The Dynamic Nature of Group Membership:
Assessing the Effects of Grouping Cues on Social Perception

Holly Anne Earls
Concord, NC

M.A., University of North Carolina Wilmington, 2007
B.A., University of North Carolina Wilmington, 2004

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James P. Morris (Chair) ____________________________

Dennis Proffitt ____________________________

Sophie Trawalter ____________________________

Stephen Cushman ____________________________

Abstract

Humans have a rapid and automatic tendency to categorize others based on their similarities, breaking the world into “us” and “them.” These similarities can be physical, such as skin color or gender, or can be non-physical, such as religious or political affiliation. These *in-group* and *out-group* distinctions lead to a variety of cognitive and behavioral discrepancies. For example, decades of research has demonstrated that other-race individuals are recognized less accurately than own-race individuals, a phenomenon known as the “Other-Race Effect” (ORE). What is less clear is whether these processing discrepancies are unique to racial categories, or whether other indicators of category membership can have a similar impact. In this dissertation, I examined neural activation associated with the processing of in-group and out-group members on both physical and non-physical dimensions. In the first three experiments, the impacts of group membership cues on early stages of face processing were examined by measuring event-related potentials (ERPs) using electroencephalography (EEG). Results indicate that although both physical and non-physical cues impact early face processing, they do so at different stages. Furthermore, physical cues impact face processing even when irrelevant to the given task. In the final experiment, functional magnetic resonance imaging (fMRI) methods were used to show that perceived group membership impacts biological motion perception. Collectively, the data suggest that group membership is malleable, and influences both perception and cognition. I suggest that motivated perception impacts very early stages of processing based on task-relevant grouping cues and these cues can interact with task-irrelevant cues, impacting both early encoding and subsequent recognition of others.

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Chapter 1

1 Introduction

1.1 Overview.

Categorization is a fundamental cognitive process that allows people to organize knowledge about the world. By categorizing stimuli based on their similarities, a great amount of information can be managed and existing knowledge can be generalized to new exemplars (e.g. Bruner, 1957; Smith & Medin, 1981). Social categorization is no exception, as rapid assimilation of information about the identity and intentions of others is critical for effective interaction. Indeed, individuals relate themselves to a group through categorization, which leads to a distinction between in-group and out-group members (e.g. Tajfel, 1970; Tajfel, 1974). This dissertation is concerned with early perceptual cues that signal group membership. Early studies have established that one such cue, race, powerfully predicts which faces are later recognized after an initial encounter (Malpass & Kravitz, 1969). This phenomenon, termed the Other-Race Effect (ORE) has been studied for decades and is one of the most replicated findings in the facial recognition literature (Chance & Goldstein, 1996). Subsequent studies have demonstrated that other cues, such as age and gender, may also impact recognition (Anastasi & Rhodes, 2006; Wright & Sladden, 2003).

Physical cues such as race and age represent only one class of cues in which others may be grouped. For example, one may be judged to be in-group or out-group based on social affiliation, such as university or team membership. Unlike physical characteristics, social affiliations may often be much more subtle or even arbitrary. For instance, minimal group designs have demonstrated that manipulating background color to signal university affiliation results in higher recognition accuracy for own-university relative to other-university faces (Bernstein, Young, & Hugenberg, 2007). Whether physical or non-physical, grouping cues clearly impact the perception of others and often have an impact on subsequent interaction.

The aim of my dissertation is twofold: first, I examine the neural signatures of perceived group membership, and whether these signatures are equivalent across multiple grouping dimensions. Second, I examine the time-course of the grouping process when grouping cues are temporarily distributed. To specify, the majority of previous research on the effects of multiple group membership on processing have presented all grouping cues simultaneously. For example, participants may be presented with an own- or other-race face simultaneously with a cue indicating university affiliation. However, in real world settings, relevant grouping cues are often detected sequentially rather than simultaneously. Therefore, this dissertation is the first study to examine the effects of sequential presentation of grouping cues on processing.

The structure of this dissertation is as follows. Chapter 1 is divided into two parts. The first part reviews research involving self- and social categorization. The second part reviews behavioral and neurological approaches to face recognition. Chapter 2 presents results of an experiment designed to assess the time-course of activation while viewing in-group and out-group faces on both physical and non-physical dimensions. The experiment presented in Chapter 3 examines whether accent is an effective grouping cue, and whether detection of a grouping cue prior to seeing a face impacts the subsequent face processing. Chapter 4 presents an experiment that incorporates the physical grouping cue of race in combination with the non-physical grouping cue of university affiliation. Using these two cues, I assess the time-course of activation while processing the faces of own- and other-race in-group and out-group members. Chapter 5 presents an experiment aimed to extend the literature beyond face recognition and assess whether perceived group membership, specifically racial group membership, modulates neural activity associated with action observation and imitation. Finally, Chapter 6 summarizes the key findings of this dissertation.

1.2. Self- and Social Categorization.

The self as a psychological construct has been the focus of empirical research for over a century. It has been proposed that the understanding of oneself is often dependant upon perceived similarities and differences between oneself and others. As stated by Turner, Oakes, Haslam and McGarty (1994), “self-categorization is comparative, inherently variable, fluid, and context dependent” (p. 458). Self-Categorization Theory (Turner & Oakes, 1986; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987) assumes that the self can be categorized at different levels of abstraction. These range from a low level of abstraction, which is one’s identity that defines the individual as a unique person, to a high level of abstraction which involves identifying oneself as human, separate from other living creatures. The median level is the social level of abstraction, also termed social identity. Social identity refers to the social categorizations of the self and others, defining oneself in terms of similarities with members of certain social categories rather than other social categories (e.g. Turner et al., 1994), therefore breaking up the social world into “us” and “them.”

The social group to which a person psychologically identifies is termed the *in-group*, whereas the *out-group* is the social group to which one does not identify. Psychological associations with a particular group have been associated with a variety of phenomena. It has been shown that people favor one's in-group over the out-group, termed in-group favoritism, in-group bias, or intergroup bias (Sherif, Harvery, White, Hood, & Sherif, 1961; Allen & Wilder, 1975; Billig & Tajfel, 1973; Brewer & Silver, 1978; Howard & Rothbart, 1980; Locksley, Ortiz, & Hepburn, 1980; Tajfel, 1970). Additionally, out-group members are perceived to be more homogeneous relative to in-group members, often referred to as the out-group homogeneity bias (Park & Rothbart, 1982; Brewer & Kramer, 1985; Jones, Wood, & Quattrone, 1981; Judd & Park, 1988; Brewer, 1993). For example, Park and Rothbart (1982) showed that sorority members directly judge the members of other sororities (out-group members) to be more similar to each other relative to the members of their own sororities. Additionally, the authors found that both men and woman believe the prevalence of stereotypic characteristics is greater for the opposite sex, and that this is not a function of lack of contact with out-group members. Therefore, the out-group homogeneity bias was shown based on gender in one case and based on sorority membership in the other, suggesting that the basis for perceiving another to be an in- or out-group member can be context dependant.

According to the Self-Categorization Theory, the self is not a stable construct, but rather a blend of information constructed from both memory and the incorporation of context and motivation. Therefore, social context can trigger aspects of a social identity and elicit evaluations associated with that identity. For example, in the aforementioned study by Park and Rothbart (1982), asking women to judge items based on dimensions of gender may have increased the salience of their own self-concept of “woman”. Therefore, other women are perceived as in-group members whereas men are perceived as out-group members. Alternatively, asking woman to judge the homogeneity of alternative sororities may increase the salience of their own self-concept of “Gamma Phi Beta” member, resulting in perceptions of group membership to be dependant on the sorority grouping cue. Further details of how in-group and out-group members are differentially processed are discussed below.

1.3. The Other-Race Effect and Models of Face Recognition.

If social identity results in differential processing of others based on similarities, then those who are perceived as similar to oneself should be differentially processed relative to those perceived as dissimilar. In the majority of previous literature, race has been used as the grouping cue. Race is often used as a variable in psychological studies and perceiving another individual to be a racial in-group or out-group member has been shown to impact both cognitive processing and social interactions.

As previously stated, research examining face recognition has consistently shown differences in recognition accuracy for own-race relative to other-race faces. This effect has been studied across races (Meissner and Brigham, 2001), countries (Chiroro, Tredoux, Radaelli, & Meissner, 2008), and developmental stages (Kelly, Quinn, Slater, Lee, Ge & Pascalis, 2007). In a typical ORE study, a simple facial recognition paradigm is used in which own-race and other-race faces are shown sequentially to participants, followed by a recognition task in which participants are again shown a series of faces and asked to indicate whether the faces were previously shown or are novel. Increased recognition accuracy for own-race faces is often due to an increase in false alarms (indicating that a face has been previously shown when it is actually novel) for other-race faces (Ng & Lindsay, 1994; Levin, 1996; see Meissner & Brigham, 2001 for a review). Although not as extensively studied, studies have shown an own-age bias (Anastasi & Rhodes, 2006) and an own-sex bias (Wright & Sladden, 2003) in facial recognition.

In the face recognition literature, there are two main theoretical models proposed to explain the ORE. Perceptual-expertise models propose that limited contact with out-group individuals leads to differential expertise in the processing of in- and out-group members, which subsequently leads to decreased recognition accuracy for out-group members (Malpass & Kravitz, 1969). Alternatively, social-categorization models propose that recognition deficits are a result of detection of an out-group cue, which leads to decreased motivation to encode out-group faces (Levin, 2000; Sporer, 2001). The mechanism that leads to out-group recognition deficits differs between these two models in that the former posits the deficit is based in perception, whereas the latter posits that the deficit is based in cognition. The evidence supporting each of these models is discussed below.

1.3.1 Perceptual-expertise model of face recognition.

According to Valentine (1991), the ORE can be explained by an individual's stored facial representations. Valentine's norm-based coding model posits that individual face exemplars are represented as vectors in a multidimensional *face-space* according to their deviation from a prototypical average. This facial prototype is the average of all faces that have ever been encoded and as a result is unique to each individual. Therefore, individuating face-space dimensions will be optimized for recognition of others who are similar to previously encountered faces. Indeed, some studies have shown that amount of experience with other-race individuals is associated with the ORE (Lavrakas, Buri & Mayzner, 1976; Carroo, 1986; Carroo, 1987; Brigham, Maass, Snyder, & Spaulding, 1982; Sangrigoli, Pallier, Argenti, Ventureyra, & de Schonen, 2005; but see also Ng & Lindsay, 1994; Meissner & Brigham, 2001).

To test the perceptual-expertise model of face recognition, Kelly et al. (2007) assessed infants' ability to discriminate own- and other-race faces. If the face prototype is the average of all encoded faces, it has been suggested that the dimensions of the prototype are broad at birth and become narrower based on the facial input received (Nelson, 2001). The researchers assessed 3-, 6-, and 9-month old infants' ability to discriminate faces of own- (Caucasian) and other-race (African, Middle Eastern, and Chinese) individuals. No ORE was found for 3-month old infants. However, the ORE emerged in 6-month old infants, in that the infants were able to recognize Caucasian and Chinese faces only, and was present in the 9-month old infants, in that they were able only to recognize Caucasian faces. The authors concluded that contact is critical for the development of the face processing system, and that perceptual expertise is the mechanism underlying the ORE.

The face inversion effect has also been used to test differences in perceptual expertise for own- and other-race faces. The face inversion effect describes the decreased ability to recognize faces when they are inverted (Yin, 1969), and is thought to be due to inhibition of spatial and/or holistic processing (Diamond & Carey, 1986; Farah, Tanaka, & Drain, 1995; Rossion & Gauthier, 2002). It has been shown that inversion causes a greater recognition detriment to stimuli with which one has expertise. For example, Diamond and Carey (1986) presented dog experts and non-experts with pictures of dogs and human faces in both upright and inverted orientations. Decreased recognition ability was found for inverted relative to upright faces for both dog experts and non-experts. Conversely, a decrease in recognition ability for inverted relative to upright dog stimuli was found only for the dog experts. This finding suggests that expertise results in greater reliance on spatial/holistic processing and therefore inversion causes a greater recognition detriment for stimuli with which one has perceptual expertise. Based on this, similar paradigms have been used to examine whether inversion is equally detrimental to own- and other-race face recognition. Indeed, stronger inversion effects have been shown for own-race relative to other-race faces (Rhodes, Brake, Taylor, & Tan, 1989). However, other studies have found no interaction of inversion and the ORE (Buckhout & Regan, 1988) or the opposite effect, where recognition of other-race faces was more disrupted by inversion relative to own-race faces (Valentine & Bruce, 1986). Therefore, although inversion effects have been used to support the perceptual-expertise hypothesis, the reliability of the inversion effect by race interaction remains unclear.

Additional support for the perceptual expertise model of facial recognition is found in research examining the own-age effect. When viewing faces of varying ages, one’s expertise in processing the faces may be dependent upon one’s own age. Young individuals generally encounter other young individuals to a higher degree than older individuals, and would therefore have greater expertise in recognizing young faces. Alternatively, older individuals were once young themselves, therefore gaining the expertise in recognition for both young and older faces throughout their lifetime. If the in-group advantage in facial recognition were due to perceptual expertise, then differences in an in-group advantage would be predicted across age groups. Young individuals should show an own-age advance in that they have acquired more perceptual expertise for young faces, while older individuals should show little to no own-age advantage because they have had experience with faces of all ages throughout their lifetime. Indeed, asymmetrical effects of the own-age recognition advantage have been found in that young participants show an own-age advantage while older participants do not (Bartlett & Leslie, 1986; Fulton & Bartlett, 1991; Melinder, Gredeback, Westerlund, & Nelson, 2010). Wiese, Schweinberger, and Hansen (2008) extended these finding using neurological measures. Their findings replicated previous work by showing an own-age bias in facial recognition for young participants (19-28 years), but not elderly participants (61-76 years). The authors concluded that these findings support perceptual expertise, rather than social categorization, theories of facial recognition.

1.3.2. Social Categorization model of face recognition.

Rather than differences in expertise based on contact, the social categorization model of face recognition posits that categorization of others as in- or out-group members leads to differential processing resulting in recognition discrepancies. Sporer (2001) proposed that detection of an out-group cue leads to cognitive disregard, inhibition of holistic processing, stereotyping, or some combination of these ineffective face-encoding strategies (see Figure 1). Therefore, the social categorization model assumes that detection of any out-group cue, whether physical or not, would result in recognition discrepancies.

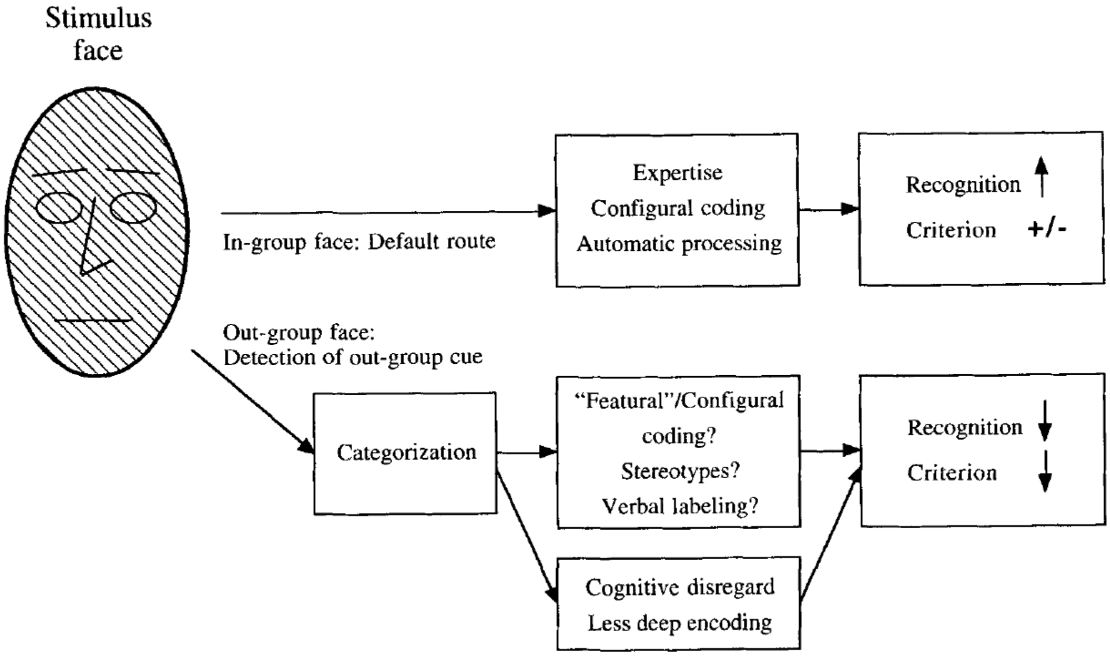

Figure 1: Sporer's (2001) In-group/out-group model (IOM) of face processing.

Original support of the social categorization theory stemmed from studies using ambiguous race faces. Using a typical face recognition paradigm, MacLin and Malpass (2001) presented Hispanic participants with ambiguous race faces differing only in hairstyle. Half of the faces were presented with a stereotypical Black hairstyle, while the other half of the faces were presented with a stereotypical Hispanic hairstyle. Although the faces were identical, the out-group cue of a stereotypically Black hairstyle resulted in a disproportionate amount of false alarms, and therefore lower recognition accuracy for those faces. This indicates that detection of an out-group cue such as hairstyle results in decreased recognition accuracy for out-group faces.

The minimal group paradigm (Tajfel, Billig, Bundy, & Flament, 1971) has been critical in differentiating between perceptual-expertise effects and social-categorization effects. In a traditional minimal group experiment, participants are arbitrarily assigned to one of two groups based on rather insignificant distinctions. For example, participants have been asked to estimate the number of items (e.g. marbles) in a container. They are then told that they are either an “over-estimater” or an “under-estimater” and that other people that are also over/under-estimaters. It has been shown that these minimal conditions for creating in- and out-groups can lead to discrimination in favor of the in-group (e.g. Tajfel, 1970). Minimal group paradigms allow for manipulation of group membership based on social categorization whilst keeping physical similarity between groups constant, ensuring that differences between groups cannot be attributed to physical similarity of the group members to the self.

