents (Qiu and Benbasat 2010). In contrast, *dissimilarity-repulsion* theory (Rosenbaum 1986) argues that similarity-attraction is actually due to dissimilarity-repulsion that makes people dislike others who are different from them. Rosenbaum argues that similarity does not enhance liking, but rather dissimilarity that is more heavily weighed, spawns repulsion. In the context of avatars, these two theories offer competing explanations as to why consumers may prefer avatars who are similar to them in terms of their ethnicity and gender.

This study aims to reconcile these two competing theories by examining the neural correlates of perceived similarity/dissimilarity using functional Magnetic Resonance Imaging (fMRI) while consumers assess their similarity or dissimilarity with avatars that vary in their ethnicity and gender to match or mismatch the consumers' ethnicity and gender. Given that ethnicity and gender are sensitive social issues and subjects may answer in a politically correct and socially appropriate way, the fMRI data aimed to supplement self-reported measures of similarity to overcome concerns that consumers may not faithfully self-report their true perceptions. As noted by Smith (1995, p. 17), "Self-reports are notorious for reporting bias and, […], self-reports of similarity and relational demography may be difficult for respondents to assess." Overcoming social desirability bias was touted as a key advantage of fMRI studies (Dimoka et al. 2010). The fMRI study draws upon the neuroscience literature to link the brain activations associated with perceived similarity in terms of ethnicity and gender to existing neural processes, thus shedding light on the nature of similarity. The fMRI study allowed the simultaneous measurement of brain activity while consumers viewed four avatars that differed on their ethnicity (Asian and Caucasian) and gender (women and men), and responded to self-reported scales on perceived similarity, following Dimoka (2010a). Hence, we integrated a behavioral examination of perceived similarity/dissimilarity with an fMRI study of the neural correlates that may underlie these processes to address the following research questions:

1. What are the neural correlates of ethnic and gender similarity with avatars, and what can we learn from the neuroscience literature about their localization in the brain?
2. Can the neural correlates of perceived similarity/dissimilarity shed light on the role of similarity-attraction versus dissimilarity repulsion in guiding consumer's decision-making?
3. Are there neurological differences between women and men in terms of perceived similarity and dissimilarity with avatars that match versus do not match their ethnicity and gender? [2]

The fMRI results show that perceived similarity elicits activation in a key *utility-laden* area (caudate nucleus) associated with rewards, but only in men. This activation is primarily due to ethnicity (but not gender) match. In contrast, brain activity in *negative emotion-laden* areas (amygdala and insular cortex) was observed for perceived dissimilarity, but only in women. These brain activations were primarily due to gender (but not ethnicity) mismatch. The results suggest that men prefer avatars that match their ethnicity (but not gender) due to similarity-attraction, while women prefer avatars that match their gender (but not ethnicity) due to dissimilarity-repulsion. Moreover, the level of brain activation in the caudate nucleus is positively correlated with the selection of an "ethnicity-matched" avatar in men, while the level of brain activation in the four active brain areas in women are negatively correlated with the selection of a "gender-matched" avatar in women.

The paper proceeds as follows: Section 2 reviews the literature, develops the theory, and proposes the hypotheses to be tested. Section 3 describes the empirical methods and Section 4 presents the results. Section 5 discusses the implications of the findings for theory and practice.

[2] This question arises because the literature has shown differences in terms of how women and men interact with avatars, specifically that women tend to rely more on ethnicity and gender (Qiu and Benbasat 2010).

2. THEORY DEVELOPMENT

2.1 Similarity-Attraction versus Dissimilarity Repulsion

People like those who are similar to them (Byrne 1971; Newcomb 1956), and perceived similarity is an important factor in human communications (Pennington 1986). Accordingly, we rely on two theories – *similarity-attraction* and *dissimilarity-repulsion* – that help explain how similarity or dissimilarity in terms of ethnicity and gender influence the use of avatars.

Similarity attraction theory (Byrne 1971) posits that a person's perceived similarity with another person results in a positive interpersonal attraction. Similarity attraction theory draws upon the theory of homophily (Lazarsfeld and Merton 1954), which also argues that a person would have a better communication and interaction with a person who has similar demographics. It also draws upon social identity theory (Tajfel and Turner 1986) that emphasizes in-group similarities and exacerbates out-of-group differences following a social identity self-categorization process (Turner 1982). Ethnicity and gender are readily observable physical cues, and they are often involved in self-categorization (Messick and Mackie 1989) and classification of others as either "in-group" or "out-group" members (Biernat and Vescio 1993). Similarity-attraction theory was applied to shopping contexts where a consumer of the same ethnicity and gender as the salesperson is more likely to evaluate the salesperson more favorably (Jones et al. 1998). Crosby, Evans, and Cowles (1990) linked consumer-salesperson similarity between with relationship quality and sales. Smith (1995) also showed that consumer-salesperson similarity facilitated open communication and relationship investment. Also, the opinions of similar people are often deemed persuasive (Naylor, Lamberton, and Norton, 2010), while the opinions of dissimilar people are discounted as they are assumed to have dissimilar preferences (Brown and Reingen 1987). Similarity attraction was also influential when people interact with computers (e.g., Nass and Lee 2000; Al-Natour, Benbasat, and Cenfetelli 2006) and when consumers interact with avatars (Qiu and Benbasat 2009).

In contrast, *dissimilarity-repulsion* theory (Rosenbaum 1986) argues that the link between similarity and attraction posited by similarity-attraction theory is actually a relationship between dissimilarity and repulsion. In other words, attraction toward people who are similar is explained in terms of repulsion for people who are dissimilar, and interpersonal attraction is more heavily influenced by dissimilar attributes than by similar ones. Rosenbaum concluded that similarity did not enhance attraction, but instead dissimilarity resulted in repulsion. Dissimilarity-repulsion theory thus offers a competing explanation to the tenets of similarity attraction theory.

While there are many attributes that can play a role in shaping a person’s similarity perception, there is ample evidence that ethnicity and gender are the most observable and instictive cues people use when assessing others (Cunningham et al. 2004; Ng et al. 2006; Phelps et al. 2000; Taylor et al. 1978). Consumers also rely on ethnicity and gender cues to categorize salespeople (Elsass and Graves 1997; Henthorne et al. 1992). Ethnic similarity results in higher interpersonal attraction (Berscheid and Walster 1978), stronger desire to interact socially (Elsass and Graves 1997), higher job ratings (De Meuse 1987), higher empathy (Kim and Atkinson 2002), and better performance evaluations (Tsui and O’Reilly 1989). Also, Caucasian men felt more comfortable dealing with salespeople who matched their ethnicity and gender (Moncrief and Shipp 1997). Gender similarity results in salespeople favoring same-gender customers (Dwyer et al. 1998), better workplace interactions (Foley et al. 2006), and closer buyer-seller relationships (Smith 1998. Ethnicity and gender similarity was also shown to build trust in organizational relationships (Ibarra 1992) and were also linked to consumers’ higher perceptions of a salesperson’s expertise, trustworthiness, likability, and attractiveness (Jones et al. 1998). Henthorne, Latour and Williams (1992) argued that a consumer’s initial perceptions of the salesperson’s ethnicity and gender can substantially affect the consumer-salesperson relationship, specifically showing that Caucasian consumers relied on ethnicity and gender to evaluate the quality of a salesperson. Taken together, we focus on the theories of similarity-attraction versus dissimilarity-repulsion in terms of ethnicity and gender, largely because these two factors have a rich history in the context of both traditional salespeople (e.g., Jones et al. 1998) and their online counterparts (avatars") in the form of virtual sales assistants with a human-like interface (e.g., Qiu and Benbasat 2010).