Bernstein et al. (2007) used a minimal group paradigm to assess the effects of social categorization on facial recognition. White participants viewed facial photographs of White males on either a green or red background. In the experimental condition, participants were told that the individuals who appeared on the red background were students at the participant’s own university (in-group), while the individuals appearing on the green background were students of another university (out-group). The participants were then given a recognition task in which they were presented with a series of faces (half of which had previously shown) and asked to indicate whether the faces had been previously shown or were novel. When the background color was indicative of group status, in-group faces were recognized more accurately than out-group faces. These data indicate that ORE could be due to mere social categorization rather than a difference in perceptual expertise across racial groups.

In Bernstein et al.’s (2007) study, all participants and photograph stimuli were of the same racial group. Therefore, the only cue that could be reliably used to distinguish between in-group and out-group members was university affiliation. However, an individual may be perceived as an in- or out-group member on more than one dimension. Research has examined crossed category memberships, where individuals are perceived to belong to numerous overlapping categories. Crossed categorization of others is generally examined by orthogonally overlapping two in-group memberships and two out-group memberships, resulting in four groups: double in-group, two crossed groups, and double out-group (Migdal, Hewstone & Mullen, 1998; Mullen, Migdal, & Hewstone, 2001; Urban & Miller, 1998). The effects of multiple grouping categories can reflect an additive pattern, where people favor the double-ingroup over partial in-group, who are preferred over double out-group (Crisp & Hewstone, 1999), or a dichotomous grouping, where double in-group members are preferred over all groups (Kenworthy, Canales, Weaver & Miller, 2003). Researchers have utilized crossed categorization paradigms to examine face processing. In one study, Shriver, Young, Hugenberg, Bernstein, and Lanter (2008) presented participants with own- and other-race faces while manipulating perceived socioeconomic status (SES). The researchers found that an in-group bias was found only for the own-race/high SES faces, showing that perceived in-group membership on both dimensions was needed before an in-group bias occurred. This finding suggests that rather than an additive pattern, face recognition may dichotomize targets into in-group and out-group categories. As suggested by Sporer (2001), detection of any out-group cue may result in poor encoding strategies, leading to a decrease in recognition ability.

In order to further examine whether the ORE is a result of social categorization or perceptual expertise, Hehman, Mania, and Gaertner (2010) presented participants with a facial recognition task where targets varied on two dimensions: race and university affiliation. During the learning phase, own-race and other-race faces were presented with a university label directly underneath, indicating that the target face was either affiliated with the participant's own university or another university. The faces were presented simultaneously and divided either by race (with all White faces presented on one side of the screen) or by university affiliation (with all own-university faces presented on one side of the screen). When categorized by race, participants had better recall for own-race relative to other-race faces. However, when categorized by university affiliation, own-university faces were recognized more accurately than other-university faces. Interestingly, other-race faces labeled as own-university were recognized more accurately than own-race faces labeled as other-university. Results showed that the ORE was eliminated by increasing recognition accuracy for other-race/own-university faces rather than decreasing recognition accuracy of own-race/own-university faces. These results are supportive of the social categorization, rather than a perceptual expertise, explanation of the ORE. If differences based on race were due to an expertise gained over a lifetime of encoding particular types of faces, then the ORE should emerge regardless of whether the faces are categorized based on race or university affiliation. However, the relevant cue of university affiliation caused a shift in this effect leading to better recognition of other-race own-university members than own-race other-university members. Additionally, the increase in own-university recognition, rather than a decrease of other-university recognition, suggests that motivation could impact face processing.

This effect was also examined by Cassidy, Quinn, and Humphreys (2011) using a face inversion task. Inversion was more disruptive for own-university targets, but only if those targets were other-race. For own-race faces, inversion was equally disruptive for own-university and other-university targets. However, when university affiliation is made the most salient categorization group by presenting own- and other-race faces in separate blocks, group membership effects of inversion are seen for both own-race and other-race faces. For both races, inversion was more disruptive for own-university than other-university faces. This suggests that non-racial out-group cues can impact facial processing, but is dependant upon what group membership cues are most salient.

In sum, although some evidence has suggested that the ORE stems from perceptual expertise, the social categorization model of face recognition can explain many of these results. Detection of an out-group cue may lead to shallow processing, which can explain phenomena such as the other-age effect. Additionally, many clever experiments have utilized minimal group and cross category paradigms to examine the effects of social categorization on face processing. Results have shown that perceiving a target to be either an in-group or out-group member results in differential processing, even when no physical grouping differences can be detected.

1.4 Neurological studies.

The aforementioned studies examining the impacts of race on processing have generally used subsequent face recognition as the dependent measure. Although racial differences on this measure are very telling, they are limited to recall and do not easily allow for an examination of perceptual mechanisms that contribute to subsequent memory. In an effort to further understand the effects of group membership on perception, many studies have employed neurological techniques such as electroencephalography

(EEG) and functional magnetic resonance imaging (fMRI). Using these measures of brain activation, early, automatic, and/or perceptual effects can be examined. In the following section, these methods will be explained, followed by a review of the literature using neuroscientific techniques to better understand social categorization.

1.4.1 Electroencephalography (EEG).

EEG is the recording of electrical activity of the human brain by plotting the changes in voltage over time. The neural responses associated with specific events are extracted by an averaging technique and are termed Event-Related Potentials (ERPs). Although spatial resolution is relatively poor, EEG has a very high temporal resolution. Therefore, ERPs are an effective measure of the time-course of brain activation, and are a good measure of the degree to which people encode social category information (Ito & Urland, 2003; Kubota & Ito, 2007).

Averaged ERP waveforms consist of positive and negative voltage deflections called components, which are generally labeled according to the polarity and the peak's latency within the waveform. For example, the P100 is a positive deflection occurring approximately 100ms after stimulus onset. This component is also referred to as the P1, as it is the first positive component. Stimulus parameters, such as luminance, can influence the P100 amplitude but the task being performed does not reliably influence P100 amplitude (Hillyard, Vogel, & Luck, 1998). The P100 component has been shown to be sensitive to the participant's state of arousal (Vogel & Luck, 2000) and to be modulated by selective attention (Hillyard & Anllo-Vento, 1998; Rutman, Clapp, Chadick, & Gazzaley, 2009). It has been suggested that the P100 reflects general visual processing and is not sensitive to face processing (Rossion, Joyce, Cottrell, & Tarr, 2003;

Rossion, Delvenne, Debatisse, Goffaux, Bruyer, Crommelinck, & Guerit, 1999). A few additional components used to assess differential processing of social stimuli are outlined below, as well as a review of studies utilizing ERP measures to assess differential processing of in- and out-group members.

The N170 component is a negative-going deflection occurring approximately 170ms after stimulus onset. The N170 is considered a face-sensitive ERP component, in that the amplitude of the component at lateral electrode sites is larger for human faces relative to non-human faces or object categories (e.g. Bentin et al., 1996). Initial studies led to the hypothesis that N170 reflects basic structural encoding of faces as the amplitude and latency was reported to be invariant to facial identity, race and expression (Eimer, Holmes, & McGlone, 2003; Holmes, Vuilleumier, & Eimer, 2003; Ashley, Vuilleumier, & Swick, 2004; Balconi & Lucchiari, 2005; Holmes, Winston, & Eimer, 2005; O'Connor, Hamm, & Kirk, 2005; Bentin & Deouell, 2000; Caldara, Thut, Servoir, Michel, Bovet, & Renault, 2003; Caldara, Rossion, Bovet, & Hauert, 2004; Ito, Thompson, & Cacioppo, 2004; Vizioli, Foreman, Rousselet, & Caldara, 2010). However, more recent reports contradict early findings, specifically in regards to the processing of race. For example, Ito and Urland (2005) presented participants with own-race and other-race faces and found larger N170s to own-race relative to other-race faces. Conversely, other studies have found larger N170s to other-race relative to own-race faces (Herrmann, Schreppel, Jager, Koehler, Ehlis, & Fallgatter, 2007; Gajewski, Schlegel, & Stoerig, 2008; Stahl, Wiese, & Schweinberger, 2008; Walker, Silvert, Hewstone, & Nobre, 2008; Balas & Nelson, 2010; Brebner, Krigolson, Handy, Quadflieg, & Turk, 2011; Caharel, Montalan, Fromager, Bernard, Lalonde, & Mohamed, 2011; Stahl, Weise, &

Schweinberger, 2010), or no difference in N170 amplitude as a function of race (Caldara et al., 2003; Caldara et al., 2004; James, Johnstone & Hayward, 2001).

The inconsistencies in the literature have lead researchers to propose alternative descriptions of the cognitive processes reflected by the N170. Some have posited that the N170 reflects perceptual expertise of ecologically relevant stimuli (Bentin et al., 1999). Evidence to support this account stems from Tanaka and Curran (2001), who presented dog and bird experts with pictures of dogs and birds. Enhanced N170s were found for the class of stimuli with which the participants had expertise. Additionally, because individuals generally come into greater contact with own-race relative to other-race faces (Allport, 1954), the finding of larger N170s to own-race faces (Ito & Urland, 2005) further supports the perceptual expertise account of the N170.

Alternatively, the N170 may reflect "effort," or the recruitment of face processing resources. Evidence for this stems from studies altering the typicality of faces, which increases the effort required to process and recognize the faces. For example, studies have found increased N170 amplitude to atypical faces (Halit, de Haan, & Johnson, 2000) and inverted faces (Rossion et al., 1999) relative to upright, non-altered faces. Some have posited that other-race faces are processed less efficiently than own-race faces (e.g. with less configural coding; Michel, Corneille, & Rossion, 2007), and therefore more effort is required in other-race face encoding when individual recognition of the face is required. Consistent with this account, other race faces evoke larger amplitude N170s to own-race faces relative to own-race faces (Herrmann et al., 2007; Gajewski et al., 2008; Stahl et al., 2008; Stahl et al., 2010; Walker et al., 2008; Balas & Nelson, 2010; Brebner et al., 2011).

In an attempt to clarify the inconsistencies in the N170 studies, Senholzi and Ito (2012) examined whether task demands could result in differential N170 amplitude for own- and other-race faces. Participants were presented with own- and other-race faces and asked to perform one of three tasks: an identity task, where attention to the individual identity of each photograph was required, a categorization task, where only attention to the individual's race was required, or a control task, where own- and other-race faces were passively viewed and attention to a non-face target was required. Interestingly, the researchers found that the effects of race on N170 amplitude were dependent upon the task goals. When attending to individual identities, enhanced N170s were found for other-race faces. Conversely, when categorizing based on race, enhanced N170s were found for own-race faces. No differences based on race were found in the control condition. It was concluded that race differentially impacts perception of faces depending on one's focus of attention.

Additional ERP components differ as a function of race. Several studies report larger amplitude N200 components at frontal and midline sites for own-race relative to other-races faces (Dickter & Bartholow, 2007; Ito et al., 2004; Ito & Urland, 2003; 2005; James et al., 2001; Kubota & Ito, 2007; Walker et al., 2008; Willadsen-Jensen & Ito, 2006, 2008), and larger amplitude P200 components for other-race than own-race faces in the posterior P200 component (Ito & Urland, 2003; 2005; Kubota & Ito, 2007; Willadsen-Jensen & Ito, 2006). It has been argued that these differences reflect attention to and detection of in-group (Ito & Urland, 2003) and out-group (Dickter & Bartholow, 2007; Ito & Urland, 2003, 2005) cues, respectively.

Though prior studies have found evidence for race-modulated evoked potential components, the mechanisms by which the differences occur are poorly understood. As such, recent studies have sought to determine whether the differences are due to physical differences in the faces or secondary social cues. Brebner et al. (2011) examined whether the ERP differences found as a function of race are modulated by skin color or facial structure. Stimuli faces were digitally altered to either Black color/Black structure, Black color/ White structure, White color/Black structure, or White color/White structure. Participants were asked to categorize faces by age while ERPs were recorded and then were given a surprise memory test. For the N170, which was the earliest component to show differences between the faces, there was a significant increase in negativity to faces with other-race skin color. The N170 has also been associated with increased negative amplitudes to faces that are inverted, which is thought to inhibit holistic processing (Itier & Taylor, 2002). This may suggest that skin color is used as an out-group cue that leads to feature-based, rather than holistic, processing of the face. There was also a difference in the N250 component as a function of skin color, and the N200 component as a function of both skin color and structure. Results of the memory test show that there is a correlation between the N200 component and subsequent memory for the faces. Differences were found in the late positive component (LPP) as a function of structure but not skin color, and these differences were not correlated with memory. The authors concluded that skin color is an important feature in categorization and is related to subsequent memory irrespective of facial structure.

Race is not the only visual grouping cue to influence ERP components evoked by faces. Hehman et al. (2011) compared the magnitude of ERPs in response to faces varying on race and university affiliation. Faces were gray-scale with neutral expressions, and background color was used to indicate university affiliation. In this experiment, faces were again labeled according to university affiliation, but were shown sequentially rather than simultaneously. There was a significant interaction in recognition accuracy for race and university affiliation. Own-race/own-university targets and own-race/other-university targets were recognized more accurately than other-race/own-university targets, and other-race/own-university targets were recognized more accurately than other-race/other-university targets. There were larger effect sizes based on the racial than university categorical dimension, and this effect of racial salience was shown in the ERP results. The P100 component showed larger positive deflections to own-race relative to other-race faces, but no difference was found for university groups. Effects of both race and university group membership were detected in the N200, with larger negative deflections for own-race and for own-university faces. There were no differences based on race or university membership for either the N100 or P200 components. The authors conclude that although university group membership can alter the ORE, race remains a more salient category.

Studies using ERPs have shown that grouping cues affect very early face processing. Many studies have focused on the face-sensitive N170 component to demonstrate differences in face processing for own-race relative to other-race faces (Herrmann et al., 2007; Gajewski et al., 2008; Stahl et al., 2008; Walker et al., 2008; Balas & Nelson, 2010; Brebner et al., 2011; Caharel et al., 2010; Stahl et al., 2010). The effects of non-physical cues are less well studied. Hehman and colleagues (2011) found differences in brain activation based on university affiliation, but these differences were preceded by differences based on the race of the presented face. Additionally, it is unclear whether these differences occurred during encoding or recall of the faces. Studies reported here address these limitations and extend current findings.

1.4.2 Functional Magnetic Resonance Imagining (fMRI).

Functional magnetic resonance imaging (fMRI) is a technique used to localize specific spatial locations involved in sensory and cognitive processing. Neural activity is indirectly reflected by mapping the hemodynamic response as assessed by a pulse sequence sensitive to the Blood Oxygenation Level Dependent (BOLD) contrast, which measures changes in oxygen levels in the blood as a result of neuronal activity (hemodynamic response or HR). The HR peaks after about four to six seconds; therefore, fMRI has poor temporal resolution relative to other measures such as EEG (Huettel, Song, & McCarthy, 2009). However, the spatial resolution is high; a 3 Tesla (3T) scanner can achieve 1.5-mm^3 resolution (see Bandettini, 1999). Therefore, fMRI is used to assess the neural correlates of psychological phenomena.

The neural substrates of the ORE have been examined using fMRI studies. Given its proposed role in face detection, many studies have targeted the fusiform face area (FFA) – a functionally defined area of the fusiform gyrus that responds more to faces than other objects in most subjects (FFA; Kanwisher, McDermott, & Chun, 1997). These studies assess whether differential activation is found based on the race of the presented face. Indeed, studies demonstrate a larger neural response in the FFA to own-race relative to other-race faces (Golby, Gabrielli, Chiao & Eberhardt, 2001; Kim, Yoon, Kim, Jeun, Jung & Choe, 2006; Natu, Raboy, & O’Toole, 2011). Interestingly, Golby et al. (2001) found that differences in recognition ability for own- and other-race faces correlated with activation in the left fusiform cortex. As these results were not contingent upon categorizing the faces according to race, the authors concluded that attention to race occurs spontaneously, in the very early stages of face processing.

Differential activation of the FFA for own- and other-race faces could be due to social categorization or perceptual expertise. Gauthier, Skudlarski, Gore, and Anderson (2000) tested whether expertise is correlated with activation in the FFA. Indeed, the researchers found that the FFA is active when car and dog experts view pictures of cars and dogs, respectively. Additionally, it has been shown that training participants to identify novel non-face objects results in FFA activation when participants later view these objects (Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999). These studies suggest that FFA activation reflects perceptual expertise of the viewed stimuli. Thus, differences in FFA activation based on race could be indicative of greater perceptual expertise for own- relative to other-race faces. However, other studies have found contrary evidence. Golarai, Ghahremani, Eberhardt, Grill-Spector, and Gabrieli (2004) found that when presenting White participants with intact and scrambled White and Black faces, FFA activation was reduced for Black intact faces. Importantly, there was a reduction in activation both when compared to White intact and White scrambled faces. As expertise with own-race scrambled (but not other-race) faces is implausible, the authors concluded that the FFA is sensitive to racial category membership. Therefore, differences in FFA activation based on race cannot be completely accounted for by differences in perceptual expertise. Detection of a categorization cue, such as skin color, can lead to differential activation of the FFA.

The amygdala, a region associated with emotion (see Adolfs, 1999) and specifically fear, has also been implicated in the ORE. While some studies have shown higher amygdala activation to other-race faces (Hart, Whalen, Shin, McInereny, Fischer & Rauch, 2000; Cunningham, Raye & Johnson, 2004), others have found differential activation only when correlated with indirect measures (Phelps, O'Connor, Cunningham, Funayama, Gatenby, Gore, & Banaji, 2000), and for Black targets regardless of participant race (Lieberman, Hariri, Jarcho, Eisenberger, Bookheimer, 2005). In a particularly telling experiment, Platek and Krill (2009) morphed participant's faces with similar and dissimilar own- and other-race faces. In addition to a correlation between amygdala activation and implicit biases, results showed a non-linear amygdala response to faces as a function of self-resemblance. These findings show that the amygdala codes faces based on socially relevant information in a multivariate fashion. Although race did impact activation, self-resemblance was also an important factor. This indicates that differential activation based on race could be a function of perceived similarity of the target faces to the self.

The effects of multiple group categorization have also been assessed using fMRI. Van Bavel, Packer, and Cunningham (2008) used a similar paradigm to those described above to assess the neural substrates of group membership. White participants were told that they were randomly assigned to one of two teams and were shown and asked to memorize photographs of the members of both teams. Each team contained own-race (White) and other-race (Black) members. After memorization of the teams, participants were instructed to categorize each of the photographs based on race or team membership in alternating blocks while undergoing fMRI. Results indicated faster reaction times to

Black than White faces when categorizing based on race, but not when categorizing based on team membership. When categorizing based on team membership, own-team faces were categorized faster than other-team faces. Of particular interest were the brain regions associated with race and team membership. There was greater activity in the left amygdala, left orbitofrontal cortex, bilateral fusiform gyrus, right putamen, and left inferior temporal cortex in response to own-team relative to other-team faces, indicative of an effect of social categorization rather than perceptual expertise. Alternatively, greater activity in response to other-race relative to own-race faces was seen in the left angular gyrus and bilateral inferior occipital cortex, showing that differential activation based on racial group membership persisted in these areas even when categorization was not based on race.

Taken together, the data using minimal group paradigms demonstrates the dynamic nature of group membership and supports the social categorization theory of in-group bias. When an individual perceives another to be part of one's own in-group, this leads to decreased facial recognition accuracy. In-group membership can be manipulated, suggesting that detection of an out-group cue leads to inferior facial processing. However, evidence from multiple group categorization studies also suggest that effects of race still persist even when targets can be categorized based on other groups, such as university affiliation or team membership.

1.5 Summary.

In this Chapter, I reviewed the literature on the effects of social categorization on the perception and processing of others. Studies have shown that whether one perceives another to be an in- or out-group member can impact their processing of and subsequent interaction with the individual. I have also presented evidence that cues associated with group membership can be physical, such as race or age, or non-physical, such as university affiliation. Recent studies have provided evidence that differential processing and recognition accuracy occurs based on group membership irrespective of the visual nature of the grouping cue (Hehman et al., 2011; Van Bavel et al., 2008). However, it remains unclear whether physical and non-physical cues affect processing in the same manner. Experiments presented in Chapters 2 and 4 directly assess the impacts of crossed category memberships and show that competing grouping cues impact processing at different stages.

Additionally, all studies previously assessing the impacts of crossed category memberships have presented all grouping cues simultaneously. However, grouping cues are generally detected sequentially, rather than simultaneously. Previous research has yet to establish the effects of perceived group membership on face processing when group membership is known prior to face encoding. Experiments presented in Chapters 3 and 4 investigate whether knowledge of group membership prior to face encoding impacts processing, and the experiment presented in Chapter 4 gives evidence of this impact at very early stages of processing.

Previous studies assessing the impacts of group membership, as well as the experiments presented in Chapters 2-4, have predominately focused on face recognition. Therefore, it is unclear whether group membership impacts other processing mechanisms, such as biological motion perception. In Chapter 5, an experiment will be presented which examines whether perception of similarity to the self impacts the neural circuits involved in action observation and imitation.

Chapter 2

2 Experiment 1: Investigating the time-course of neural activation when viewing mixed-race in-group and out-group faces.

Faces of own-race others are processed differently than faces of other races. However, studies have also shown that arbitrary, non-physical, group membership can result in behavioral discrepancies similar to those shown by the ORE. It is important to note that a variety of underlying mechanisms can result in the same behavioral outcome. It is possible that recognition discrepancies occur based on race and on arbitrary group membership, but result from alternative underlying mechanisms. One way to examine whether physical and non-physical grouping cues identically impact face processing is to assess brain activation while participants view mixed-race in-group and out-group faces. Previous studies have examined brain activation using fMRI while participants view own- and other-race faces (e.g. Golby et al., 2001; Hart et al., 2000). Increased activation when viewing own-race relative to other race faces has been found in certain brain areas, such as the fusiform face area (Golby et al., 2001), and the amygdala (Hart et al., 2000). To expand on these findings and test whether differential brain activation is indicative of differential processing based on group membership rather than race per se, Van Bavel and colleagues (2008) tested brain activation while participants viewed own- and other-race faces of own-team and other-team members. In their study, participants were arbitrarily placed on one of two “teams” and shown photographs of their own and the other team members. After learning the team members, participants were asked to categorize based on team membership or race while undergoing fMRI. Results indicate that brain regions previously shown to be sensitive to race were differentially activated based on team membership. Specifically, the fusiform gyri, amygdala, orbitofrontal cortex, and dorsal striatum showed greater activation when viewing own-team relative to other-team members, and were not moderated by race. Interestingly, this was the case even when participants were categorizing based on the race of the face rather than team membership. These findings show that brains areas previously thought to be sensitive to race-related features are differentially activated based on perceived group membership rather than race per se.

The results of Van Bavel et al. (2008) suggest that others are processed based on relevant grouping cues rather than race per se, and that differences in recognition accuracy may stem from motivated social perception. Specifically, perceiving another individual as an in-group member may increase his or her motivational significance and result in deeper processing relative to “irrelevant” out-group members. However, due to the poor temporal resolution of fMRI, it is still unclear at what processing stage categorization impacts perception. The BOLD activation measured using fMRI cannot separate feedback and feedforward active networks in a region. For these reasons, Ratner and Amodio (2013) examined the time-course of activation while viewing in-group and out-group members, focusing on the N170 ERP component, which is associated with face processing (e.g. Bentin et al., 1996). Using a paradigm adopted from Tajfel et al. (1971), participants were assigned to a novel group that they believed was based on their tendency to overestimate or underestimate the number of objects encountered.

Participants were then shown a series of own-race faces on a background indicative of the individuals' classification as an over- or underestimator. The authors found larger (more negative) N170 amplitude for in-group relative to out-group faces in lateral posterior sites, demonstrating that top-down information can influence early processing of faces. The authors concluded that motivated visual perception based on social group information affects early face processing.

The findings of Ratner and Amodio (2013) provide important insight into the impact of group membership on face processing. However, because own-race faces were randomly assigned as in- or out-group members, only one possible grouping cue could be used to categorize the presented faces. Therefore, it is still unclear how physical and non-physical grouping cues interact at early stages of visual processing. At least two possible mechanisms can explain the results of Van Bavel et al.'s (2008) study. Team membership may indeed override all effects of race on processing. This would suggest that race is a grouping cue, but the physical nature of race is not different from any other grouping cue, whether physical or non-physical. Alternatively, it is possible that race does in fact impact face processing but is then overridden after conscious realization that the processed face is that of an in-group member.

The aim of Experiment 2 is to assess the time-course of activation while participants view mixed-race in- and out-group members. Using a paradigm adopted by Van Bavel et al. (2008), participants were told that they were randomly assigned to one of two teams. Each team consisted of both own-race and other-race individuals. Participants are asked to learn the faces their own and the other team's members. After learning team membership, participants are asked to categorize each of the faces based on team membership.

In order to assess the time-course of activation while participants viewed the faces of in-group and out-group members, EEG was used to record ERPs. In this and the following two experiments, I will focus on a few key components, which are described below.

P100: The P100, a positive deflection occurring approximately 100ms after stimulus onset, is thought to be an early visual sensory response. As stated in Chapter 1, P100 amplitude is influenced by stimulus parameters (Hillyard et al., 1998), arousal (Vogel & Luck, 2000), and selective attention (Hillyard & Anllo-Vento, 1998). With regards to face recognition, it has been suggested that the N170 is the earliest ERP component to reflect the perceptual processing of a face (Rossion & Caharel, 2011; Rousselet, Husk, Bennett, & Sekuler, 2008). However, some studies have indeed shown P100 selectivity to faces (Herrmann, Ehlis, Ellgring, & Fallgatter, 2005; Itier & Taylor, 2002).

A recent study by Cunningham, Van Bavel, Arbuckle, Packer and Waggoner (2012) examined whether motivational states could influence very early ERP components evoked by faces. In their study, an approach/avoidance frame was used while participants viewed own- and other-race faces. In a blocked design, participants were told to either “pull the face towards you” using a joystick, or “push the face away from you.” The results show a race by motivational state interaction. When participants pushed the joystick away from themselves, therefore inducing an avoidance motivation, higher P100 amplitude was found for own-race relative to other-race faces. However, when approach motivation was induced by pulling the joystick towards themselves, no differences in P100 amplitude were found. These results show that 1) race can impact very early, automatic face processing, and 2) motivational states can alter the influence of social categories even at very early stages of processing.

In this experiment, the P100 will be measured while participants view mixed-race in-group and out-group members. As shown by Cunningham et al. (2012), differences in viewing faces of own- and other-race individuals can occur at this very early stage of processing, but are dependant on the motivational state of the participants. By manipulating the relevance of grouping cues, this experiment will examine whether there are differences in this early component based on the physical, but task-irrelevant, grouping cue of race or whether P100 differences emerge based on the non-physical but task-relevant grouping cue of team membership.

N170: The N170 component is a negative-going deflection occurring approximately 170ms after stimulus onset. The N170 is a face-sensitive ERP component (e.g. Bentin et al., 1996), and differences in N170 amplitude have been shown based on the race of the target face (e.g. Ito & Urland; Herrmann et al., 2007; Gajewski et al., 2008; Stahl et al., 2008; Walker et al., 2008; Balas & Nelson, 2010; Brebner et al., 2011). In this experiment, N170s were assessed based on both the race and the team membership of the presented faces. Senholzi and Ito (2012) found that attending to the physical grouping cue of race results in greater N170 amplitude for own-race relative to other-race faces. Alternatively, motivation to attend to individuating features of the face resulted in greater N170 amplitude for other-race relative to own-race faces. This experiment examines the impacts of race when an alternative, more relevant grouping cue is attended to.

The aim of the present experiment is to examine the time-course of brain activation while participants view mixed-race in-group and out-group members. Two components of interest, the P100 and the N170, will be examined to assess 1) at what stage of processing differences based on arbitrary group membership emerge, and 2) whether arbitrary group membership completely overrides the effects of race, or whether differences in brain activation still occur based on the race of the face.

Method

Participants.

Thirty-three White male[1] University of Virginia students participated for course credit or monetary compensation.

Stimuli.

Facial photographs of White and Black males were obtained from the Tarr lab database (www.tarrlab.org). Twenty-four photographs (12 Black) were used in the baseline phase and 24 (12 Black) were used in the learning and categorization phases. All faces had a neutral expression and were wearing identical clothing.

Procedure.

The paradigm for Experiment 2 was adopted from Van Bavel et al. (2008). Upon entering the lab, participants gave verbal and written consent and their photograph was taken using a Logitech webcam. Participants were told to hold a neutral expression, and

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[1] To control for race and gender, only White males were used as participants in the experiments in this dissertation, and stimuli consisted of White and Black males. Therefore, “own-race” refers to White stimuli, while “other-race” refers to Black stimuli.

that the photograph would be used in the study but would then be discarded. After their photograph was taken, participants were connected to the EEG system and seated at a computer in a private experimental room. The experimental procedure consisted of three phases. The first phase was used to obtain baseline measures of brain activation when viewing own- and other-race faces prior to team manipulation. Participants were shown own- and other-race faces and were instructed to press a key on a keyboard if the same face was immediately repeated in the sequence. EEG was recorded throughout this phase. Twenty-four faces (12 Black) were used in this phase and were shown four times in random order for three seconds each, with an inter-stimulus interval of an average of two seconds. Four runs of 24 faces were presented, for a total of 96 trials. In the next phase, participants were assigned membership to one of two teams (team "Tiger" or team "Leopard"), which were counterbalanced between participants. EEG was not recorded for this phase. Each team consisted of 24 faces (12 Black). Participants were instructed that they would be presented with a series of faces, half of which are members of their own team and half of which are members of the other team. Participants were presented with an array of faces for three minutes for each of the teams. Following the arrays, faces of team Leopard were presented sequentially for five seconds each, followed by sequential presentation of faces of team Tiger for five seconds each. Participants were then shown the faces in random order for five seconds each with the team labeled underneath the photograph. Following this, the faces were presented in random order without team labels, including the participants' own photograph, and participants were asked to indicate the team membership of each face by pressing a key on the keyboard and were given feedback. This sequence continued for a minimum of four runs and until participants reached 90% accuracy of labeling team membership.

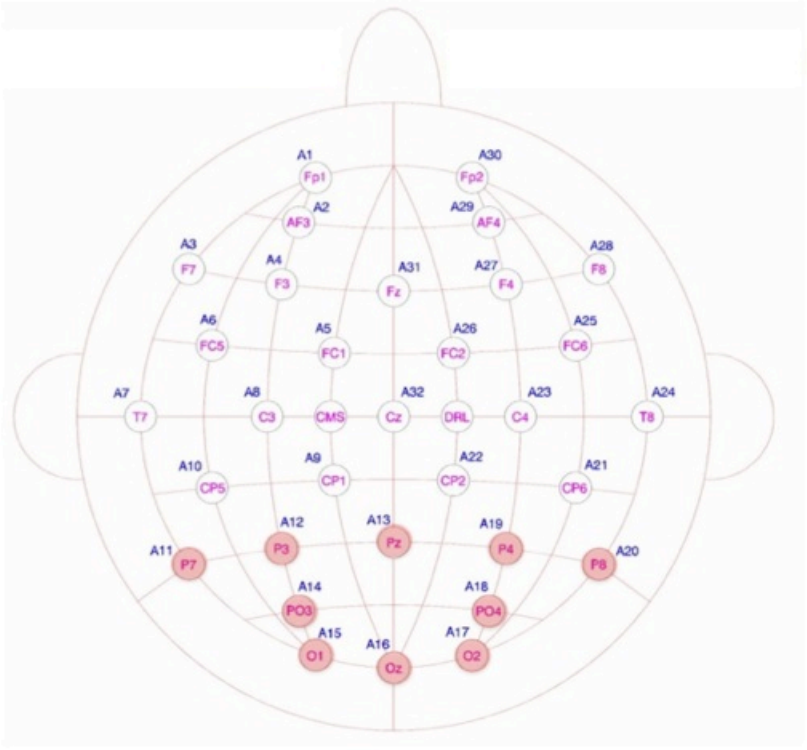
After learning team membership, participants completed a categorization task while EEG was again recorded. The categorization phase consisted of four runs of 25 trials for a total of 100 trials. In each run, 25 faces were presented randomly and participants categorized each face by team membership by pressing a key on the keyboard. Twelve of the faces in each run were own-team (6 Black), twelve were other-team, and the participant's own face was presented once in each run.

Analyses

ERP recording and processing: Scalp electroencephalographic data were collected during the first (baseline) and third (team categorization) phases, and was recorded continuously from a 32-channel BIOsemi cap based on the International 10/20 system, with two additional electrodes places on the left and right mastoids, one electrode placed above the right eye and one below the right eye. EEG data were analyzed using ERPLAB (Lopez-Calderon & Luck, 2010; www.erpinfo.org/erplab) and EEGLAB (Delorme & Makeig, 2004) toolboxes that operate within the MATLAB framework. Raw EEG data were resampled to 256 Hz and referenced off-line to the average of the mastoids, and band-pass filtered with cutoffs of 0.1 and 30 Hz. The EEG was segmented into epochs starting 200ms before and ending 800ms after stimulus onset. Eye-blink artifacts were removed based on manual inspection.

ERP analysis: To examine the effects of group membership on face processing, components known to index face processing were examined at lateral posterior sites. These components included the P100, a positive deflection occurring approximately

100ms after stimulus onset, and the N170, a negative deflection occurring at approximately 170ms after stimulus onset. The P100 component peak amplitude was defined as the peak amplitude between 80-120ms post stimulus onset. The N170 component peak amplitude was defined as the peak amplitude between 150-190ms post stimulus onset. The lateral posterior electrodes, where the N170 (Bentin, 1996) and P100 (Cunningham et al., 2012) are maximal were examined, which included the P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, and O2 electrodes[2]. The location of each of these electrodes on the cap can be seen in Figure 2.



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[2] P100 peak amplitude is defined as the peak amplitude between 80-120ms post stimulus onset, N170 peak amplitude is defined as the peak amplitude between 150-190ms post stimulus onset, and only the occipito-parietal electrodes are examined in the dissertation experiments involving ERPs.

Figure 2: Occipito-parietal electrode cites (in red) that are used in the analysis of Experiments 1, 2, and 3.

Results

Baseline phase: In the first phase of the experiment, participants were shown own- and other-race faces without a team manipulation. This was to assess whether there were differences based on the race of the face prior to a manipulation. One subject was removed due to problems with data collection during this phase of the experiment. Therefore 32 subjects were used in the analysis.

P100: The P100 was measured by taking peak amplitude between 80-120ms for each participant in the baseline phase. The Greenhouse-Geiser epsilon correction for non-sphericity was applied where appropriate (Jennings and Wood, 1976). Only corrected probability values and degrees of freedom are reported throughout the dissertation. A 2 (Race: own-race vs. other-race) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures Analysis of Variance (ANOVA) was conducted. Results indicate a significant main effect of electrode, F(3.85, 119.29) = 11.322, p<.001, np2 = .268. No significant effects of race were found (p=.33).

N170: The N170 component was measured by taking peak amplitude for each subject between 150-190ms post stimulus onset. A 2 (Race: own-race vs. other-race) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Results indicate a significant main effect of electrode, F(3.62, 112.27) = 15.52, p<.001, np2=.334, and a significant electrode x race interaction, F(5.23, 162.147) = 5.04, p<.001, np2 = .14. Posthoc analyses revealed more negative N170 for own-race relative to other-race stimuli at electrodes Pz (Own-race: M= -.51, SE= .41, Other-race: M=.69, SE = .53, p<.01) and PO3 (Own-race: M= -1.32, SE= .75, Other-race: M=-.18, SE = .86, p<.05). Results can be seen in Figure 3.