2.2 Similarity-Attraction: Ethnicity and Gender Match versus Mismatch

Ethnicity and gender impressions affect consumer's perceptions of avatars, and we propose that ethnicity and gender match elicits different brain activations than ethnicity and gender mismatch. This is because similarity attraction theory posits that similarity results in interpersonal liking (attraction) that results in favorable overall assessmenets that result in perceiving positive outcomes. Thus, consumers will perceive more positive outcomes from avatars that are similar to them than dissimilar ones, and they are likely to perceive higher utility when dealing with similar avatars. [3] For product recommendation avatars where consumers tend to take in account the avatars' identity when assessing the usefulness of their recommendation (Gershoff, Broniarczyk, and West 2001), advice from demographically similar avatars are likely to be deemed of higher value to them. Thus, we expect perceived similarity with an avatar to activate brain areas linked to utility and rewards.

In the neuroscience literature, the caudate nucleus, a part of the dorsal striatum, has been associated with utility and the magnitude of anticipated rewards (e.g., Haruno and Kawato 2006; Hsu et al. 2005; King-Casas et al. 2005). The caudate nucleus is innervated by dopaminergic input from the midbrain, and it is activated when people receive a positive reward (Knutson *et al*., 2001). King-Casas et al. (2005) showed caudate nucleus activation when subjects acted cooperatively to obtain an anticipated reward. As well, Rilling et al. (2008) showed the caudate nucleus to predict a

[3] Interpersonal attraction (liking) is distinct from aesthetic attraction, which is not expected in this study because all avatars were similarly attractive. The nucleus accumbens, another brain area in the rewards system, that has been associated with attractive faces due to aesthetic evaluation (Aharon et al. 2001) is not expected to be activated, and we only expect caudate nucleus activation from rewards evaluation.

person's decision to reciprocate cooperation toward mutual gain. Thus, we propose that perceived similarity in terms of ethnicity and gender will be associated with a consumer's expected utility when interacting with a matched avatar, and it will induce activation in the caudate nucleus.

H1: A consumer's perceived similarity with an avatar that matches her ethnicity and gender is associated with higher activation in the *caudate nucleus* than with an avatar that does <u>not</u> match her ethnicity and gender.

The corrolaries of H1 is that either ethnic or gender similarity can each elicit activity in the caudate nucleus, and we distinguish between ethnic similarity (H1a) and gender similarity (H1b). First, Hart et al. (2000) showed that ethnicity stimuli plays an important role when people assess the faces of people of other ethnicities. Nass et al. (2000) also found that Asian users were more likely to perceive an Asian-looking avatar to be more trustworthy, attractive, and value congruent than a Caucasian avatar. Thus, we propose ethnic similarity to elicit activation in the caudate nucleus. Second, the role of gender, particularly for female salespeople, is an important issue in the literature (e.g., Palmer and Bejou 1995). Gender similarity was linked to positive evaluations in the context of consumer-salesperson interactions (Jones et al. 1998). Thus, we also expect gender similarity (versus gender dissimiliarity) with an avatar to also elicit activation in the caudate nucleus.

H1a: A consumer's perceived similarity with an avatar that matches her ethnicity is associated with higher activation in the *caudate nucleus* than with an avatar that does <u>not</u> match her ethnicity.

H1b: A consumer's perceived similarity with an avatar that matches her gender is associated with higher activation in the *caudate nucleus* than with an avatar that does <u>not</u> match her gender.

We also predict that the gender of the consumer will moderate the effect of similarity attraction. Men are more task-oriented and focus more on utilitarian issues (Minton and Schneider 1980). Also, men tend to view people as objects of potential reward, making it more likely to activate the brain's reward circuity than women (Aharon et al. 2001). Thus, it is more likely to have stronger activations in areas associated with rewards and utility (Bush et al. 2002; Hsu et al. 2005). Hence:

H2: The activation in the *caudate nucleus*, associated with a consumer's perceived similarity with an avatar that matches her ethnicity and gender than with an avatar that does <u>not</u> match the user's ethnicity and gender, *will be higher in men than women.*

2.3 Dissimilarity-Repulsion: Ethnicity and Gender Mismatch Versus Match

Following the tenets of dissimilarity-repulsion theory (Rosenbaum, 1986), we propose that avatars that do not match the consumer's ethnicity and gender will cause activations in brain areas associated with negative evaluations compared to avatars that match the consumer's demographics. This is because repulsion from dissimilar avatars is likely to create negative evaluations of avatars that differ from the consumer's ethnicity and gender and trigger negative emotional responses, consistent with dissimilarity-repulsion theory. The literature has shown that social anxiety from dissimilar social groups triggers activation in emotion-laden brain areas, particularly the amygdala (Bishop, Jenkins, and Lawrence 2007; Dickie and Armony, 2008; Mathews, Yiend, and Lawrence, 2004). The amygdala was linked to negative emotional responses and fearful faces (Bishop 2004; LeDoux 2003) and amygdala activation is involuntary and automatic (Bishop et al. 2007). Hence, the neuroscience literature found amygdala activation in White people who looked at Black faces (e.g., Cunnigham et al. 2004; Lieberman et al. 2005), and the level of amygdala activation was significantly correlated with an indirect measure of social prejudice (Phelps et al. 2000). Therefore, we expect repulsion from dissimilar avatars to trigger activity in the amygdala. As well, given that repulsion is often linked to fear, the insular cortex, a brain area associated with fear and disgust (e.g., Wicker et al. 2003) is also proposed to be activated for perceived dissimilarity with avatars.

The involuntary brain activations in these emotional areas derived from dissimilarity repulsion are also expected to be accompanied by areas in the prefrontal cortex that aim to regulate the fearful stimuli and maintain cognitive control. Two brain areas in the prefrontal cortex have been implicated to controlling social prejudice (Richeson 2003), inhibiting strong negative emotions (Beauregard et al. 2001; MacDonald et al. 2000), and detecting and resolving cognitive conflict. First, the right Dorsolateral Prefrontal Cortex (DLPFC) (BA 9) is linked to controlling intense social inferences, such as social stereotyping (Cunningham et al. 2004; Milne and Grafman 2001). Second, the dorsal anterior cingulate cortex (dorsal ACC) (BA 32) [4] is responsible for regulating social prejudice, social anxiety, and conflict (e.g., Bishop et al. 2004; Ochsner et al., 2002). Both brain areas are activated when subjects tried to control unwanted prejudicial reactions to racial bias (Black versus White faces). A measure of racial bias was correlated with activation in the right DLPFC ($r=.53$, $p<.05$) and dorsal ACC ($r=.44$, $p<.05$) (Richeson et al. 2003). Cunningham et al. (2004) showed activation in both brain areas when White subjects tried to control intense emotions in response to Black (versus White) faces. In sum, the DLPFC is associated with exacting control while the dorsal ACC is responsible for monitoring the need for control (Botvinick et al. 2001; MacDonald et al., 2000; Miller and Cohen 2001). Thus, perceived dissimilarity is expected to activate these two cognitive brain areas (right DLPFC and dorsal ACC) associated with an attempt to inhibit a consumer's unwanted intense negative emotions in the amygdala and insular cortex when suppressing ethnicity and gender bias that results from dissimilarity with an avatar.

[4] The dorsal (posterior) part of the ACC is a more cognitive part of the ACC, and it is distinct from the anterior (frontal) of the ACC that is the evaluative part of the ACC that is associated with rewards (Bush et al. 2000). Also, the rostral part of the ACC is involved in emotional (versus cognitive) processing (Bishop et al. 2004).

H3: A consumer's perceived dissimilarity with an avatar that does not match her ethnicity and gender is associated with higher activation in the (i) *amygdala*, (ii) *insular cortex*, (iii) *right dorsolateral prefrontal cortex* (BA9), and (iv) *dorsal anterior cingulate cortex* (BA32), than with an avatar that matches her ethnicity and gender.

Given that perceived (ethnic and gender) dissimilarity is the driver of these brain activations (H3), the corrolaries of H3 is that either perceived ethnic (H3a) or gender (H3b) dissimilarity can elicit these activations. For example, Hart et al. (2000) showed that amygdala activation deteriorated slower for same ethnicity faces versus for faces of other ethnicities. Thus, we propose either perceived ethnic (H3a) or gender (H3b) dissimilarity to elicit these brain activations.