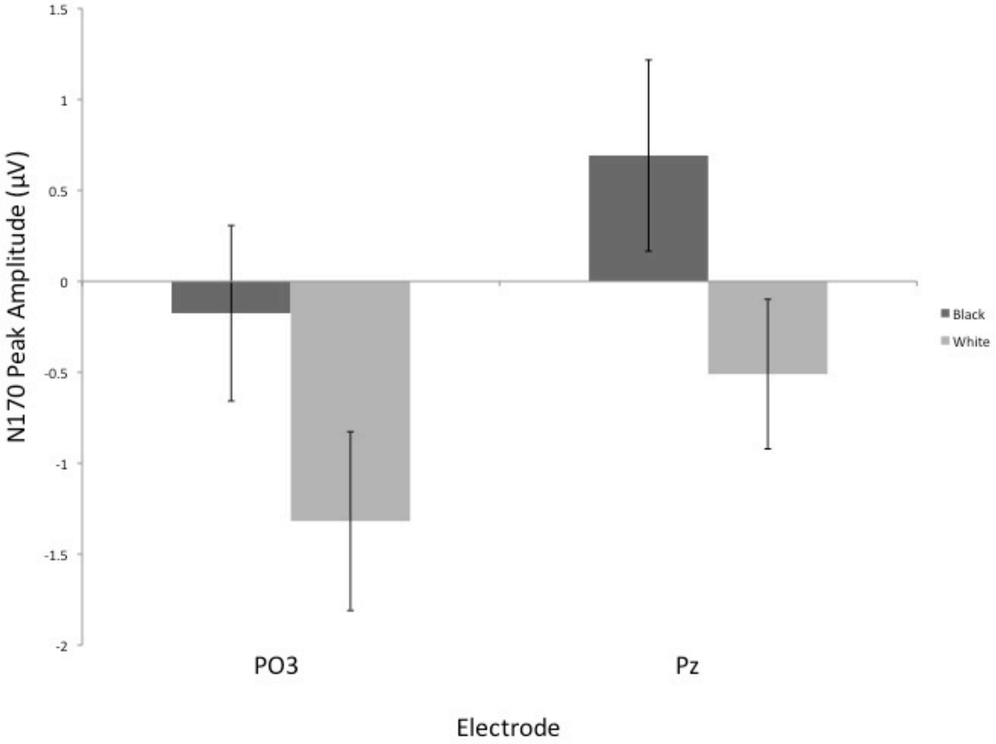

Figure 3. N170 peak amplitude for own-race (White) and other-race (Black) stimuli at parietal electrodes PO3 and Pz in the baseline phase of Experiment 1.

Categorization phase: This phase of the experiment was after participants had learned team membership and were asked to categorize each of the faces based on team membership. Two participants were removed due to excessive movements and/or eye blinks resulting in rejection of more than 50% of trials. One participant was removed due to failure to accurately learn team membership. Thirty participants were used in the analysis.

P100: To assess differences in P100 amplitude based on race, a 2 (Race: own-race vs. other-race) x 2 (Team: own-team vs. other-team) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Results indicate a significant main effect of electrode, F(3.12, 90.46) = 8.423, p<.001, np2 = .225, as well as a significant team x electrode interaction, F(4.776, 138.499) = 2.346, p<.05. To further examine the interaction, and because there were no effects of race, each condition was collapsed across race. Own-team elicited greater P100 amplitude relative to other-team at electrodes P7 (Own-team: M=8.4, SE=1.08; Other-team: 5.72, SE= .72), P3 (Own-team: M = 8.79, SE = 1.03; Other-team: M=5.78, SE = .85), PO3 (Own-team: M=11.69, SE = 1.25; Other-team: M=8.56, SE= .91), and O1 (Own-team: M=11.67, SE=1.87; Other-team: M= 9.13, SE=.9), all p<.05, indicating that the effects was left-lateralized. The results can be seen in Figure 4.

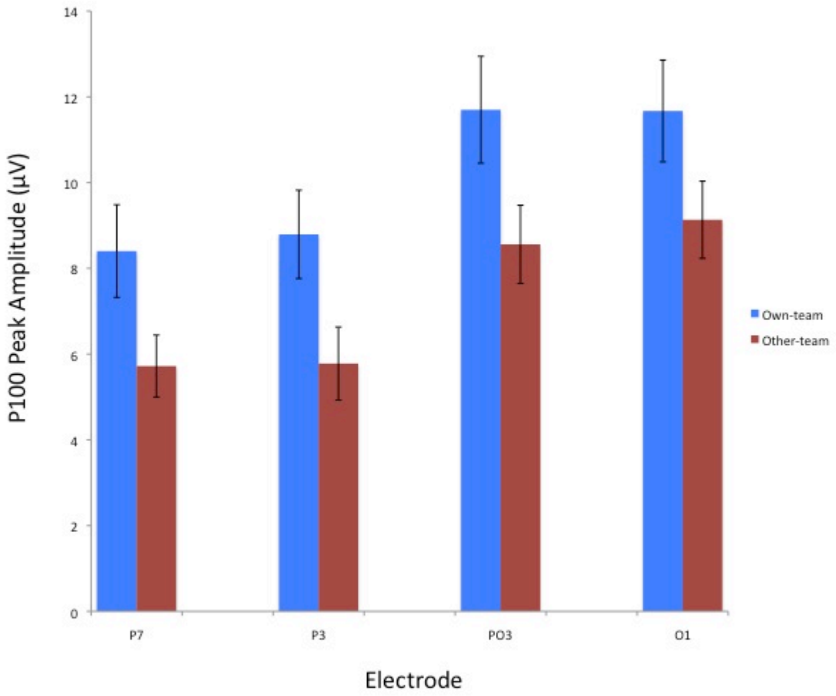

Figure 4: Results for the P100 component during the categorization phase of Experiment 1. The own-team stimuli elicited significantly greater peak P100 amplitude relative to other-team stimuli at left occipito-parietal electrodes P7, P3, PO3, and O1.

N170: To assess differences in N170 amplitude based on race during the categorization phase, a 2 (Race: own-race vs. other-race) x 2 (Team: own-team vs. other-team) x 10 (electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Results indicate a significant main effect of electrode, F(3.734, 108.284) = 16.182, p<.001, np2= .358, and a significant race x electrode interaction, F(4.352, 126.209) = 5.175, p<.001, np2= .151. To further examine the race x electrode interaction, conditions were collapsed across team at each electrode. Results indicate other-race stimuli elicited greater (more negative) N170 amplitude relative to own-race stimuli at occipital electrode sites: 01 (Other-race: M= -2.6, SE=1.811; Own-race: M=.352, SE= 1.634, p<.05), Oz (Other-race: M= -6.324, SE= 1.78; Own-race: M= -1.932, SE = 1.59, p<.01) and O2 (Other-race: M= -5.993, SE = 1.649; Own-race: M= -1.642, SE = 1.549, p<.01). These results can be seen in Figure 5. There were no significant effects of team.

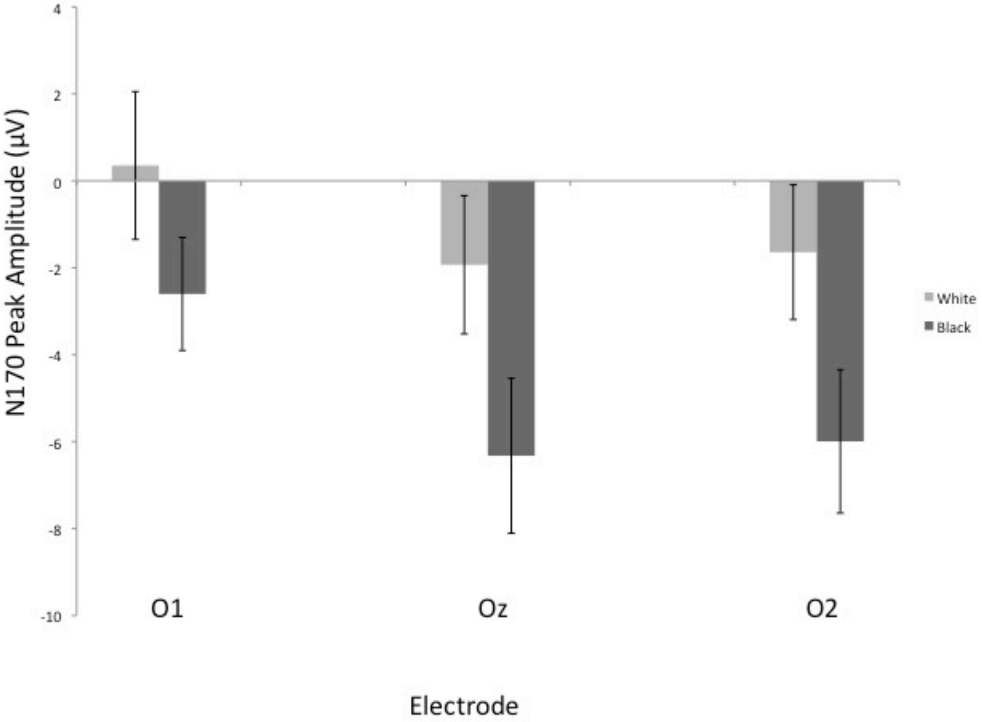

Figure 5: Results for the N170 component during the categorization phase of Experiment 2. The other-race (Black) stimuli elicited greater N170 amplitude relative to own-race (White) stimuli at occipital electrode sites O1, Oz, and O2.

Discussion

The aim of this experiment was to examine whether physical and non-physical cues impact the same stage of face processing. Participants were arbitrarily placed on one of two mixed-race teams and were told that they would need to recall team membership for each of the presented faces. Prior to seeing the faces of their own and other team members, participants were presented with non-affiliated own- and other-race faces while ERPs were recorded. Results show that there was no difference between own- and other-race faces for the P100 component, but that differences emerged at the N170 component, with own-race faces showing more negative amplitude relative to other-race faces. This finding replicates previous literature, which has shown differential N170 amplitude based on race (Herrmann et al., 2007; Gajewski et al., 2008; Stahl et al., 2008; Walker et al., 2008; Balas & Nelson, 2010; Brebner et al., 2011; Caharel et al., 2010; Stahl et al., 2010). After the baseline phase, participants were presented with facial photographs of the members of both mixed-race teams and were told that they would need to recall team membership for each of the presented faces. Using this manipulation, team membership is the relevant grouping cue, while race is the task-irrelevant physical grouping cue. Results indicate that differences in processing based on team membership, but not race, occurred as early as 100ms after stimulus onset. Differences in processing based on race still occurred, but did so later in processing (N170 component).

The results of this experiment show that although both physical and non-physical cues impact face processing, they do so at different stages. Specifically, differences in processing based on the task-relevant non-physical grouping cue occur prior to differences based on the non-relevant physical grouping cue. The differences found at very early stages of visual processing based on group membership are indicative of motivated perception. Indeed, it has been posited that motivation tunes perceptual attention to goal-relevant cues (Amodio, 2010; Balcetis & Dunning, 2006). For example, Balcetis and Dunning (2006) investigated whether people's motivational states influence visual perception by presenting participants with ambiguous figures and asking them to report what was perceived. Using both explicit and implicit measures, the authors found that participants interpreted visual stimuli in an advantageous manner based on the favored outcome, demonstrating that motivation can impact the processing of visual stimuli.

More recently, it has been shown that motivation can also impact the processing of socially relevant stimuli, such as faces. For example, Skelly and Decety (2012) found that activation in the neural network associated with face processing, including the amygdala and superior temporal sulcus, is augmented by increased motivation to attend to the processed faces. Additionally, greater recognition accuracy was found for the faces processed during the motivated relative to the non-manipulated trials. As demonstrated by Cunningham et al. (2012), Ratner and Amodio (2013), and the current experiment, motivation can impact very early stages of the visual processing of faces. These experiments also provide further support indicating that the P100 component is sensitive to at least some aspects of face processing and that the N170 is not the earliest component to reflect the perceptual processing of faces. Additionally, this experiment is the first to show that differences in processing occur for the socially relevant grouping cue prior to any differences based on the race of the processed face.

It is important to note that the differential P100 amplitude between own-team and other-team members occurred after repeated presentation of the group members. Therefore, the effect could be due to conditioning. Indeed, it has been shown that P100 amplitude is modulated by repeated pairings of faces with negative and neutral stimuli. Beckes, Coan, and Morris (in press) presented participants with smiling faces that were preceded either by a snake (negative unconditioned stimulus; US) or a rolling pin (neutral US). After 20 presentations of each US-face pairing, participants completed a lexical decision task where they were presented with words and non-words and were asked to indicate which was presented. A conditioned face from the previous task primed each of the words/non-words. Results showed that P100 amplitude was higher for snake-paired relative to rolling pin-paired faces in occipito-parietal electrode sites of the left hemisphere, giving direct evidence that P100 amplitude can be modified by conditioning. Notably, P100 amplitude was impacted by group membership in this experiment at the same scalp areas. The following two experiments directly assess whether the results of the current experiment are due to conditioning of the presented faces.

In sum, this experiment examined the time-course of activation while participants viewed mixed-race own-team and other-team members. Results indicated that although both race and group membership impacted face processing, they did so at different stages. Motivated perception caused very early processing differences based on the relevant social grouping cue, while differences based on race occurred at later, albeit still early in processing, stages. This experiment clearly demonstrates that although the task-relevant grouping cue of team membership impacts processing at earlier stages than the irrelevant physical cue of race, the impacts of race on processing are not completely overridden.

Chapter 3

3 Experiment 2: Investigating the time course of the grouping process when the grouping cue of accent precedes face detection.

3.1. Overview.

When encountering others, a variety of cues can signal whether that person is similar or dissimilar to the self. Processing is influenced by several factors such as race, gender and age (e.g. Malpass & Kravitz, 1969; Meissner and Brigham, 2001). However, recent work suggests that other, non-physical factors may also impact processing. For example, minimal grouping cues such as stimulus background color signaling social group affiliation (Bernstein et al., 2007; Ratner & Amodio, 2013) or team membership learned over the time course of the experiment (Van Bavel et al., 2008; see also Experiment 2), can result in effects similar to those seen in studies focusing on physical aspects such as race and gender. By altering the relevance of grouping cues, many studies have found differential processing based on the most relevant cue (Hehman, Mania, & Gaertner, 2010; Cassidy et al., 2011). These results are indicative of an underlying motivational mechanism, such as deeper encoding of in-group relative to out-group members. These studies often involve static photographs with visual cues indicating crossed category group membership. For example, an individual photograph may be an other-race, own-university member. If participants are not instructed to attend to a specific grouping cue, differences in processing based on race are often observed. However, if instructed to attend to a different grouping cue, such as university or team affiliation, the effects of race are often lessened or diminished (Van Bavel et al., 2008).

In previous studies assessing the effects of minimal grouping cues on processing, all grouping cues have been presented simultaneously, as was the case in Experiment 2. In the following two experiments, grouping cues will be presented sequentially rather than simultaneously. These methods will allow for the individual assessment of the effects of each type of cue. Additionally, explicitly directing attention to a specific cue will allow us to assess whether the most relevant cue does override the effects of other cues when those cues are detected sequentially rather than simultaneously.

3.1.2 Rationale for using accent as a grouping cue.

From an evolutionary perspective, it is been argued that racial diversity would not have been a factor in ancient times prior to long-distance migration. Rather, language and voice accent may have been more prominent signals of group affiliation (Kurzban, Tooby & Cosmides, 2001). This hypothesis suggests that verbal cues are indicators of social group membership, and could be more relevant than visual cues. Recent studies have indicated that voice accent is used as a cue for categorization even beyond visual input such as race (Rakic, Steffens & Mummendey, 2011; Kinzler, Shutts, DeJesus & Spelke, 2009). Kinzler et al. (2009) found that children prefer native speaking playmates to foreign-language or foreign-accented children, even when those playmates are of another race. Additionally, Rakic et al. (2011) examined the effects of visual and verbal cross-categorization in adults, and found that voice accents are used as categorization indicators to a greater degree than visual cues. In their study, German participants were presented with visual photographs of prototypically German-looking and prototypically Italian-looking individuals, along with verbal statements (either in German or Italian accents) allegedly made by the photographed individual. Results indicated that participants relied more on verbal than visual information to form categories, based on the finding that targets who spoke in an Italian accent were remembered less well than those who spoke in a German accent, regardless of looks.

Due to the difficulty of obtaining and manipulating auditory social stimuli (relative to visual stimuli), very few studies have been able to study the effects of voice accent, which may be a more powerful and ecologically valid group membership cue. Therefore, voice accent was used as an auditory perceptual grouping cue in the following experiment. The rationale for use of voice accent in these experiments is two-fold: to extend the literature examining the impact of voice accent on face processing, and to ensure that visual grouping cues are held constant.

Method

Participants.

Thirty White males were recruited from the psychology participant pool at the University of Virginia and received course credit for participation. Of these, three were excluded from the analyses due to excessive head movements and eye blinks, resulting in 27 participants in the final analyses. Additionally, 47 participants volunteered to rate the stimuli based on perceived accent.

Stimuli.

Face photographs. Sixty face photographs of White males with neutral expressions and standardized clothing were obtained from the Tarr lab database (www.tarrlab.org) and used in this study. Of those, 30 were used in the learning phase and all 60 were used in the testing phase.

Vocal recordings. Thirty males were recruited to read a list of statements to be used as stimuli in the following two experiments. All volunteers signed a materials release form approved by the University of Virginia’s Institutional Review Board allowing for the use of the vocal recordings as stimuli. These statements included a list of 30 male names, each containing two syllables. Additionally, two statements of university affiliation (“I am a UVA/Virginia Tech student”) were recorded. Thirty vocal recordings of stated names [“My name is (Nathan)”] were used in the learning phase of the experiment. Of these, 15 were in a foreign/non-American accent and 15 were in an American accent.

Procedure.

After obtaining verbal and written consent, the experimenter set the participant up with the EEG system and told them that they would be viewing a series of faces. The participants were informed that they would hear each of the photographed individuals state their names prior to the presentation of their photograph in order to aid in their memory. They were also informed that some of the photographed individuals were American and others were foreign. They were asked to pay close attention to each of the presented faces because they would be asked to recall them later in the experiment.

The experiment involved two phases, the learning and the testing phase. In the learning phase, a vocal statement was presented followed by a face photograph. A focal point appeared on the computer screen while the participant was presented with the statement. The focal point remained on the screen for one second after the completion of the statement, and then the face appeared for three seconds. There was an interstimulus interval of two seconds following the presentation of each face, followed by the next statement. Participants were presented with thirty face/name pairs. Of those, half were presented in a foreign accent (out-group) and half were presented in an American accent (in-group). The faces and names were randomized between participants. Therefore, the faces of “in-group” members were different for each participant, ensuring that there are no visual differences for in-group and out-group members.

After completion of the learning phase, a five-minute filler task was given to participants, followed by the testing phase. Vocal recordings were not used in the testing phase. Sixty faces (30 that were previously presented in the learning phase and 30 novel) were presented sequentially and participants were instructed to indicate whether the faces were previously presented (target present) or were novel (target absent) by pressing a key on the keyboard. Faces were randomly presented and remained onscreen until a response was made. In order to limit movement while EEG was being recorded, the face was presented on the screen for two seconds prior to the instructions asking participants to indicate whether the face was previously shown or was novel. Participants were not able to respond until after the face was on the screen for two seconds and the instructions appeared. This limited the impact of motor movements on the components of interest (P100 and N170). The face then remained on the screen until a response was made.

Analyses

ERP recording, processing, and analysis were identical to that described in Experiment 2.

Results

Vocal recordings: Forty-seven volunteers rated the stimuli based on the perceived accent of each recorded voice. Participants listened to each of the recordings used in the experiments and were asked to rate the degree of *accentedness* ranging from one, indicating “no accent at all,” to seven, indicating a “very strong accent” (adopted from Rakic et al., 2011). A one-way ANOVA showed that the voices in the foreign condition were rated as having significantly higher accentedness relative to the voices in the American condition, $F(1, 28) = 149.9$, $p<.001$.

P1: The P1 was measured by taking peak activation 80-120ms after stimulus onset for each subject. A 2 (Accent: American vs. Foreign) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. The Greenhouse-Geiser epsilon correction for non-sphericity was applied where appropriate

(Jennings and Wood, 1976). Only corrected probability values and degrees of freedom are reported. There was a significant main effect of electrode [F(3.625, 94.257) = 15.226, p<.001, η_p^2= .369). No other significant results were found for the P1 component in the learning phase. For the testing phase, a 2 (Accent: American vs. Foreign) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Again, there was a significant main effect of electrode [F(3.72, 96.731) = 27.703, p<.001, η_p^2= .516), but no other significant effects were found.

N170: The N170 was measured by taking peak activation 150-190ms after stimulus onset for each subject. A 2 (Accent: American vs. Foreign) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted for the learning phase. There was a main effect of electrode [F(3.75, 97.5) = 6.26, p<.001, η_p^2= .194). No other significant effects, including effects of accent, were found. For the testing phase, a 2 (Accent: American vs. Foreign) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Again, there was a significant effect of electrode [F(3.174, 82.532)= 5.765, p=.001, η_p^2= .181), but no other significant results were found.

Behavioral: Face recognition sensitivity was measured using standard Signal Detection Theory (SDT; Green & Swets, 1966). To calculate sensitivity (d'), the Z(false alarm rate) was subtracted from the Z(hit rate). For this experiment, a 'hit' was defined as correctly responding 'Old' in the testing phase to a face that was presented in the learning phase, while a 'false alarm' was defined as incorrectly responding 'Old' to a face that had not been previously presented in the learning phase. The d' was calculated separately for faces paired with an American and a foreign accent, resulting in measure of sensitivity for in-group (American) and out-group (foreign) faces. A paired-samples t-test was conducted to assess whether there were differences between sensitivity for in-group and out-group faces. No effects were found (p=.927, ns).

Discussion

This study assessed whether using accent as a grouping cue changes brain activation evoked while processing faces, and subsequent recognition of the in-group and out-group members. The results indicate that accent was not sufficient to elicit perceived group membership, and therefore there were no differences in face processing for in-group relative to out-group members. This could be due to a variety of reasons. First, it is possible that accent is not used as an indicator of group membership. However, due to previous research showing that accent results in differential processing and interaction (Kinzler et al., 2009; Rakic et al., 2011), this is unlikely to be the case. Second, it is possible that only hearing brief statements from the foreign individuals was not powerful enough to elicit perceived group membership. In previous research, participants heard the accents of the foreign individuals for a greater amount of time than the brief statements of the individual's name. For example, in Rakic et al.'s (2011) study, participants heard statements expressing points about a university on topics such as the library, exams, or assignments. Additionally, it is possible that the use of accents from multiple countries resulted in an ill-defined group representation. The perceived unity of a group, termed entitativity (Campbell, 1958), involves the salience of perceptual cues such as physical similarity or spatial proximity. Impression formation of nonentitative (heterogeneous) social groups is more difficult than entitative (homogeneous) social groups (Lambert, Barton, Lickel & Wells, 1998; Dasgupta, Banaji, & Abelson, 1999), and perceivers make more spontaneous inferences about entitative than nonentitative groups (Dasgupta et al., 1999). Perhaps the heterogeneity of the foreign group resulted in increased difficulty of perceiving those individuals as a clear out-group. Future research is needed to determine whether longer exposure to foreign accents would elicit perceived group membership and result in differential face processing of in-group and out-group members, or whether accents from a single area or country elicit perceived group membership.

Chapter 4

4 Experiment 3: Investigating the time course of the grouping process when social cues are temporally distributed

The experiment presented in this chapter examines how faces are processed prior to the detection of the relevant grouping cue. Prior to this, it was unclear whether the default face processing is more similar to in-group members or out-group members. This is because a variety of cues can signal group membership, including race and age. Given the vast visual information that can cue group membership, individuals cannot see a face without detecting at least one grouping cue. However, many studies have shown that it is the relevant grouping cue, rather than detection of any grouping cue, that leads to differential processing (Hehman et al., 2010; Cassidy et al., 2011). Therefore, manipulation of the relevant grouping cue allows for the assessment of face processing prior to and post detection of this cue. This allows a comparison of face processing prior to detection of the relevant grouping cue, or a close indication of the “default” method of face processing.

Imagine the following scenario: you are at a pick-up basketball game and are waiting for teams to be chosen. As you look at the other players, you know some of them are going to be on your own team and some are going to be on the opposing team. At that moment, do you process the others as in-group members, which will aid in your later ability to recognition them, or do you process the others as out-group members, leading to decreased recognition accuracy? The aim of the following experiment is to test this question. The grouping cue of university affiliation will be presented through vocal statements, as the presentation of vocal statements can be temporarily manipulated. The statements will be either “I am a UVA student,” indicating in-group membership, or “I am a Virginia Tech student,” indicating out-group membership. The grouping cue will either be presented prior to the face, as was done in Experiment 3, or after the face is presented. Presenting the grouping cue after the face is presented allows for the assessment of face processing prior to the detection of the relevant grouping cue. This can then be compared to activation while processing faces of known in-group and out-group members. Therefore it can be tested whether, prior to the detection of the relevant grouping cue, others are processed more like in-group or out-group members.

In addition to the grouping cue of university affiliation, the grouping cue of race will also be examined in this study. It has been shown that race can be a powerful grouping cue and results in differential processing of own- and other-race individuals (e.g. Meissner & Brigham, 2001). However, many of the effects of race can be overridden by presenting participants with alternative, more relevant, grouping cues. University affiliation has been shown to be another powerful grouping cue (Bernstein et al., 2007), and therefore is used in this experiment as the task-relevant grouping cue. Both own-race and other-race faces will be presented as own-university and other-university members, and the presentation of the grouping cue of university affiliation will be presented either before or after face processing. This will allow a close look at the default method of face processing for both own-race and other-race individuals.

Method

Participants.

Fifty-five White males were recruited from the University of Virginia psychology participant pool and received course credit for participation. Of the 55 participants, 3 were removed due to excessive movement and eye-blinks, resulting in a total of 52 participants in the final analysis.

Stimuli.

Vocal recordings of 15 American males were created and used as stimuli. Each volunteer read statements of university affiliation ("I am a UVA/Virginia Tech student") while their voices were recorded. The University of Virginia Institutional Review Board approved all stimuli creation. Additionally, sixty faces (30 Black males and 30 White males) with neutral expressions were used in the experiment. Stimulus images courtesy of Michael J. Tarr, Center for the Neural Basis of Cognition and Department of Psychology, Carnegie Mellon University, http://www.tarrlab.org/.

Procedure.

Upon entering the lab, participants were greeted by the experimenter and given a consent form. After giving verbal and written consent, participants were set up for the EEG system, seated in front of a computer, and given headphones. Participants were instructed that they were going to be viewing a series of faces of University of Virginia and Virginia Tech students and they needed to remember the faces based on university affiliation because they would be asked to recall them later. They were told that each photographed individual would state his university affiliation vocally. The experiment consisted of two blocks: a *pre-face* block, in which the participants heard the voice indicating university affiliation prior to seeing the photograph, and a *post-face* block, in which the participants heard the voice indicating university affiliation after seeing the photograph. Each block consisted of a learning and testing phase. In the learning phase 30 faces (15 Black) were randomly presented for three seconds each, either proceeded or followed by a vocal statement indicating university affiliation. Of the statements, 15 were own-university ("I am a UVA student") and 15 were other-university ("I am a Virginia Tech student"), which were randomly paired with the faces. Following the learning phase and a five minute unrelated filler task, participants we given the testing phase in which they were again shown each of the previously shown faces and asked to indicate university affiliation by pressing the appropriate key on the keyboard. No auditory or visual cues of university affiliation were given during the testing phase. Each participant completed both the pre-face and post-face blocks, the order of which was counterbalanced across participants.

Analyses

ERP recording, processing, and analysis were identical to that described in Experiment 2.

Results

Learning Phase: The P1 component was measured by taking the peak activation 80-120ms after stimulus onset at occipital and parietal channels for each subject. The “unknown” university condition was the learning phase of the post block, in which participants did not yet know the university affiliation of the presented face. The Greenhouse-Geiser epsilon correction for non-sphericity was applied where appropriate (Jennings and Wood, 1976). Only corrected probability values and degrees of freedom are reported. A 2 (Race: own-race vs. other-race) x 3 (University: UVA/VT/Unknown) x 10 (electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures Analysis of Variance (ANOVA) was conducted for the learning phase. Results reveal a race x university interaction, $F(1.497, 76.323)=4.38$, $p<.05$, $\eta_p^2= .079$, a university x electrode interaction, $F(9.594, 489.296) = 2.331$, $p=.01$, $\eta_p^2= .044$, and a main effect of electrode, $F(4.312, 219.902) = 18.723$, $p<.001$, $\eta_p^2= .269$. Results by electrode can be seen in Figure 6.

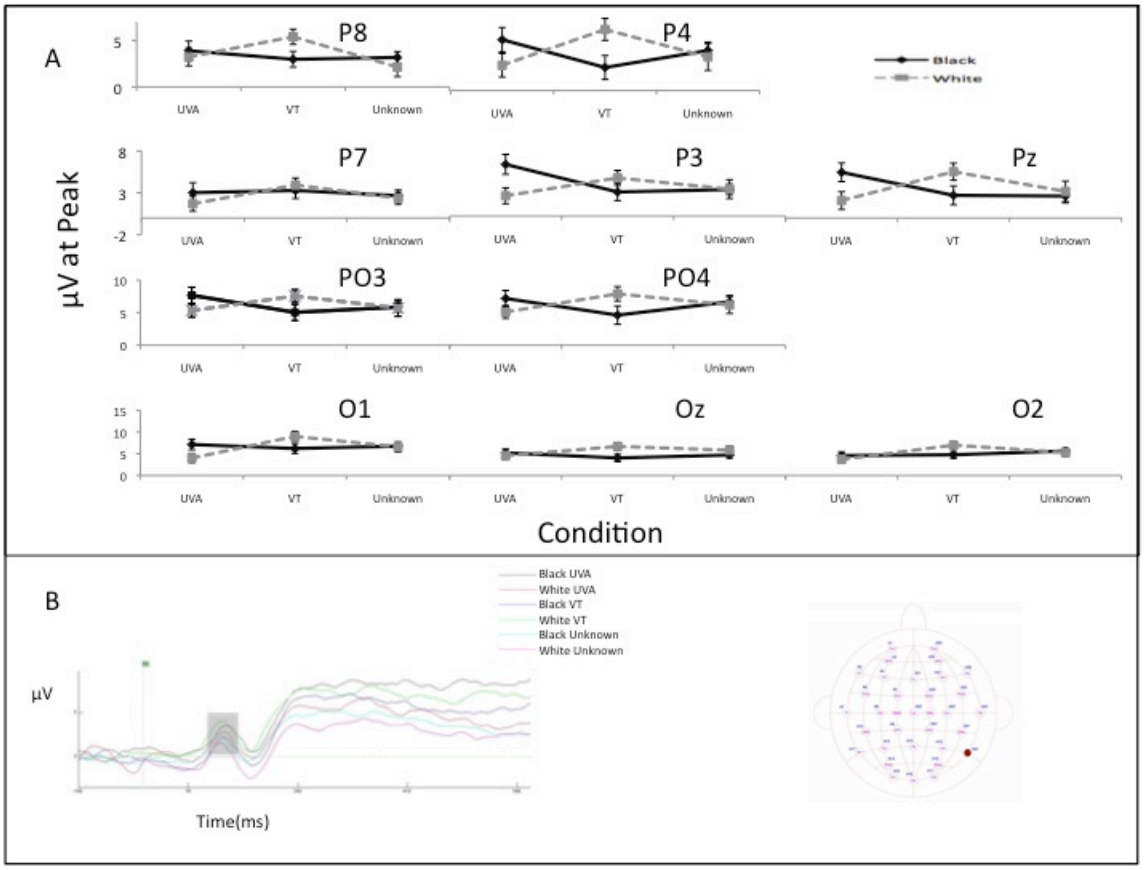

Figure 6. A) P100 component peak activation in the learning phase for own-race (White) and other-race (Black) stimuli in the in-group (UVA), out-group (VT), and Unknown conditions at each of the occipito-parietal electrodes. B) Respresentative waveform at electrode P8 (right parietal) by race and condition, with the time section used to measure P100 amplitude (80-120ms) marked by the grey box.

To explore the race x university interaction, separate ANOVAs were run for each race, collapsing across electrode. For other-race stimuli, there was a significant effect of university, F(2, 17.272) = 8.454, $p < .01$, $\eta_p^2 = .495$. Post hoc tests using the Bonferroni correction revealed that UVA (M=5.81, SE=.325) elicited a greater peak amplitude relative to VT (M=4.4, SE=.333, $p<.01$) but did not differ significantly from Unknown (M=4.82, SE=.325, $p=.09$). VT did not differ from Unknown ($p=.72$). For own-race stimuli, there was again a significant effect of university, F(2, 18.671)=61.694, $p<.001$, $\eta_p^2 = .869$. Post hoc tests using the Bonferroni correction revealed that VT (M=6.74, SE=.336) elicited a higher peak amplitude relative to UVA (M= 3.7, SE=.327, p<.001) and to Unknown (M=4.71, SE=.336, p<.001). Unknown elicited a significantly higher peak amplitude relative to UVA (p<.05). Analyses also showed that for the UVA condition, other-race stimuli (M=5.809, SE = .234) evoked greater P100 peak amplitude relative to own-race (M=3.548, SE = .223, p<.001). Conversely, for the VT condition, own-race stimuli (M=6.744, SE = .214) evoked greater P100 peak amplitude relative to other-race stimuli (M= 4.280, SE = .214, p<.001). There were no differences between races in the Unknown condition (White: M= 4.713, SE = .191; Black: M= 4.819, SE = .191, p=.696). Results averaged across electrode can be seen in Figure 7.

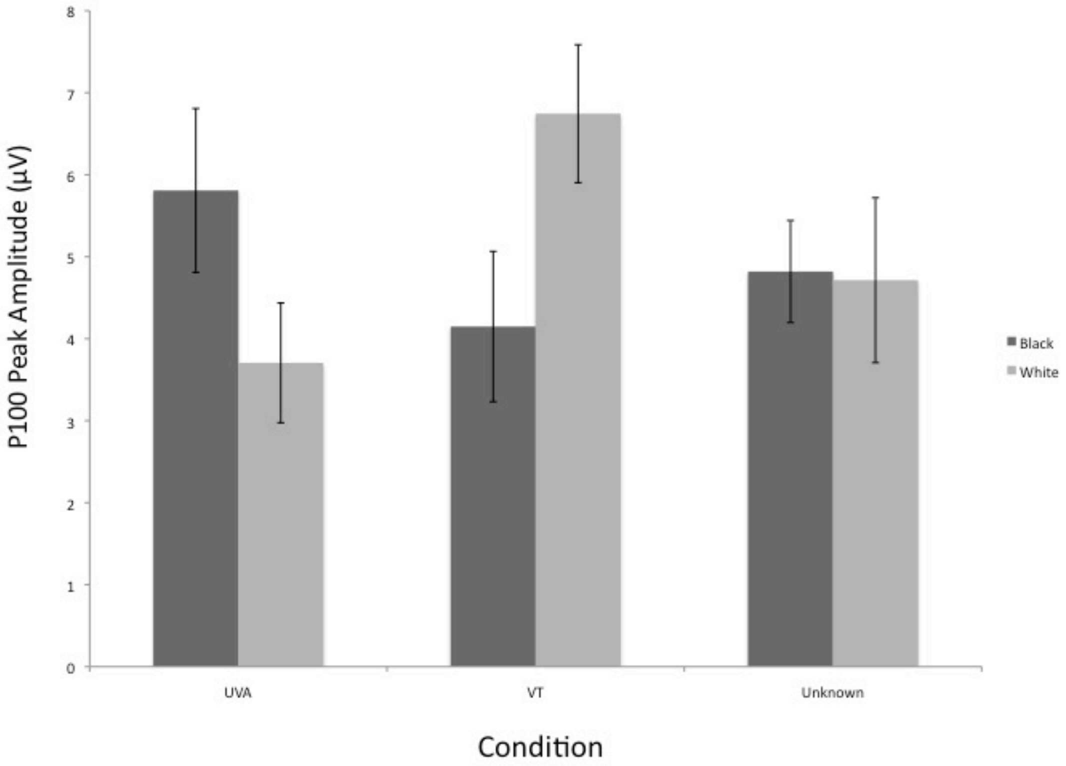

Figure 7. P100 peak amplitude for the learning phase, averaged across electrodes.