H3a: A consumer's perceived dissimilarity with an avatar that does *not* match her ethnicity is associated with a higher activation in the i) *amygdala*, (ii) *insular cortex*, (iii) *right dorsolateral prefrontal cortex* (BA9), and (iv) *dorsal anterior cingulate cortex* (BA32), than with an avatar that matches her ethnicity.

H3b: A consumer's perceived dissimilarity with an avatar that does *not* match her gender is associated with a higher activation in the i) *amygdala*, (ii) *insular cortex*, (iii) *right dorsolateral prefrontal cortex* (BA9), and (iv) *dorsal anterior cingulate cortex* (BA32), than with an avatar that matches her gender.

We also predict that the consumer's gender will moderate the effect of dissimilarity repulsion. The activations in the brain areas associated with perceived dissimilarity (H3) are proposed to be more salient in women than in men. Emotional, social, and identity needs are more prominent in women's consumer behavior than in men's (e.g., Dittmar 2000; Dittmar, Long and Meek 2004). Sociologists have repeatedly shown that women are more oriented to their ethnic identity than men (Masuda, Hasegawa and Matsumoto 1973; Ting-Toomey 1981; Ullah 1985). It is likely that female consumers, being more aware of their own ethnic identity as well as that of the avatar, are more prone to use ethnicity as cue of "out-group" connections. Favorable same-ethnicity bias in performance rating was only observed for female subordinates with female superiors (Tsui et al. 1989). One possible explanation is that women are generally more expressive and can convey meaning more clearly using *nonverbal cues* (Briton and Hall 1995; Burgoon and Dillman 1995; Spangler 1995). Women are also better than men in decoding, understanding, and using nonverbal cues sent by others (Briton et al. 1995; LaFrance and Henley 1994) and are more oriented to their ethnic identity than men (Ting-Toomey 1981). Thus, women, being more aware of their own and the avatar's demographics, are more prone to use ethnicity and gender as "in-group" associations, thus eliciting higher brain activity when evaluating an ethnicity and gender mismatched avatar.

H4: The brain activation in the i) *amygdala*, (ii) *insular cortex*, (iii) *right dorsolateral prefrontal cortex* (BA9), and (iv) *dorsal anterior cingulate cortex* (BA32), associated with a consumer's perceived dissimilarity with an avatar that does not match her ethnicity and gender than with an avatar that matches her ethnicity and gender, *will be stronger in women than men.*

3. RESEARCH METHODOLOGY

To test the proposed hypotheses, an fMRI experiment was conducted in which subjects were scanned while responding to a set of stimuli associated with perceived similarity. To refine the fMRI experiment, a behavioral study with 190 subjects was conducted as a pretest, following the guideline of integrating fMRI and behavioral data (Huettel and Payne 2009; Yoon et al. 2009).

3.1 Experimental Design

A 2×2 within-subject factorial experimental design (subject-avatar ethnicity match/mismatch × subject-agent gender match/mismatch) was used (Table 1). Within-subject designs are preferred in fMRI studies to enable direct comparisons across subjects. Four avatars were designed to vary on ethnicity (Caucasian, Asian) and gender (Male, Female). We chose Caucasian and Asians since the two ethnicities are used commonly with the literature (e.g., Ng et al. 2006; Qiu and Benbasat 2010). Four groups of subjects were recruited whose ethnicity and gender were permuted to create four categories (Table 1) - ethnicity and gender match or mismatch (and two partial mismatches). All subjects viewed all four avatars, albeit the match and mismatch varied across subjects (Table 2).[5]

--- INSERT TABLE 1 AND TABLE 2 HERE ---

3.2 Design of Experimental Stimuli

The four avatars for the fMRI experiment were adapted from Wang and Benbasat (2007). The avatars were designed with Oddcast Sitepal, a software that provides a wide-array of avatars that can be modified in terms of physical appearance. The four avatars with salient ethnic and gender characteristics (Figure 1) were selected after several pretests, which showed that *all* subjects correctly identified the avatar's ethnicity and gender and they were no significant differences among their physical attractiveness and professionalism.

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3.3 Experimental Procedures

24 right-handed (6 Caucasian males, 6 Asian males, 6 Caucasian females, 6 Asian females) subjects who were pre-screened for fMRI safety (no medical implants or metal objects) participated in the fMRI study for $35 compensation. The n=24 number of subjects was chosen to ensure adequate power of analysis (80%) at a threshold of p<.05 (Desmond and Glover 2002). fMRI studies require a smaller number of subjects than traditional behavioral studies because they produce more data per subject (about 10,000 datapoints), the repetition of the experimental stimuli, and the within-subject design (which is mainly used to allow comparisons across the same brains). Subjects were recruited from the metropolitan area of a major US university using an open flyer. The protocol and ad were reviewed and approved by the University's Institutional Review Board.

[5] Since match/mismatch is based on a subject-avatar association, the avatar that is matched for some subjects may be mismatched for others. This design gives counter-balanced control of any systematic differences that may exist among the four avatars, allowing us to explore differences across subjects.

The fMRI design, experimental procedures, and measurement items were calibrated and refined with a behavioral study of 190 subjects that spanned the four demographic groups. The behavioral study replicated the fMRI study besides capturing brain activity with fMRI. Since the fMRI study also collected behavioral responses, we compared the behavioral data in the fMRI scanner with the corresponding behavioral data from a traditional lab experiment to ensure that the behavioral results do not differ across studies (e.g., Yoon et al. 2009). Indeed, the behavioral results were statistically similar across studies, thus inferring ecological validity.

3.3.1 Before the fMRI Session

Subjects were asked to interact with the four avatars to get advice about a digital camera for themselves. Digital cameras were chosen as the focal product for the avatars as decision aids because of the complexity of their product characteristics, the large number of alternative models in the market, the short lifespan of each product generation, and ethnicity and gender neutrality. Notably, selling of digital cameras does not have an apparent bias toward either ethnicity or gender. Subjects were told to provide their preferences about a digital camera by answering a common set of 10 questions posed by all four avatars. Subjects simultaneously viewed all four avatars at the top of the screen that jointly asked them questions about digital cameras (Figure 2). Subjects were asked to select an answer to each question for a certain digital camera characteristic. If a subject wanted to know more about a characteristic, she could click the "About This Question" button for more information. To make the experiment as realistic as possible, subjects were told that they have to evaluate and act upon the advice of these four avatars to purchase a digital camera. After the subjects responded to the questions, they were told that each of the four avatars would show them the best digital camera choice for them (that would be revealed during the fMRI session). For added realism, subjects also selected one of three different price ranges, and all avatars' recomendations were within this price range.

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To minimize any differences across the four avatars (besides ethnicity and gender), the recommended digital cameras from all avatars were *identical* in terms of their basic characteristics (e.g., price, resolution, zoom). We slightly modified these characteristics (picture, model number) to appear that the four options presented by each avatar are different. Several between-subjects experimental pretests revealed that subjects could not distinguish across the four digitcamera types, and their evaluations and intentions to purchase each of the four cameras were not statistically different across cameras. For added realism, subjects initially saw three digital cameras from each avatar (which were also virtually identical besides the model number) followed by each avatar's top choice, which was superior in terms of all characteristics relative to the other two options.

Besides price that was selected by the subject and used in the avatar's recommendation, all other attributes were fixed irrespective of the subjects' preferences. This is to ensure that all subjects saw an identical set of cameras to avoid variations across subjects. No differences were observed across subjects who selected a different price range and were shown a corresponding camera within their chose price range. Despite the fact that the recommended digital cameras were the same across all subjects and did not follow the subjects' stated preferences, none of the subjects raised concerns that the recommended cameras were unacceptable to them. Also, we did not observe any behavioral or neurological differences across subjects because the recommended cameras differed from their posted preferences.