The N170 component was measured by taking the peak activation of each subject 150-190ms after stimulus onset at occipital and parietal channels. A 2 (Race: own-race vs. other-race) x 3 (University: UVA, VT, Unknown) x 10 (electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted for the learning phase. Results reveal a race x university interaction, F(1.661, 84.728) = 3.436, p<.05, η_p^2= .063, a race x electrode interaction, F(5.207, 265.537)=6.824, p<.001, η_p^2= .118, and a three-way race x university x electrode interaction, F(10.004, 510.227)=2.22, p<.02, η_p^2= .042. The results across electrodes can be seen in Figure 8.

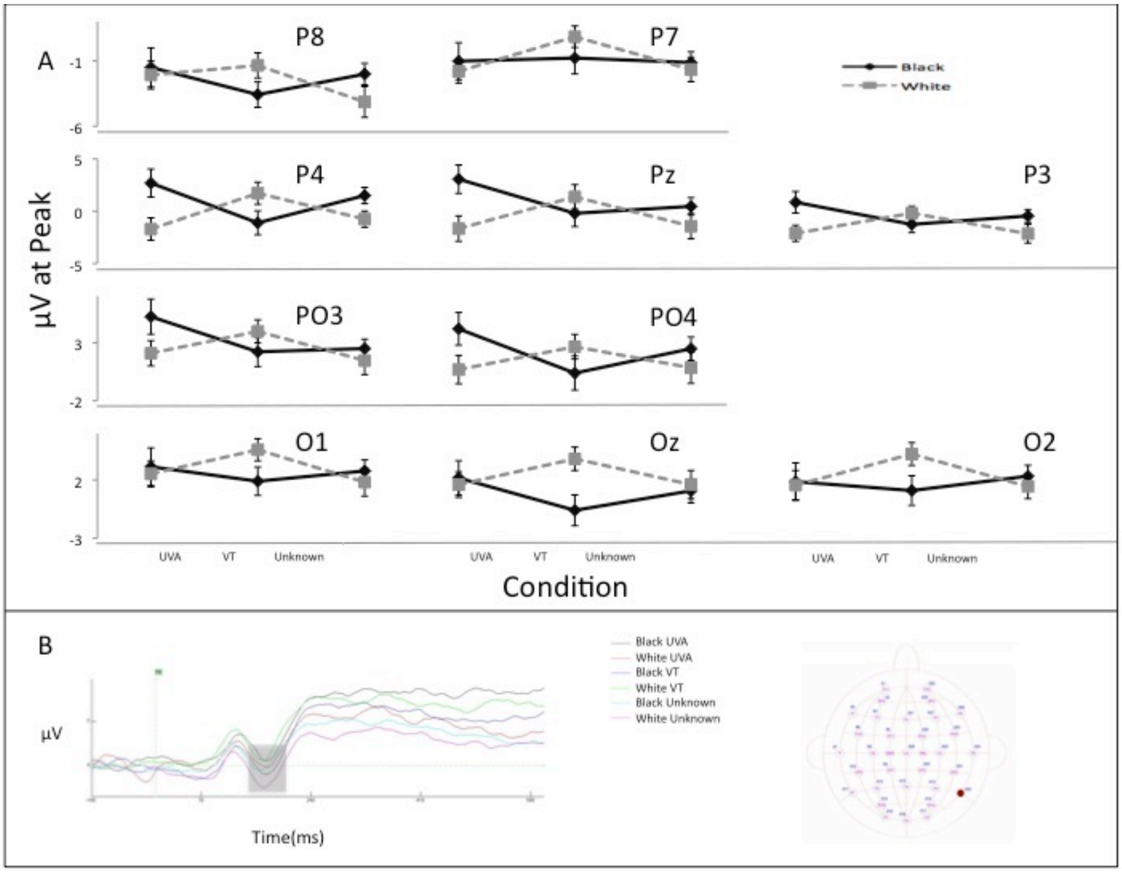

Figure 8. A) N170 component peak activation in the learning phase for own-race (White) and other-race (Black) stimuli in the in-group (UVA), out-group (VT), and unknown conditions at each of the occipito-partietal electrodes. B) Respresentative waveform at electrode P8 (right parietal) by race and condition, with the time section used to measure N170 amplitude (150-190ms) marked by the grey box.

To explore the race x university interaction, separate ANOVAs were run for each race, collapsing across electrodes. For other-race stimuli, there was a significant effect of university, F(2, 18) = 21.801, p<.001, η_p^2= .708. Post hoc tests using the Bonferroni correction revealed that UVA elicited a less negative amplitude (M= 2.443, SE = .388) relative to VT (M = .099, SE = .389, p < .001), but there were no significant differences between UVA and Unknown (p=.09) or VT and Unknown (p=.11). For own-race stimuli, there was a significant effect of university, F(2, 18) = 84.496, p<.001, η_p^2= .904. Post hoc tests using the Bonferroni correction revealed that UVA elicited a more negative average peak amplitude (M= 0.135, SE = .351) relative to VT (M= 2.462, SE = .351, p<.001) but did not differ significantly from Unknown (M=-0.06, SE = .351, p=1), whereas Unknown elicited a more negative peak amplitude relative to VT (p<.001). Analyses also showed that for the UVA condition, there was no significant differences between N170 peaks for other-race stimuli (M=2.443, SE = 1.34) relative to own-race stimuli (M=0.135, SE= .957, p=.20). For the VT condition, other-race stimuli (M=.073, SE= 1.07) elicited a more negative N170 relative to own-race stimuli (M=2.49, SE = .81, p<.05). In the Unknown condition, there were no differences between other-race stimuli (M=1.26, SE = .72) relative to own-race stimuli (M=-.073, SE = 1.06, p=.28). The results averaged across electrode can be seen in Figure 9.

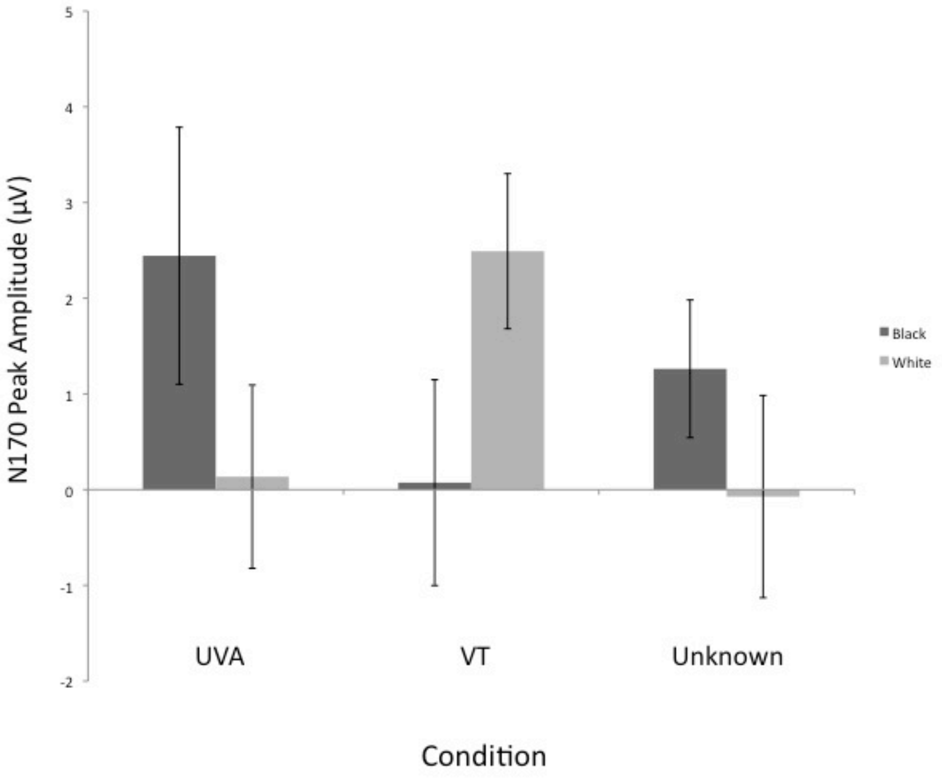

Figure 9. N170 peak amplitude for the learning phase, averaged across electrodes.

Peak-to-Peak measurements: Peak-to-peak measures were assessed to test whether the N170 differences found in the learning phase were a function of the differential P100 amplitude. Peak-to-peak measurements were taken by subtracting N170 peak amplitude from P100 peak amplitude for each subject. Differences in these peak-to-peak measurements were then analyzed using a 2 (Race: own-race vs. other-race) x 3 (University: UVA, VT, Unknown) x 10 (electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA. Results indicate a significant race x electrode interaction, $F(4.88, 249.1) = 3.52$, $p<.01$, $\eta_p^2 = .065$, and a main effect of electrode, $F(3.218, 164.097) = 7.369$, $p<.001$, $\eta_p^2 = .126$. No other significant main effects were found, indicating that the race x university interaction for N170 peak amplitude is not a function of differential P100 amplitude.

Testing Phase: For the testing phase for the P100 component, a 2 (Race: own-race vs. other-race) x 2 (University: UVA vs. VT) x 2 (Block: pre vs. post) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Results reveal a race x university interaction, $F(1,51) = 7.303$, $p<.01$, $\eta_p^2 = .125$, and a main effect of electrode, $F(3.236, 180.328) = 33.383$, $p<.001$. As there were no effects of block, the pre and post blocks were collapsed for remaining analyses. To independently explore the effects of university across race, separate ANOVAs were conducted. For other-race stimuli, there was a significant effect of university, $F(1, 1872) = 5.423$, $p<.05$, with higher peak amplitude for VT (M=4.625, SE=.119) relative to UVA (M=4.232, SE=.119). For own-race stimuli, there was a significant effect of university, $F(1, 1872) = 33.387$, $p<.001$, with higher peak amplitude for UVA (M=5.096, SE=.122) relative to VT (M=4.097, SE=.122). For UVA, there was a significant effect of race, $F(1,51) = 4.59$, $p<.05$, with higher peak amplitude for own-race (M= 5.1, SE= .137) relative to other-race (M= 4.23, SE= .137). For VT, there was no significant difference between other-race (M= 4.63, SE=.149) and own-race (M=4.1, SE=.149) stimuli, $p=.25$. Results can be seen in Figure 10.

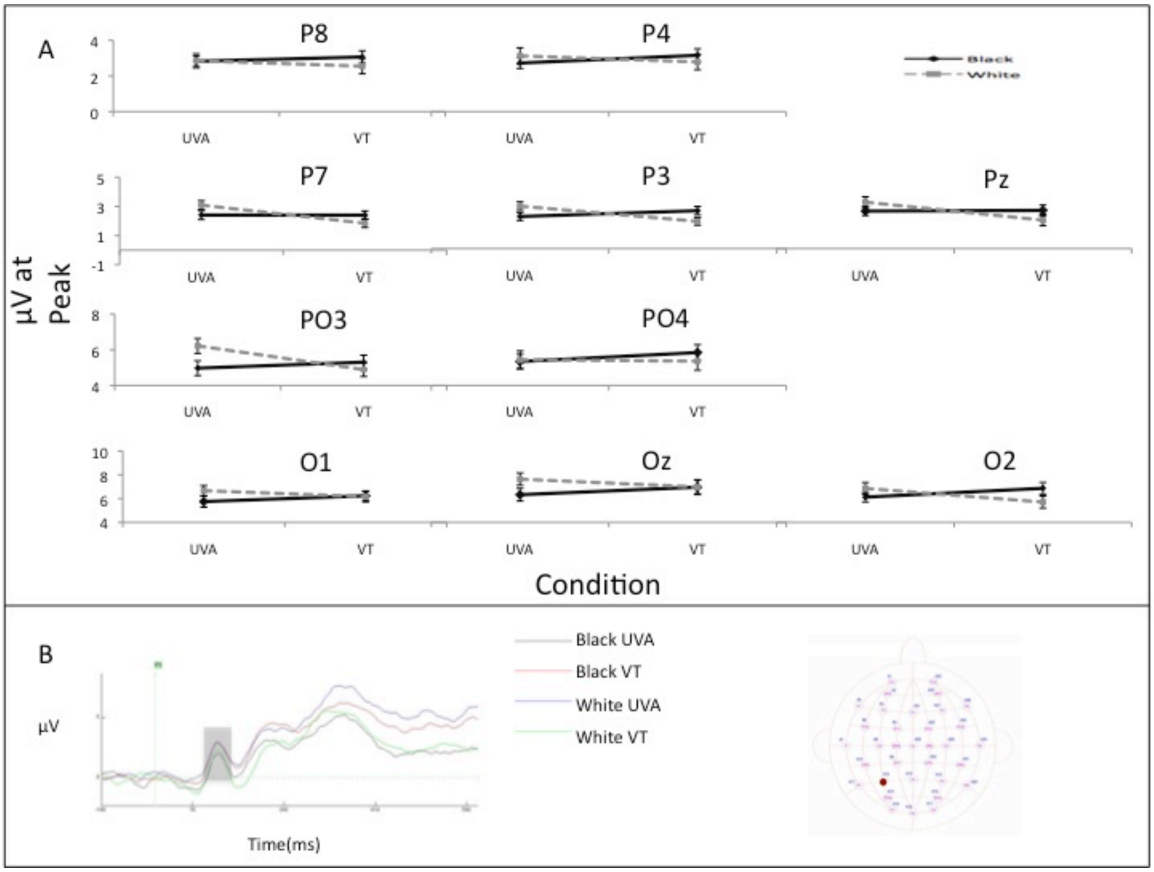

Figure 10. A) P100 component peak activation in the testing phase for own-race (White) and other-race (Black) stimuli in the in-group (UVA) and out-group (VT) conditions at each of the occipito-parietal electrodes. B) Respresentative waveform at electrode P3 (left parietal) by race and condition, with the time section used to measure P100 amplitude (80-120ms) marked by the grey box.

For the N170 component, A 2 (Race: own-race vs. other-race) x 2 (University: UVA vs. VT) x 2 (Block: pre vs. post) x 10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted. Results show a race x university interaction, F(1,51)=7.065, p=.01, η_p^2= .122, and a main effect of electrode, F(3.707, 189.046) = 11.652, p<.001, η_p^2= .186. As there were no effects of block, remaining analyses were collapsed across blocks. To examine the race x university interaction, separate ANOVAs were run for each race, collapsing across electrode. For other-race stimuli, the was no significant difference between universities, F(1, 2078) = 3.523, p=.061, although there was a trend for UVA to have more negative amplitude (M= -0.647, SE = .187) relative to VT (M= -0.151, SE=.187). For own-race stimuli, there was a significant effect of university, F(1, 2078)=23.448, p<.001, with VT eliciting more negative amplitude (M=-.695, SE=.174) relative to UVA (M=.498, SE=.174). These results can be seen in Figure 11.

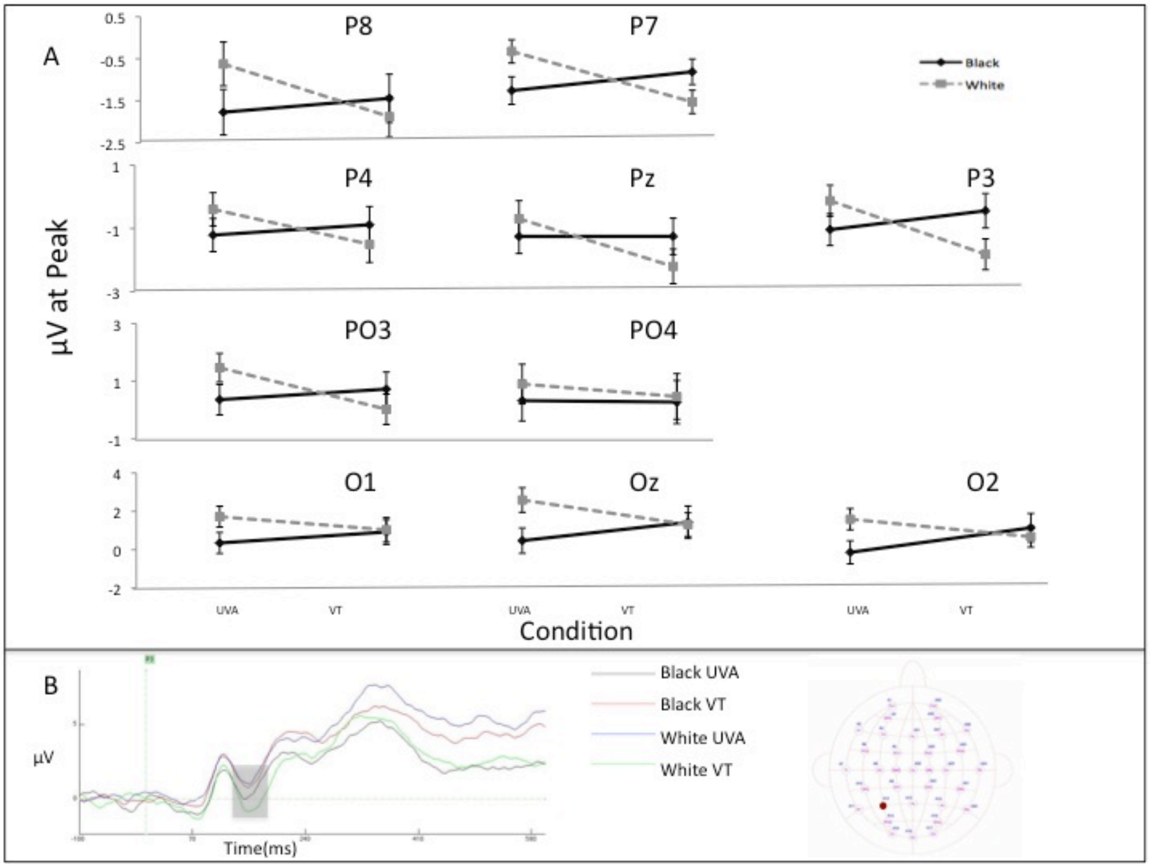

Figure 11. A) N170 component peak activation in the testing phase for own-race (White) and other-race (Black) stimuli in the in-group (UVA) and out-group (VT) conditions at each of the occipito-partietal electrodes. B) Respresentative waveform at electrode P3 (left parietal) by race and condition, with the time section used to measure N170 amplitude (150-190ms) marked by the grey box.

Peak-to-Peak measurements: Peak-to-peak measurements were taken by subtracting the peak N170 amplitude from the peak P100 amplitude for each subject. A 2 (Race: own-race vs. other-race) x 2 (University: UVA vs. VT) x 2 (Block: pre vs. post) x

10 (Electrode: P7, P3, Pz, P4, P8, PO3, PO4, O1, Oz, O2) Repeated Measures ANOVA was conducted on the peak-to-peak measures. Results show a race x electrode interaction, F(5.7, 29.5) = 2.61, $p < .05$, $\eta_p^2 = .049$, a block x electrode interaction, F(5.69, 289.92) = 2.452, $p < .05$, $\eta_p^2 = .046$, and a main effect of electrode, F(2.88, 146.89) = 7.253, $p < .001$, $\eta_p^2 = .125$. There was not a significant race x university interaction, indicating that the N170 results were not a function of differential P100 amplitude.

Behavioral: Sensitivity for university affiliation was assessed by using standard Signal Detection Theory (SDT; Green & Swets, 1966). To calculate sensitivity (d'), the Z(false alarm rate) was subtracted from the Z(hit rate). For this experiment, a 'hit' was defined as correctly responding 'UVA' to a face that was paired with a UVA statement, while a 'false alarm' was defined as incorrectly responding 'UVA' to a face that was paired with a VT statement. A 2 (Race: own-race vs. other-race) x 2 (Block: pre vs. post) Repeated Measures ANOVA was conducted. There was a significant main effect of block, F(1,51) = 8.378), $p < .01$, $\eta_p^2 = 0.141$, with greater sensitivity after the pre-condition block (M=.775, SE=.096) than the post-condition block (M=.449, SE=.081), which can be seen in Figure 12. There were no significant effects of race. It is important to note that although performance during the learning task was greater when participants heard university affiliation prior to seeing each face, they were still able to accurately categorize by university above chance in the post-face block, when the university affiliation was not stated until after they were presented with the face.

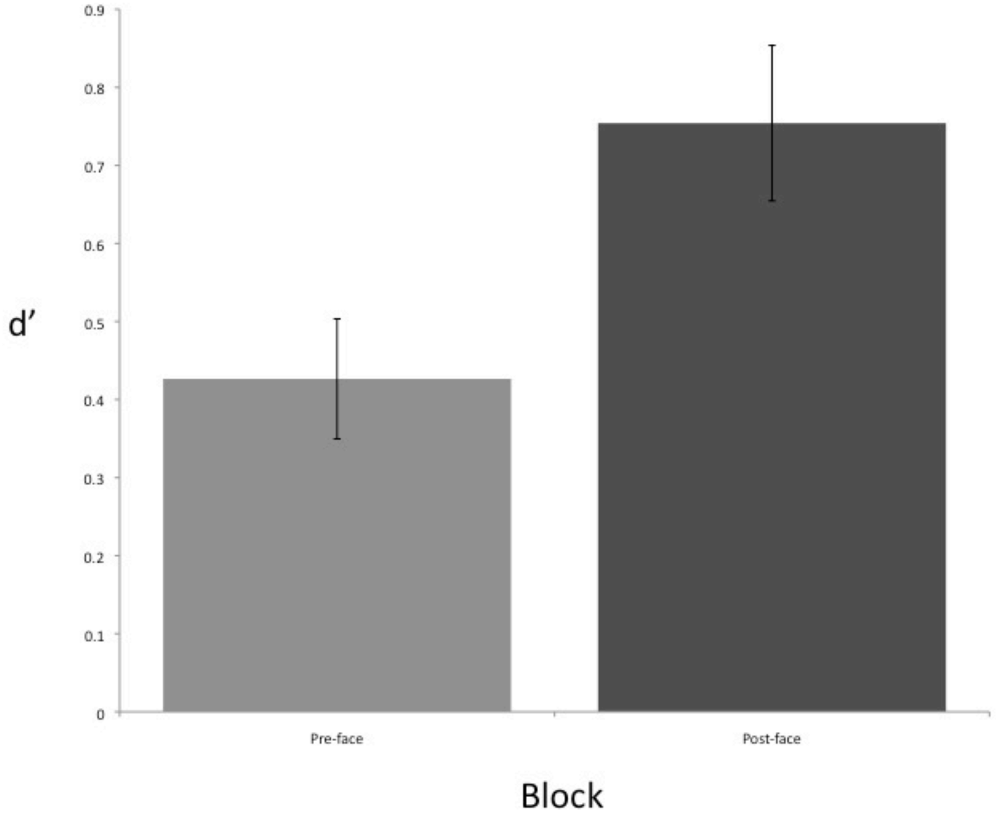

Figure 12. Sensitivity, as measured by d', to university affiliation for faces presented in the pre-face and post-face blocks.

It was then examined whether sensitivity measures were correlated with brain activation of the components of interest. Peak amplitude was averaged across each of the ten electrode sites of interest for this analysis, resulting in an averaged P100 and an averaged N170 peak amplitude for each condition for each subject. Additionally, differences in peak amplitude were calculated across race for each condition, resulting in a P100 modulation index for the UVA condition (Black UVA - White UVA), the VT condition, and the Unknown condition. For the learning phase, sensitivity (d') to university affiliation was positively correlated with P100 peak amplitude in the Black Unknown condition, $r(52) = .306$, $p<.05$ and negatively correlated with P100 amplitude in the Black VT condition, $r(52) = -.306$, $p<.05$. The negative correlation is accounted for by a significant positive correlation between P100 modulation in the VT condition and recognition accuracy r(52) = .283, p<.05, whereby greater the difference at peak between White and Black lead to greater recognition accuracy. Results can be seen in Figure 13. There were no significant correlations of P100 amplitude and d' in the testing phase. There were no significant correlations between N170 peak amplitude and d' for either the learning or testing phases.

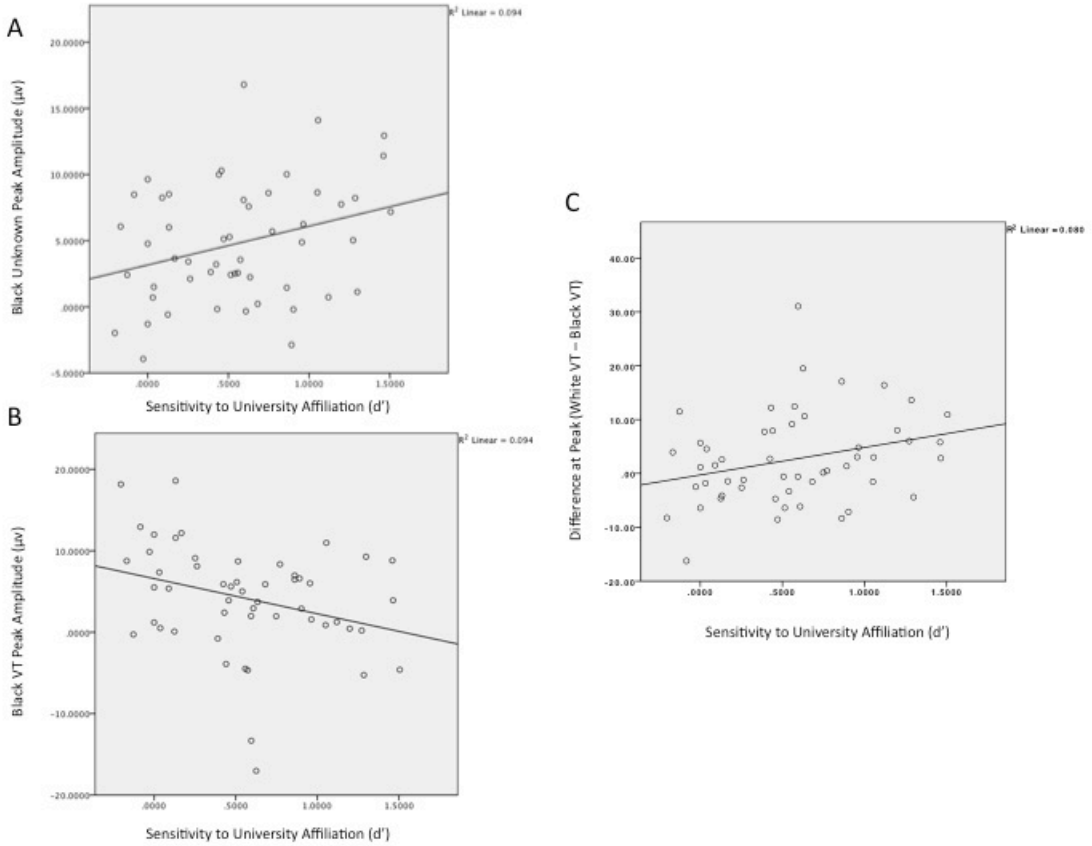

Figure 13. A) Positive correlation between P100 peak amplitude in the other-race (Black) Unknown condition and sensitivity to university affiliation as defined by d'. B) Negative correlation between P100 peak amplitude in the other-race (Black) out-group (VT) condition and sensitivity to university affiliation. C) Positive correlation between the difference between peak P100 amplitude for own-race (White) and other-race (Black) stimuli in the out-group condition and sensitivity to university affilation.

Discussion

Results indicate the knowledge that an individual is an in- or out-group member prior to visual presentation of their face causes changes in very early face processing, and that this can impact later recognition ability. Differences in peak amplitude were found based on group membership as early as 100ms after face presentation. However, known university affiliation interacted with the race of the face. These results are discussed in sections below.

Default method of face processing: One aim of the current experiment was to test the “default” method of face processing. More specifically, I examined how faces were processed prior to the detection of the relevant grouping cue in the learning phase of the post block, when participants were informed that each photographed individual was either a UVA or VT student but that they wouldn’t find out university affiliation until after the face was presented. In this condition, there were no significant differences based on race for either the P100 or N170 components. This gives evidence that race does not impact very early face processing when the perceiver is waiting on another more relevant grouping cue. In order to assess whether faces are processed more as in-group or out-group members prior to detection of the relevant grouping cue, the conditions in which the participant was given the relevant grouping cue are compared to the condition in which they did not receive the group membership cue until after the face was presented. For Black faces, there was no difference in P100 peak amplitude between the VT and the unknown condition, but P100 peak amplitude was higher for the UVA condition relative to the other two. This indicates that other-race individuals are processed as out-group members in very early stages of face processing. Alternatively, for White faces, higher P100 peak amplitude was shown for VT relative to unknown and for unknown relative to UVA. This indicates that own-race faces are processed as neither out-group nor in-group members in very early face processing when the perceiver is anticipating the relevant grouping cue. Peak amplitude for the N170 component showed a similar pattern. For Black faces, more negative amplitude was found for VT relative to unknown and from unknown to UVA. Therefore, the default N170 amplitude for Black faces was in-between the in-group and out-group amplitudes. For White faces, more negative amplitude was found for both UVA and unknown relative to VT, showing that the default method of processing was not significantly different from in-group processing. Taken together, the results of this experiment indicate that prior to detection of the relevant grouping cue, own-race faces are processed more similarly to in-group members, whereas other-race are processed more similarly to out-group members at very early stages of face processing.

P100: In this experiment, differences in face processing for in-group and out-group members emerged as early as 100ms after the face was presented. Specifically, when an upcoming face was known to be an in-group member (UVA) and an other-race face was shown, there was an increase in P100 amplitude. The same pattern occurred when an upcoming face was known to be an out-group member (VT) and an own-race face was presented. Therefore, this pattern of results seems to indicate a congruency effect. Specifically, results suggest that preparing for an in-group member and then being presented with a racial out-group member causes a shift in processing strategy.

In a very telling experiment, Petrenko (2008) demonstrated that shifting the strategy of visual perception results in increases in P100 amplitude. Participants were presented with hierarchical figures, which were either coincident or noncoincident in their global and local levels. Specifically, a global cross could be made up of smaller crosses (local level same) or smaller rectangles (local level different). A cue preceding the target stimuli indicated whether the participant should respond to the global or local level. ERPs were averaged over situations of steadily repeated presentation of the same level and of cases when the level of recognition switched from global to local or vice versa. Results found increased P100 amplitude in the caudal areas when participants switched recognition strategies.

Petrenko's (2008) finding has important implications for the results of the current experiment. When participants were informed that the upcoming face was an in-group (UVA) member, P100 amplitude was higher when the subsequent face was an other-race (Black) face relative to an own-race (White) face, while the opposite was found when the participants were informed that the upcoming face was an out-group (VT) member. Therefore, hearing "I am a UVA student," followed by viewing an other-race face lead to increased P100 amplitude. This could indicate that participants were prepared for one recognition strategy and switched strategies upon seeing an out-group cue. The same was found when hearing "I am a Virginia Tech student" and then viewing an own-race face, indicating that participants were prepared to encode an out-group member and recognition strategies switched after detecting an in-group cue.

It is unclear whether we would see these effects if all of the faces were own-race. Specifically, the differential P100 amplitude may be reflective of a switch in face processing strategy. If participants did not have the race and university cross-categorization, then they may hold their processing strategy when the face is presented.

Therefore, there may be no differences in P100 amplitude based on university affiliation if that is the only cue that can be used for group membership, just as there are no differences based on race. Future studies are needed to further examine this possibility.

Additional analysis revealed that early component differences correlated with the ability to accurately identify the faces as either in-group or out-group members during the subsequent testing phase. When participants knew that the upcoming face was a VT student, and then the presented face was Black, there was a negative correlation between P100 amplitude and categorization accuracy whereby lower amplitude was associated with higher recognition accuracy. Additionally, when viewing a Black face prior to the detection of the relevant grouping cue, there was a positive correlation between P100 amplitude and categorization accuracy.

The negative correlation between P100 amplitude and categorization accuracy for the Black VT faces may indicate improper allocation of attention to irrelevant stimuli. In this experiment, race is irrelevant as participants were told to attend to and were tested on university affiliation. Indeed, it has been shown that P100 modulation is associated with subsequent memory (Zanto & Gazzaley, 2009; Rutman, Clapp, Chadick, & Gazzaley, 2009). For example, Zanto and Gazzaley (2009) found that lack of P100 modulation was associated with lower performance on a subsequent memory task. Futhermore, Rutman et al. (2009) found that top-down modulation of the P100 component, defined as the difference in P100 amplitude across tasks, is positively correlated with later recognition. The authors concluded “the degree to which a participant selectively modulates activity in the first 100ms of encoding a stimulus is a significant predictor of their ability to accurately recognize the stimulus after a 4-sec delay” (pg. 1232). Indeed, the results of the current experiment suggest a lack of modulation of the P100 component for the Black VT faces results in decreased accuracy in a later memory task, while an increase in P100 modulation for the Black unknown faces results in higher performance in the memory task.

Interestingly, the pattern of P100 activation switches during the testing phase. In this phase, the faces have already been encoded once, group membership is now known, and categorization of group membership is explicitly being tested. Results show that for other-race (Black) faces, out-group members (VT) elicited higher P100 amplitude relative to in-group members (UVA), while the reverse was found for own-race (White) faces. In-group members showed differential P100 amplitude based on the race of the face, with higher peak amplitude for White relative to Black stimuli, while no difference was found based on race for out-group members. To specify, White UVA faces elicited higher amplitude relative to White VT, which did not differ from Black VT, which was higher than Black UVA. This finding suggests that any out-group cue, whether it is the relevant grouping cue of university affiliation or the non-relevant racial grouping cue, leads to decreased amplitude relative to the double in-group faces. If you recall, there was a switch in processing strategy reflected by an increase in P100 amplitude during encoding. The results of the testing phase could indicate that this switch was disadvantageous.

Finally, the results of this experiment give clear evidence that conditioning is not required for differential P100 amplitude based on perceived group membership. Differences emerged in the learning phase, which was the first time that faces were encoded and therefore could not be caused by emotional conditioning of the faces.

Therefore, these results are indicative of motivated perception rather than emotional conditioning.

N170: In the learning phase, results indicate a pattern of N170 amplitude similar to that of the P100 component. Again, there was an interaction between university affiliation and race. For White stimuli, UVA faces did not differ in amplitude relative to Unknown, but had greater (more negative) N170 amplitude for both the UVA and Unknown conditions relative to the VT members. The opposite pattern was found for Black stimuli, with greater N170 amplitude for the VT and Unknown conditions relative to UVA members.