3.3.2 During the fMRI Session

Subjects then entered the fMRI scanner lying comfortably on their back. Visual stimuli were shown to them through fiber-optic goggles connected to a computer. To spawn brain activation in the brain areas associated with perceived similarity, measurement items in the form of validated Likert-type scales for all constructs were used. Consistent with both similarity-attraction and dissimilarity-repulstion theories, demographic similarity leads to perceived similarity, which either leads to interpersonal attraction or repulsion, respectively. This is consistent with Dimoka (2010a) and Winston et al. (2002) who used a numerical scale to rate the credibility of sellers and faces, respectively, and used these ratings as parametric covariates to contrast with the levels of brain activation. The measurement scale for perceived similarity with an avatar (recommendation agent) was based on Qiu and Benbasat (2010) with minor wording changes (Table 3).[6]

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First, one randomly-selected avatar was presented together with a randomly-selected measurement item for the same focal avatar. Each stimulus was shown for 5 seconds without the scale, which was shown to be ample time for subjects to read and process the item (Dimoka 2010b). Then, the 7-point Likert-type scale appeared (Table 3), and subjects selected their choice by depressing one of the seven buttons with a fiber-optic mouse using their right hand. Subjects had unlimited time to make their choice, but the actual time in practice was only about 2 seconds. After clicking on their choice, they were shown a new randomly-selected avatar followed by a randomly-selected measurement item. This procedure was repeated for all four avatars and measurement items,[7] as shown in Figure 3. The total time spent in the fMRI was **4 x 10 x 10 = 400 seconds** (4 avatars times 10 measurement items for each avatar times about 10 seconds for each cycle) or about 6 minutes (besides 4 minutes for obtaining the anatomical brain images).

--- INSERT FIGURE 3 HERE ---

For the fMRI analysis, brain activations were analyzed during the 5-seconds while subjects were reading each measurement item (before posting their response) to assure temporal separation

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[6] Because the measurement items (Table 3) serve as stimuli to induce activation in the areas associated with perceived similarity, the length of the measurement items was designed to be similar. Differences in visual stimuli due to longer measurement items may cause spurious activations in the visual cortex (occipital lobe).

[7] fMRI studies require appropriate control variables to “cancel out” spurious brain activation due to visual stimuli, movement, and other sources of noise, thereby isolating brain activation associated with the stimuli. In this study, the comparison was made by comparing brain data *across* avatars.

between the brain activity while reading the measurement item and the self-reported response on the Likert-type item to prevent hand movement when responding to the measurement item.

3.3.3 After the fMRI Session

Subjects were asked to select one of the four avatars that they wished to transact with. Upon completion of these questions, the subjects were thanked, debriefed, and dismissed.

3.4 fMRI Data Analysis

The fMRI analysis aimed at identifying the neural correlates of perceived similarity by contrasting brain activations across the four contrasts (Table 2). For example, the contrast between the 'full match' and 'full mismatch' avatar reflects the *difference* in brain activation due to the measurement items when assessing the similarity of an avatar that matches the subject's ethnicity and gender versus the avatar that does not match the subject's ethnicity and gender. In contrast, the 'mismatch' versus 'match' contrast reflects the difference in brain activation when responding to the measurement items about an avatar that does not match the subject's ethnicity and gender versus an avatar that matches the subject's ethnicity and gender. Since it is not possible to derive negative brain activation when subtracting two brain images, and we can only observe positive activation that exceeds a certain statistical threshold, the contrast between ethnicity and gender match versus mismatch can be different from the contrast between mismatch versus match. This is consistent with Byrne et al. (1986) who explained that dissimilarity attributes are first assessed to exclude undesirable others, followed by similarity characteristics that are used to include desirable ones. This two-step process can be captured by examining both the match versus mismatch and the mismatch versus match contrasts (in addition to the partial contrasts). Technical details associated with the fMRI equipment, data pre-processing, and statistical data analysis are reported in Table 4.

--- INSERT TABLE 4 HERE ---

The fMRI data were first analyzed for each subject individually using ROI analysis (Table 4). Then, second-level one-sample t-tests were used on the aggregate data to create random-effect group analyses for perceived similarity across all avatars. For each contrast at the group level, Statistical Parametric Maps (SPMs) were generated with the z-value of each voxel (3D pixel) that exceeded a $p<.05$ threshold.[8] ROI analysis was used to define an area of interest in the brain within which to observe localized activity across subjects.

4. PRESENTATION OF RESULTS

4.1 fMRI Results

To test H1, we examined the neural correlates of perceived similarity when evaluating avatars that matched consumers in terms of ethnicity and gender. There was significant activation in the caudate nucleus ($z=3.04$, $p<.01$) for all subjects, supporting H1 (Figure 4). When conducting the analysis by gender, there was significant bilateral activation in the caudate nucleus ($z=3.82$, $p<.01$) in men only; however, no significant activation ($p>0.10$) was found in women, supporting H2.[9]

--- INSERT FIGURE 4 HERE ---

In terms of the effects of ethnicity match for all subjects (Figure 5), there was *no* significant activation in the caudate nucleus, failing to support H1a. However, the analysis by gender showed a significant bilateral activation in the caudate nucleus ($z=2.82$, $p<.01$) in men, but no significant activation ($p>0.10$) in women. These results support the ethnicity match versus full mismatch contrast (H1a) but for the male sample only, while offering further support for the gender differences as far as caudate nucleus activation (H2).

--- INSERT FIGURE 5 HERE ---

[8] The z-values correspond to the unit normal distribution that renders the same p-values as the t-statistic.

[9] While Figure 5 shows that there is significant activation in the caudate nucleus in men but not in women, we also compared the brain activations in the caudate nucleus in men versus women for each subject to statistically show that there is higher ($p<.01$) brain activation in the male versus the female sample.

In terms of gender match, there was no significant activation in the caudate nucleus for all subjects (Figure 6). However, there was a marginally significant activation in the caudate nucleus ($z=1.80$, $p=.053$) in men (not in women), partially supporting H1b. This also supports H2 because of the higher activation in the caudate nucleus in men than women. The level of brain activation in the caudate nucleus due to ethnicity match ($z=2.82$) was significantly ($p<.01$) higher than that due to gender match ($z=1.80$), implying that the activation in the caudate nucleus is mostly due to ethnicity (and to a lesser degree) gender match. While both ethnicity and gender are important attributes, ethnicity is often regarded as the most important one (e.g., Cowell and Stanney 2005; Cunningham et al. 2004). For example, Cowell and Stanney showed that most subjects chose a character that mathes his/her ethnicity, but there was no strong preference toward characters of the same gender. Therefore, gender similarity effects are comparatively weak and, hence, easily subordinated to ethnicitity similarity (Taynor and Deaux 1973).

--- INSERT FIGURE 6 HERE ---

For H3, there was no significant activation in the amygdala and insular cortex in all subjects (Figure 7). However, there was significant brain activation in the dorsal ACC ($z=2.58$, $p<.05$) and right DLPFC ($z=2.36$, $p<.05$) for all subjects associated with perceived dissimilarity due to ethnicity and gender mismatch because of suppression of unwanted ethnicity and gender biases (e.g., Beauregard et al. 2001; Cunningham et al. 2004; MacDonald et al., 2000). Thus, there is only partial support for H3, though the results for women showed significnt activations in all four hypothesized brain areas, amygdala ($z=2.61$, $p<.05$), insular cortex ($z=3.13$, $p<.01$), dorsal ACC ($z=3.01$, $p<.01$), and right DLPFC ($z=3.39$, $p<.01$), thus fully supporting H3 for women. However, there was no significant brain activation in men in neither of the four hypothesized brain areas. The differential activation between women and men for dissimilarity also helps support H4.

Please note that the observed activations in these brain areas were highly correlated to each other, consistent with the notion that higher activation in the amygdala and insular cortex (presumably because of intensive emotions due to dissimilarity) would be associated with higher activation in the areas of the prefrontal cortex associated with executive control and monitoring.

--- INSERT FIGURE 7 HERE ---

For H3a (ethnicity mismatch versus match), the results showed no significant brain activation in all subjects, thus not supporting H3a (Figure 8). The only significant activation was in the insular cortex ($z=3.03$, $p<.01$), but only in women. Thus, there was modest support for H3a.

--- INSERT FIGURE 8 HERE ---

For H3b (gender mismatch versus match), there were no significant activation in the amygdala and insular cortex. However, there was significant activation in the dorsal ACC ($z=2.06$, $p<.05$) and right DLPFC ($z=1.90$, $p<.05$) for all subjects (Figure 9). These results partially support H3b. The analysis in women only showed significant activations in the amygdala ($z=2.06$, $p<.05$), insular cortex ($z=1.95$, $p<.05$), dorsal ACC ($z=1.79$, $p<.05$), and right DLPFC ($z=2.08$, $p<.05$), thus fully supporting H3b for women. However, there was no significant activation in men, thus supporting H4. These results suggest that ethnicity and gender mismatch (Figure 7) are almost exclusively explained by gender mismatch (Figure 9). These results are in contrast to Taynor and Deaux (1973) who argued that gender effects are weak relatively to ethnicity effects, and they suggest that perceived dissimilarity is much more prevalent for gender than for ethnicity effects.

--- INSERT FIGURE 9 HERE ---

In general, men exhibit significant activations in a utility-laden brain area (caudate nucleus), while women have stronger activations in brain areas associated with intense negative emotions (amygdala, insular cortex) and suppression of unwanted prejudices (dorsal ACC, right DLPFC). The results imply that men cognitively draw utility from perceived similarity from similar avatars in terms of ethnicity and gender, but they do not show any significant activations from avatars that do not match their ethnicity and gender. In sharp contrast, women show significant activations in “emotion-laden” and “social control” brain areas but do not exhibit activation in utility areas.

It is important to note that no significant activation was identified in the nucleus accumbens, the area associated with attractive faces (e.g., Aharon et al. 2001). This implies that attractiveness did not spawn the observed brain activity, validating our behavioral pretest that all avatars were similarly attractive. Furthermore, aesthetic evaluation was shown to be distinct from rewards evaluation (Aharon et al. 2001), implying that our results are not driven by aesthetic evaluation. Also, there was no significant activation in the ventrolateral prefrontal cortex, an area associated with evaluations marked by ambivalence (Cunningham et al. 2003). This suggests that subjects were not ambivalent about their evaluations of avatars in terms of simialarity and dissimilarity.

Finally, subjects were finally asked to select the recommendation from one of the four avatars. 7 out of 11 women chose an avatar that matched their gender, while 7 out of 11 men chose an avatar that matched their ethnicity. There was a significant correlation ($r=.71$, $p<.01$) between the level of brain activation in the caudate nucleus and the men’s selection of avatars that match their ethnicity (not gender). There were also significant correlations ($p<.05$) between the levels of brain activation in the right DLPFC ($r=-.46$), amygdala ($r=-.52$), and insular cortex ($r=-.40$) with the women’s decision to select avatars that match their gender (not ethnicity). These results suggest that brain activations are consistent with the subjects’ decision to select “matched” avatars, albeit men selected “ethnicity-matched” avatars whereas women selected “gender-matched” avatars.

4.2 Behavioral Results[10]

Table 5 presents the descriptive statistics for perceived similarity.

[10] Because the behavioral data from the lab and fMRI experiments were very similar, we only present the behavioral data in the fMRI scanner. This implies that the fMRI context did not bias the behavioral data, implying the ecological validity of the fMRI study, at least relative to a behavioral experiment.

--- INSERT TABLE 5 HERE ---

Across all subjects, perceived similarity is significantly higher ($p<.05$) for ethnicity and gender match ($\mu=3.81$) versus ethnicity and gender mismatch ($\mu=2.70$), ethnicity match ($\mu=2.82$), and gender match ($\mu=3.45$). Perceived similarity was positively linked to ethnicity ($r=0.32$, $p<.01$) and gender ($r=0.25$, $p<.05$). When splitting the data by gender, women perceive similar similarity for both ethnicity and gender match ($\mu=3.85$) and ethnicity match ($\mu=3.72$), which are significantly ($p<.05$) higher than ethnicity match ($\mu=2.54$) and full mismatch ($\mu=2.44$), which are statistically indistinguishable. Men perceive higher ($p<.01$) similarity for avatars who match their ethnicity and gender ($\mu=3.76$) than all other combinations, which are statistically indistinguishable from each other (i.e., ethnicity match, gender match, full mismatch).

ANOVA was used to examine whether ethnicity-match and gender-match affect perceived similarity (Table 6). There was a significant gender-match effect for all subjects, implying that subjects perceived same-gender avatars to be similar to them. Women perceived both ethnicity and gender match to be similar to them, while Caucasians perceived only gender match to be linked to higher similarity. No significant differences were observed for the Asian sample.

--- INSERT TABLE 6 HERE ---

5. DISCUSSION

5.1 Key Findings

A major concern for studies that deal with sensitive issues, such as ethnicity and gender, is that subjects answer in politically correct and socially appropriate ways (Dimoka et al., 2010). The fMRI study was thus undertaken to mitigate social desirability bias and open the "black box" of marketing demography to uncover the underlying reasons that consumers select avatars that match their ethnicity and gender. First, the fMRI results showed activation in a *utility-laden* brain area (caudate nucleus) triggered by avatars that match the consumer's ethnicity and gender. Second, activations in two *emotion-laden* brain areas (amygdala and insular cortex) were triggered for avatars that did *not* match their ethnicity and gender , but they were only evident in women. Third, two brain areas associated with controlling negative emotions, regularing social prejudice, and mitigating ethnicity and gender stereotyping (right DLPFC and dorsal ACC) were activated for avatars that did not match the consumers' ethnicity and gender, particularly in women. In sum, the results show that men elicit brain activations in a key utility-laden brain area (caudate nucleus) from ethnicity-matched avatars, while women elicit activations in brain areas linked to both intense negative emotions (amydgala and insular cortex) and also suppressed social prejudices (right DLPFC and dorsal ACC) from gender-mismatched avatars. The fMRI results imply that men tend to prefer "ethnicity-matched" avatars because they perceive utility from ethnic similarity, while women prefer "gender-matched" avatars, not because they like matched avatars but because they experience intense negative emotions and social prejudice mostly from gender dissimilarity.

5.2 Implications for Theory and Practice

5.2.1 Implications for Similarity-Attraction and Dissimilarity-Repulsion Theories in Marketing

The marketing literature on traditional and virtual salespeople concluded that consumers prefer salespeople or avatars who match their ethnicity and gender, resulting in higher credibility and sales. However, the theoretical reason for this empirical finding remains a gap in the marketing literature. Two competing theories – *similarity-attraction* (Byrne 1971) and *dissimilarity-repulsion* theory (Rosenbaum 1986) were used to explain why consumers prefer similar salespeople. While there have been several studies (e.g., Chen and Kendrick 2002; Tan and Singh 1992) trying to reconcile these two theories after Rosenbaum's (1986) and Byrne's (1986) debate, past work may have been restricted by social desirability bias that may have prevented uncovering the true reasons that people prefer similar entities, particularly in the marketing context of avatars. The fMRI results suggest that the observed behavioral preference toward similar avatars is more heavily influenced by perceived dissimilarity in the female population (consistent with dissimilarity-repulsion theory), primarily gender dissimilarity, while men are more heavily influenced by perceived similarity (consistent with similarity-attraction theory), primarily ethnic similarity. While the behavioral data could not offer a compelling explanation for the applicability of these two competing theories, the fMRI results reveal a distinct pattern across genders. The distinct pattern of brain activation across genders follows Byrne et al. (1986) who explained that dissimilarity attributes are assessed to exclude undesirable ones, and similarity attributes are used to include potential partners. Notably, the former process may be more applicable to women, while the latter is more applicable to men. Albeit the fMRI results are consistent with the behavioral results, the added benefit of the brain data is to enhance the descriptive power of a model that explains why perceived similarity/dissimilarity has its observed behavioral outcomes differently in women than in men, thus filling a gap in the marketing literature on why consumers prefer sales assistants who match their ethnicity and gender.

The fMRI results suggest that women are negatively influenced by social cues conveyed by avatars that do **not** match their ethnicity and gender, while men are affected by utilitarian cues conveyed by avatars that match their ethnicity and gender. These results are consistent with the literature that showed that only female superiors saw their female subordinates more favorably (Tsui et al. 1989). While one behavioral explanation is that women are generally more emotionally expressive and can convey their emotions easier than men (e.g., Briton and Hall 1995; Burgoon and Dillman 1995; Spangler 1995), the fMRI results show that only women elicit strong emotional reactions in their brain from perceived dissimilarity. In other words, it is not that men suppress or cannot behaviorally convey their emotions; rather, men do not have the same brain activations in the emotion-laden brain areas as women do and they do not seem to suppresss them. In contrast, utility-laden brain areas drive their behavior, confirming the literature that men are more utility-driven than women (Minton and Schneider 1980).

While both ethnicity and gender are important attributes, ethnicity is often regarded as the strongest attribute (Cowell and Stanney 2005; Cunningham et al. 2004; Taynor and Deaux 1973). Our results suggest that ethnicity is more salient in men, while gender is more salient in women, challenging the literature that has shown ethnicity is the most important attribute and that similarity-attraction and "in-group" favoritism are primarily important for ethnicity.

5.2.2 Broader Implications for Marketing

How do our results in the context of online avatars generalize to consumer-salespeople and other social relationships? Evidence suggests that consumers use social stereotypes similar to those applied in traditional interpersonal communications evaluate avatars (Qiu and Benbasat 2010). While we do not have empirical evidence to suggest that our results may generalize to other types of social relationships where human faces or actual people are involved, if avatars that only offer product recommendations for digital cameras are able to elicit such distinct effects across genders, one may speculate that our findings are likely to generalize to customer-salespeople and even other social relationships where ethnicity and gender come into play. Future research should nonetheless extend our findings to other contexts, including other types of avatars, avatars with human faces, traditional salespeople, other types of social interactions, and even relationships in virtual worlds.

5.2.3 Implications for Practice

Even if social prejudice is considered unacceptable and consumers are likely to suppress and not self-report biases toward other ethnicities or genders, the fMRI data suggest a different story. Thus, our research calls for more attention to social demographics - ethnicity and gender - in the design of human-like avatars to match the customer's demographics. In contrast to physical settings that is rather costly to offer traditional salespeople to match the customer's demographics, designing avatars to match the customer's ethnicity and gender is relatively easy and inexpensive. While asking the customer's demographics may seem awkward at first, given the strong utility benefits (primarily for men) and intense emotional reactions (primarily for women), it may be worthwhile to solicit the customer's demographics before presenting an avatar as a decision aid. Dissimilar avatars induce activation in cognitive brain areas that aim to control and regulate unwanted prejudicial emotions, which are associated with reduced ability in subsequent executive decision-making tasks by depleting cognitive resources (Bishop et al. 2004; Richeson et al. 2003). Accordingly, irrespective of whether the reason (social prejudice) may be politically inappropriate, avatars whose ultimate purpose is to enhance decision-making should not inadvertently hinder the consumer's cognitive ability due to their demographics. At the very least, websites could offer diverse avatars that vary in their ethnicity and gender and allow consumers to pick an avatar with their desired demographics. In sum, using socially diverse avatars can be used to cost-effectively gain access and legitimacy in differentiated market segments, including niche markets, while enjoying the utility benefits of social similarity and preventing the negative effects of dissimilarity.

5.3 Limitations and Suggestions for Future Research

While similarity-attraction and dissimilarity-repulsion theories are competing at first brush (and perhaps reconciled based on gender, as our fMRI results attest), Chen and Kendrick (2002) found both similarity-attraction and dissimilarity-repulsion effects for people who may be similar in certain attributes and dissimilar in others. Thus, it is possible to have both similarity-attraction and dissimilarity-repulsion effects simultaneously, and future research could delve deeper as to the relative importance of both effects across genders and other ethnicities beyond those studied here.

Qiu and Benbasat (2010) showed that avatars that match the consumer's ethnicity (but not gender) were perceived to be more sociable, more enjoyable, and more useful to interact with than mismatched ones. Qiu and Benbasat (2010) found avatars that matched the consumer's ethnicity were perceived to have a higher sense of social presence and to be more useful than mismatched avatars. The authors showed that women were more likely than men to favorably evaluate a matched avatar than a mismatched one in terms of usefulness, trust, and social presence, resulting in higher intentions to choose a matched avatar in women than men. Future research could examine the neural correlates of other constructs that affect consumers' evaluations of avatars, such as social presence, enjoyment, usefulness, and intentions to work again with these avatars.

The study was conducted with avatars as opposed to actual sales assistants with human faces. While it is more common to use software than human faces in online shopping environments, future research could examine whether our findings are similar or are exacerbated by real faces.

While our focus has been on demographic (ethnic and gender) similarity that is readily salient but still surface-level, there are other deeper-level traits (personality, culture, life stage, attitudes), which may also play a role in attraction or repulsion. Future research may test our findings to other types of similarity between consumers and avatars.

Finally, Holzwarth et al. (2006) found that an attractive avatar is a more effective sales assistant at moderate levels of product involvement, while an expert avatar is a more effective at high levels of product involvement. Future research could examine how product involvement interacts with consumers' perceived similarity and dissimilarity with demographically diverse avatars.

CONCLUDING REMARK

Lawrence (1997) called for opening the "black box" of organizational demography to examine how demographic characteristics affect organizational and work outcomes. By showing the hidden impact of demographic factors (ethnicity and gender) in marketing relationships, this study aims to bring sales force diversity into the forefroant of marketing research and entice future research on identifying how sensitive issues, such as similarity and dissimilarity, that people may be unwilling, unable, or uncomfortable to self-report could be captured with direct neurophysiological measures.

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Table 1: Correspondence between Avatars and Subjects

Subject \ Avatar		Male		Female	
		Asian	**Caucasian**	**Asian**	**Caucasian**
Male	**Asian**	AA-MM	AC-MM	AA-MF	AC-MF
	Caucasian	CA-MM	CC-MM	CA-MF	CC-MF
Female	**Asian**	AA-FM	AC-FM	AA-FF	AC-FF
	Caucasian	CA-FM	CC-FM	CA-FF	CC-FF

Table 2. Experimental Design

Ethnicity \ Gender	Match	Mismatch
Match	**(Full Match)** AA-MM, CC-MM, AA-FF, CC-FF	**(Ethnicity Match – Gender Mismatch)** AA-FM, CC-FM, AA-MF, CC-MF
Mismatch	**(Ethnicity Mismatch – Gender Match)** CA-MM, AC-MM, CA-FF, AC-FF	**(Full Mismatch)** CA-FM, AC-FM, CA-MF, AC-MF

Table 3: Measurement Items for Perceived Similarity

1. In general, this recommendation agent and I look similar:
2. In general, the recommendation agent and I look roughly the same.
3. In general, the recommendation agent and I look almost alike.
4. In general, this recommendation agent and I look practically alike.
5. In general, this recommendation agent and I look somewhat identical.
6. In general, this recommendation agent and I are similar
7. In general, this recommendation agent and I are virtually alike.
8. In general, this recommendation agent and I are nearly identical.
9. In general, this recommendation agent and I are just about the same.
10. In general, this recommendation agent and I are basically alike.

Table 4. Technical Details

Equipment: The fMRI scanner was a 3 Tesla, Siemens whole-body scanner with a standard CP head coil. Subjects were scanned with contiguous (no gap) 5 mm axial high-resolution T1-weighted structural slices (matrix size=256×256; TR=600ms; TE=15 ms; FOV=21cm; NEX=1; slice thickness=5 mm) were collected for spatial normalization procedures and overlay of functional data. Precise localization based on standard anatomic markers (AC-PC Line) was used for all subjects (Talairach and Tournoux, 1988). Functional scans were acquired with a gradient-echo planar free induction decay (EPI-FID) sequence (T2*weighted: 128×128 matrix; FOV=21 cm; slice thickness = 5 mm; TR = 2s; and TE = 30 ms, slices=28) in the same plane as the structural images. Voxel size was 3.33 mm × 3.33 mm × 5 mm.
Data Pre-Processing: The data were processed using SPM8 (Statistical Parametric Mapping, Wellcome Department of Cognitive Neurology, University College of London, UK) under Matlab® (The Mathworks, Inc., Natick, MA). Slice timing correction was performed in order to compensate for delays associated with acquisition time differences among slices during sequential imaging. A 3D automated image registration routine (six-parameter rigid body, sinc interpolation; second order adjustment for movement) was applied to the volumes to realign them with the first volume of the first series used as a spatial reference. All functional and anatomical volumes were then transformed into standard anatomical space using the T2 EPI template and the SPM8 normalization procedure (Ashburber and Friston, 1999). Next, all volumes underwent spatial smoothing by convolution with a Gaussian kernel of 8 cubic mm full width at half maximum (FWHM) to increase the signal-to-noise ratio (SNR) and account for inter-session differences.
Statistical Data Analysis: Subject-level analyses based on changes in Blood Oxygenation Level Dependent (BOLD) contrasts were performed with the General Linear Model (GLM) in SPM8. The four conditions (avatars) were modeled with a canonical hemodynamic response function (hrf). Contrast maps were obtained through linear contrasts of all event types. Group-level random effects analyses for main effects were accomplished by entering whole brain contrasts into one-sample *t* tests. For group level analysis, Region of Interest (ROI) analysis was implemented, which involves defining a specific area of interest in the brain within which to make local analyses. A significance threshold based on spatial extent using $t \geq 1.96$ and cluster probability of an uncorrected $p \leq 0.05$ (Forman *et al*., 1995) was applied to the ROI areas.

Table 5. Descriptive Statistics for Perceived Similarity across Genders

Contrast	All Subjects (Mean)	Women (Mean)	Men (Mean)
All Contrasts Together	3.22	3.14	3.30
Ethnicity and Gender Match	**3.81**	**3.85**	**3.76**
Ethnicity Match	2.82	2.54	3.10
Gender Match	**3.45**	**3.72**	3.17
Ethnicity and Gender Mismatch	2.70	2.44	2.97

Table 6: ANOVA Results for Perceived Similarity

Actual Similarity	All Subjects	Women	Men	Caucasian	Asian
Ethnicity Match	F=0.50$^{N/S}$	**F=6.30***	0.00$^{N/S}$	0.12$^{N/S}$	0.32$^{N/S}$
Gender Match	**F=8.50****	**F=7.14***	1.05$^{N/S}$	**F=10.95****	0.23$^{N/S}$
Ethnicity Match × Gender Match	F=0.18 $^{N/S}$	0.54$^{N/S}$	0.06$^{N/S}$	0.17$^{N/S}$	0.14$^{N/S}$

Figure 1: The Four Avatars Used in the fMRI Study

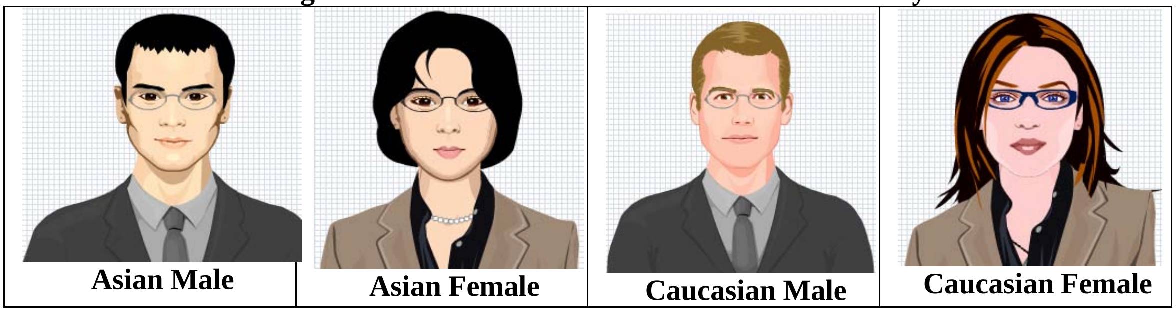


Figure 2. Screenshot of the Avatar Interface

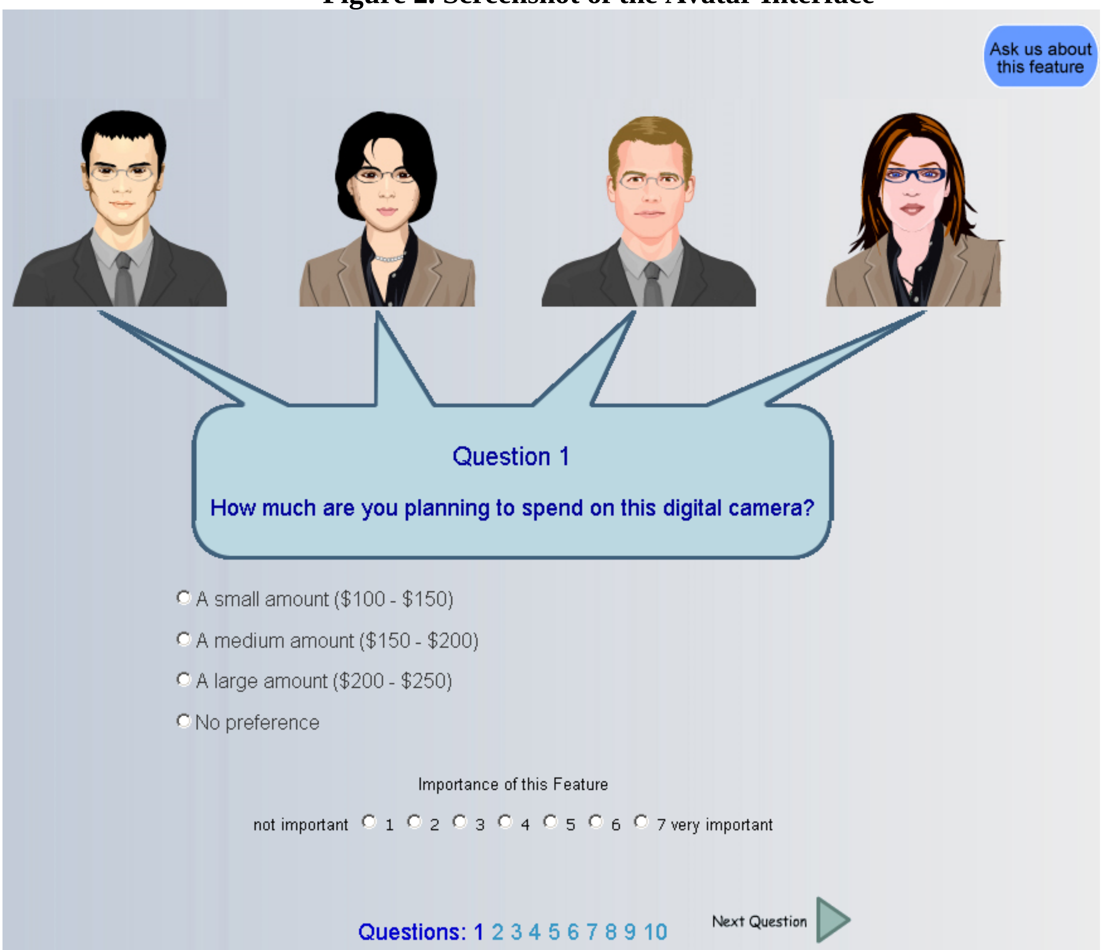


Figure 3. Graphical Description of the fMRI Study and Presentation of Stimuli

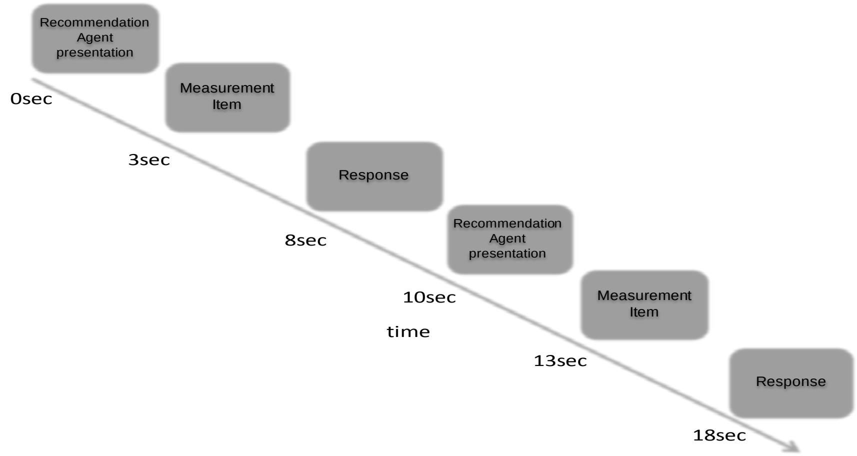


Figure 4. fMRI Results for Ethnicity and Gender Match versus Mismatch

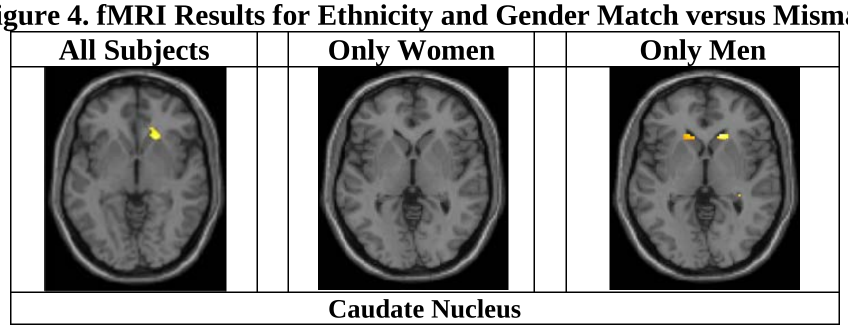


Figure 5. fMRI Results for Ethnicity Match versus Mismatch

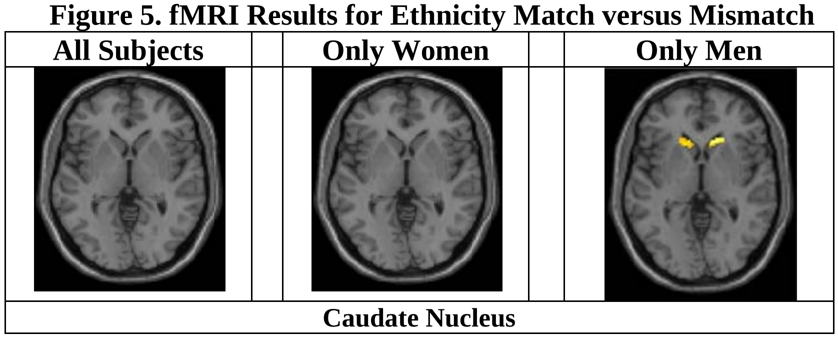


Figure 6. fMRI Results for Gender Match versus Mismatch

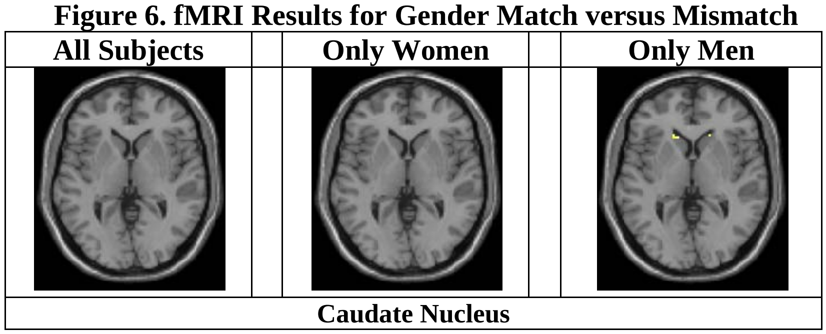
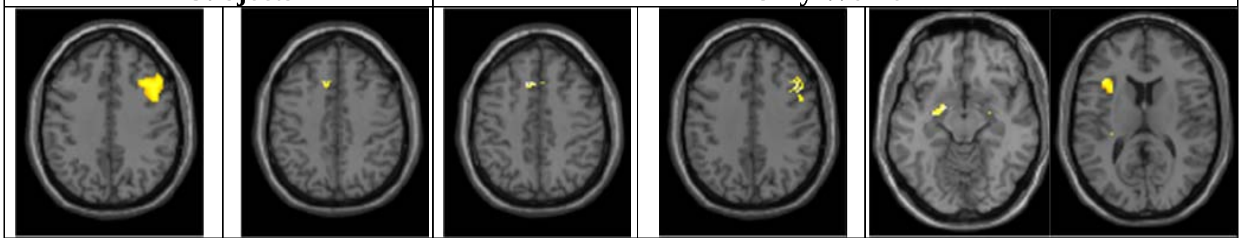
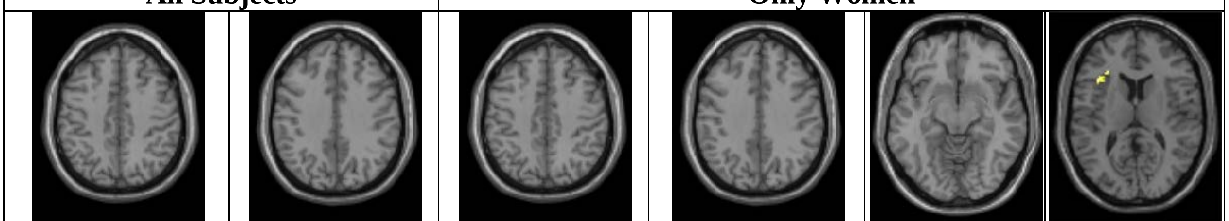


Figure 7. fMRI Results for Ethnicity and Gender Mismatch versus Match



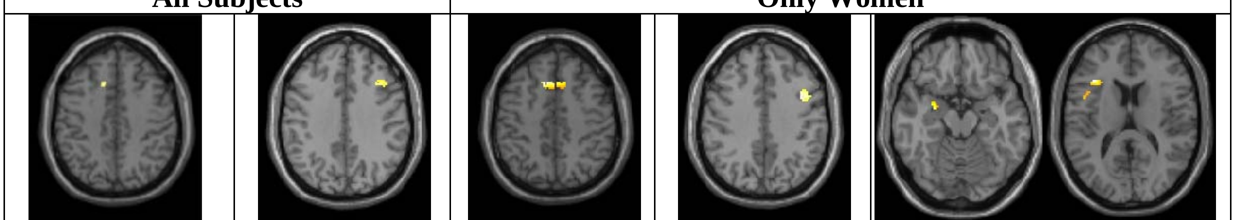
All Subjects		Only Women			
Right Dorsolateral Prefrontal cortex (BA 9)	Dorsal Anterior Cingulate cortex (BA32)	Dorsal Anterior Cingulate cortex (BA 32)	Right Dorsolateral Prefrontal cortex (BA 9)	Amygdala	Insular cortex

Figure 8. fMRI Results for Ethnicity Mismatch versus Match



All Subjects		Only Women			
Dorsal Anterior Cingulate cortex	Right Dorsolateral Prefrontal cortex	Dorsal Anterior Cingulate cortex	Right Dorsolateral Prefrontal cortex	Amygdala	Insular cortex

Figure 9. fMRI Results for Gender Mismatch versus Match



All Subjects		Only Women			
Dorsal Anterior Cingulate cortex	Right Dorsolateral Prefrontal cortex	Dorsal Anterior Cingulate cortex	Right Dorsolateral Prefrontal cortex	Amygdala	Insular cortex