As was the case for the P100 component, results shift during the testing phase. In this phase, increased N170s were found for Black in-group relative to out-group members and White out-group relative to in-group members. These results indicate an increase in effort for other-race in-group and own-race out-group members. As shown by Senholzi and Ito (2012), the N170 component is more negative for other-race faces when identification is needed, suggesting increased effort. Interestingly, this increase in effort is shown not only for Black in-group faces, but also for White out-group faces.

To return to the pick-up basketball game example: if you are waiting to be chosen for a basketball team and are processing the faces of the potential teammates, does one process them more as in-group or out-group members? The results of this experiment suggest that you although there are no significant differences based on race in this situation, to discover that the own-race individuals are now part of the other team would result in a switch in processing, while discovering that the other-race individuals are part of one’s own team would result in a similar processing strategy switch. It seems as though expectations, motivation, and group membership cues are all important factors in face processing and subsequent recognition.

In sum, this study was the first to examine the time-course of brain activation when grouping cues are temporally distributed. Informing participants that each phase was either an in-group or out-group member, but not giving the grouping cue until after the face was processed allowed the assessment of a “baseline” or “default” method of face processing prior to the detection of relevant grouping cues. In this condition, there were no differences based on the race of the face. However, when participants had expectations about the upcoming face (either in-group or out-group) and yet an opposing grouping cue was detected (either own-race or other-race), a shift in processing strategy was shown in very early face processing. This shift then was correlated with subsequent categorization accuracy of the processed faces. Finally, differences in N170 amplitude suggest that detection of any grouping cue, whether it be the relevant grouping cue of university affiliation or the task-irrelevant racial cue, leads to increased effort in face processing.

Chapter 5

5 Experiment 4: Investigating the impacts of race on biological motion perception.

The experiment presented in this chapter demonstrates that perceived group membership, specifically racial group membership, impacts biological motion perception. The majority of previous research examining the effects of perceived group membership on processing, as well as the aforementioned dissertation experiments, has focused on face recognition. However, social interactions involve more than just the ability to accurately identify faces. The ability to understand the actions and intentions of others seems to be rooted in a co-opted system by mapping observations onto one's motor repertoire (e.g. Uddin, Iacoboni, Lange & Keenan, 2007). However, it has yet to be examined whether this mapping is dependent upon perceived similarity of the self and others.

The observation and imitation of others' actions is an integral part of human interaction. Imitation of others often leads to increased liking and affiliation (e.g. Anderson, Keltner & Oliver, 2003; Chartrand & Bargh, 1999). There is evidence that people automatically and unintentionally imitate other's emotional facial expressions (Dimberg, Thunberg, & Elmehed, 2000; Hatfield, Cacioppo & Rapson, 1992), and even more so for well-liked people (Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008). Furthermore, research has shown that people are more accurate at recognizing emotional facial expressions of in-group relative to out-group individuals (Elfenbein & Ambady, 2003; Elfenbein, Mandal, Ambady, Harizuka, & Kumar, 2004).

There has also been some evidence that automatic imitation of facial expressions differs as a function of target group membership. The temporal duration estimation of angry facial expressions is generally overestimated, likely due to increases in arousal (Droit-Volet, Brunot, & Niedenthal, 2004), but only when automatic imitation is uninhibited (Effron, Niedenthal, Gil, & Droit-Volet, 2006). Using this implicit measure of attention, Mondillon, Niedenthal, Gil, and Droit-Volet (2007) found differences in overestimations of angry facial expression based on participant and target race. For French Caucasian participants, there was a temporal bias only when estimating Caucasian facial expressions. However, for Chinese participants, a temporal bias was shown for both own- and other-race facial expressions. The authors conclude that both familiarity and motivation can account for these cross-race differences.

As both imitation and empathetic responses can be modulated by group membership, it is possible that the perception of group membership can impact the shared neural circuitry thought to be involved in embodied simulation. Gutsell and Inzlicht (2010) hypothesize that embodied simulation (termed *perception-action coupling* by the authors, adapted by Preston & de Waal, 2001) is limited to the in-group. Participants were shown videos of own-race and other-race models performing actions and then were asked to perform the actions themselves while EEG activity was recorded. Results showed increased mu rhythm suppression for own-race relative to other-race observation. The data suggests that there was motor cortex activation while participants viewed own-race but not other-race members, suggesting a lack of mental simulation of other-race members. There was a significant linear trend in that mu suppression was greatest when participants were performing the action (the self condition), followed by observation of an own-race individual, and showed the least mu suppression when observing an other-race individual. This study gives evidence that perceived similarity of other to the self impacts shared neural circuitry.

The notion of shared neural circuitry between one’s own and other’s actions and intentions is an extension of the findings of *mirror neurons* originally discovered in area F5 in the premotor cortex of macaque monkeys (Gallese, Fadiga, Fogassi & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese & Fogassi, 1996). Mirror neurons are a specific type of neurons that are active both when an action is executed and when the same action is observed. In monkeys, neurons responding to the observation of action are present in the rostral part of the inferior parietal lobule, the ventral premotor cortex (including area F5), and the superior temporal sulcus (STS[3]; see Rizzolatti & Craighero, 2004 for a review). Although the specific function of mirror neurons is an area of high debate, it has been proposed that mirror neurons function to mediate action understanding (e.g. Rizzolatti & Fabbri-Destro, 2008) and imitation of others (e.g. Iacoboni, 2009). In humans, imitation of others is prevalent in social interactions and begins early in development. It has been shown that newborns as early as 18 hours after birth are capable of imitating mouth and face movements of adults (Meltzoff & Moore, 1977). As infants do not have access to the visual output produced by their own movements, this finding indicates that visual information and bodily movements share a common framework (Meltzoff & Moore, 1983), which may be similar to the mirror neurons found in monkeys.

Indirect evidence of a system in humans similar to the monkey mirror neuron system stems from neuropsychological studies. Very early studies by Gastaut and colleagues (Cohen-Seat, Gastaut, Faure & Heuyer, 1954; Gastaut & Bert, 1954) found activity in the motor cortex of humans based on action observation. Using EEG measurements, a specific brain rhythm, termed the *mu rhythm*, is strongly suppressed during performance of motor acts. This suppression has been shown not only during motor actions, but also during action observation (e.g. Oberman, Pineda & Ramachandran, 2007; Babiloni, Carducci, Cincotti, Rossini, Neuper, Pfurtscheller, & Babiloni, 1999) and action imaging (Pfurtscheller & Neuper, 1997), indicating that a system involved both in action observation and execution does exist in humans.

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[3] Although the STS region does respond to action observation, there are no motor properties in this area. Therefore, the STS has properties similar to mirror neurons located in motor areas, but is not defined as part of the mirror circuit (Rizzolatti & Craighero, 2004).

Studies using fMRI have also found a complex network associated with action observation and execution. For example, Iacoboni, Woods, Brass, Bekkering, Mazziotta, and Rizzolatti (1999) tested the hypothesis that imitation is based on an internal motor representation of the observed action, which they termed the *direct matching hypothesis*. The authors found two regions that were active during action and more highly active during imitation of the same action: the left inferior frontal cortex and the right superior parietal lobule, an area also implicated in self-recognition (Uddin et al., 2005).

Originally, this network was thought to only be involved in action recognition. However, it has now been argued to be additionally involved in understanding action intention. Iacoboni, Molnar-Szakacs, Gallese, Buccino, Mazziotta, and Rizzolatti (2005) showed participants scenes of hand grasping actions within contexts and without context, and a scene containing objects without hand grasping actions while undergoing fMRI. The premotor mirror areas had a significant signal increase while participants viewed motor actions embedded in context relative to the other two conditions. It was proposed that a mirroring-type mechanism is used for action and intention understanding by way of embodied simulation, in which interactions with the world are simulated within the brain (Rizzolatti, Fogassi & Gallese, 2001; Fogassi & Giuseppe, 2005).

There is increasing evidence that human understanding of others' actions and intentions is based in embodied simulation. Gallese (2009) explains the notion of embodied simulation as

> *a direct understanding of others from within…internal nonlinguistic 'representations' of the body-states associated with actions, emotions, and*

> *sensations are evoked in the observer, as if he or she were performing a similar action or experiencing a similar emotion or sensation* (pg. 524)

Gallese (2007) proposed the *neural exploitation hypothesis*, which posits that embodied simulation is the basis of many aspects of social cognition, such as emotional understanding of others. Indeed, when viewing emotions such as disgust (Wicker, Keysers, Plailly, Royet, Gallese & Rizzolatti, 2003), and pain (Jackson, Brunet, Meltzoff & Decety, 2006; Singer, Seymour, O'Doherty, Kaube, Dolan & Frith, 2004; Jackson, Meltzoff & Decety, 2005; Botvinick, Jha, Bylsma, Fabian, Solomon & Prkachin, 2005), as well as the sensation of touch (Keysers, Wicker, Gazzola, Anton, Fogassi & Gallese, 2004; Blakemore, Bristow, Bird, Frith & Ward, 2005; Ebisch, Perrucci, Ferretti, Del Gratta, Romani & Gallese, 2008), some of the same neurons are active as when the observer subjectively experiences these.

Both Iacoboni's (2009) and Gallese's (2007) theories of the understanding of others involve a direct link to a self-representation. Although the similarity between this and mirror neurons found in monkeys is still an area of debate (see Gallese, Gernsbacher, Heyes, Hickok & Iacoboni, 2011), there is abundant evidence of shared neural circuitry between processing the self and processing others. If these embodied simulation theories are correct, then the processing of others' actions, emotions, and behaviors should reflect a similarity of the other to the self.

The aim of the experiment presented in this chapter is to test whether similarity between an imitated target and the self, based on the physical dimension of race, may impact brain structures supporting action observation and imitation. To test this, I employed a simple paradigm where White subjects either passively viewed or imitated hand movements of White or Black actors. I localized brain systems involved in imitation and then tested for activation differences as a function of the actor's race.

Method

Participants.

Twenty healthy White males (ages 19-27) participated in the experiment. All were right-handed, with normal or corrected-to-normal vision and no history of neurological or psychiatric illness. Participants gave informed consent and were paid for their participation.

Stimuli.

Two Black males and two White males were recruited to record sequences of four button presses using an MR-compatible button box (see Figure 14). Twenty-four clips were recorded for each male, resulting in a total of 96 clips (48 Black male). Each clip was four seconds in length. During scanning, imitation was specular, with the button box placed underneath participants' right hands so that responses could comfortably be made with their index, middle, ring, and pinky fingers. Each run consisted of 24 randomized trials (12 own-race) of a four-second clip followed by an inter-stimulus interval ranging from 8 to 12 seconds.

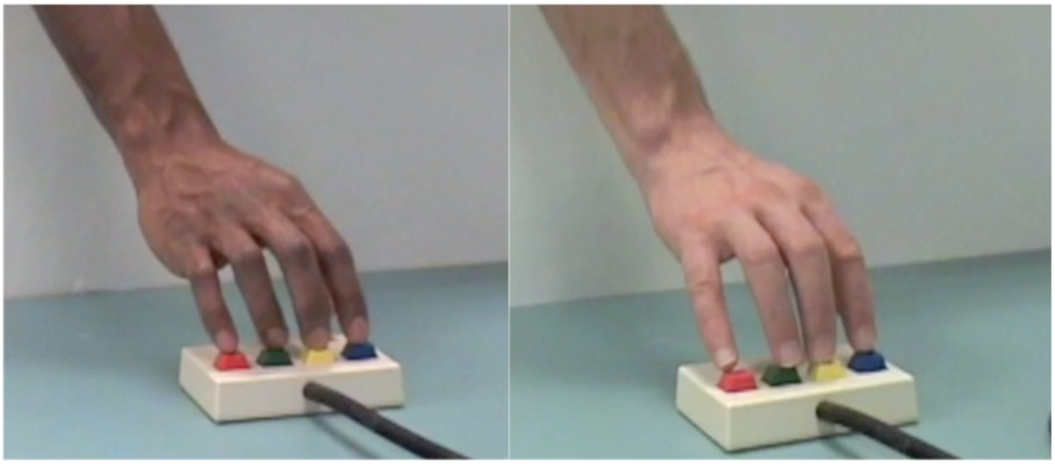

Figure 14. Still images of the video clips of other-race (left) and own-race (right) stimuli.

Procedure

This study was a 2 (stimuli race) x 2 (imitate/observe) within subjects design. While in the scanner, participants completed four runs of a simple imitational paradigm, adopted from Heiser, Iacoboni, Maeda, Marcus, and Mazziotta (2003). Each participant completed two runs of each of two conditions: an *observe* condition, in which participants were instructed to passively view the clips of button press sequences; and an *imitate* condition in which participants were instructed to imitate the actions on the screen. Each run consisted of 24 stimulus clips (12 Black male), and stimulus race was randomized within the run. During the imitation runs, participants imitated the actions in the clips by depressing four keys on the same MR-compatible button box that was used to create the stimulus clips concurrently with the actions presented on the screen. The conditions were counterbalanced within and between subjects. Instructions were given both verbally and visually prior to each run.

Image acquisition and data analysis

Scanning was performed on a Siemans 3 Tesla MAGNETOM Trio high speed imaging device scanner equipped with a 12-channel head-coil with an attached mirror for stimulus presentation. Cushioned head stabilizers were used to minimize participant head movement. 176 high-resolution images were acquired using Siemens' MPRAGE pulse sequence (TR, 1900 ms; TE, 2.53 ms; FOV, 250 mm; voxel size, 1 mm × 1 mm × 1 mm) and used for coregistration with functional data. Whole brain functional images were acquired using a T2*-weighted Echo Planar (EPI) sequence sensitive to BOLD contrast (TR, 2000 ms; TE, 40 ms; voxel size, 3.0 × 3.0 × 4.2 mm; flip angle = 90°).

FMRI data preprocessing was carried out using FEAT (fMRI Expert Analysis Tool) version 5.98, part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). Head motion was detected by center of mass measurements, and no participant had greater than 3-mm deviation in the center of mass in the x-, y-, or z-dimensions. Pre-statistics processing included motion correction using MCFLIRT (Jenkinson, Bannister, Brady & Smith, 2002) and non-brain area removal using BET (Smith, 2002). The functional data were spatially smoothed with an isotopic Gaussian kernel (5mm).

The primary analysis consisted of a random-effects assessment of the difference between same-race and other-race observation and imitation at the peak of the hemodynamic response (HDR). This analysis consisted of the following steps: 1) The epoch of image volumes beginning 2 seconds before and 14 seconds after the onset of each clip was excised from the continuous time series of volumes. 2) The average intensity was computed from 6-10s post-stimulus onset for each condition. For each individual subject, a t-statistic was computed at each voxel within the brain to quantify the HDR differences among the conditions. 3) The individual t-maps were subjected to a random-effects analysis to assess the difference across-subjects. To reduce the number of statistical comparisons, the results of the random-effects analyses computed above were then restricted to only those voxels in which a significant HDR was evoked by imitation and observation, collapsed across race. For this analysis, we thresholded our activation at a False Discovery Rate (FDR; Genovese, Lazar & Nichols, 2002) of .05, imitation ($t_{(19)} > 2.25$), observation ($t_{(19)} > 2.73$). The voxels with significant HDRs were identified in the following steps: (4) The single-trial epochs for each subject were averaged separately for each condition and the average BOLD-intensity signal values for each voxel within the averaged epochs were converted to percent signal change relative to the prestimulus baseline. (5) The time waveforms for each voxel were correlated with a canonical reference waveform and t- statistics were calculated for the correlation coefficient for each voxel. This procedure provided a whole=brain t-map in MNI space. We identified active voxels as those that surpassed the FDR threshold for both imitation and observation. (6) The difference t-map computed in step 3 was then restricted to only those voxels that passed threshold.

Results

Both imitation and observation trials evoked broad areas of the brain, including the inferior frontal gyrus, ventral premotor cortex, inferior parietal lobule, and posterior superior sulcus, replicating previous findings (e.g. Rizzolatti & Craighero, 2004;

Pelphrey, Morris & McCarthy, 2004). These results can be seen in Figure 15.

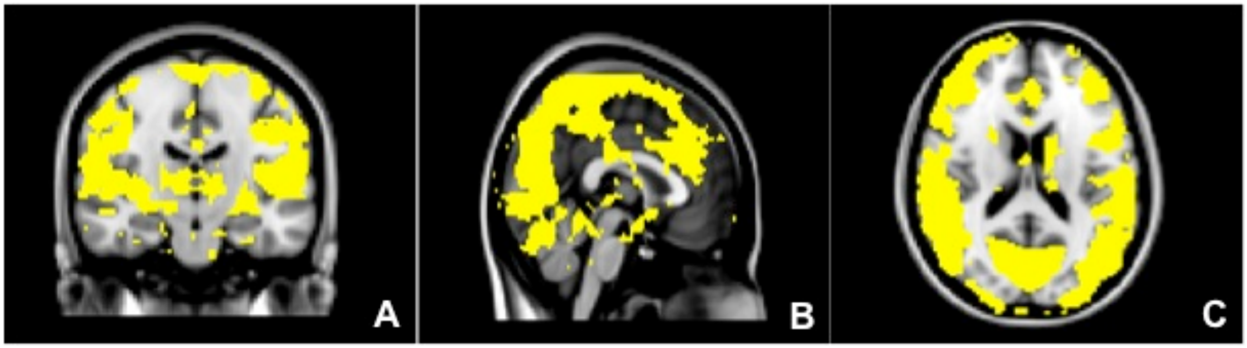

Figure 15. Areas activated by both observation and imitation, collapsing across race. A) Coronal slice, B) Sagittal slice, and C) Horizontal slice, MNI coordinates: X=45, Y=54, Z=45

I examined the areas in which there were differences in activation based on actor race ($q=.05$, $t_{(19)} > 3.64$). For both the imitate and observe conditions, five clusters were found which showed significantly higher peak activation while observing and imitating White relative to Black actors. These results are shown in Figure 16.

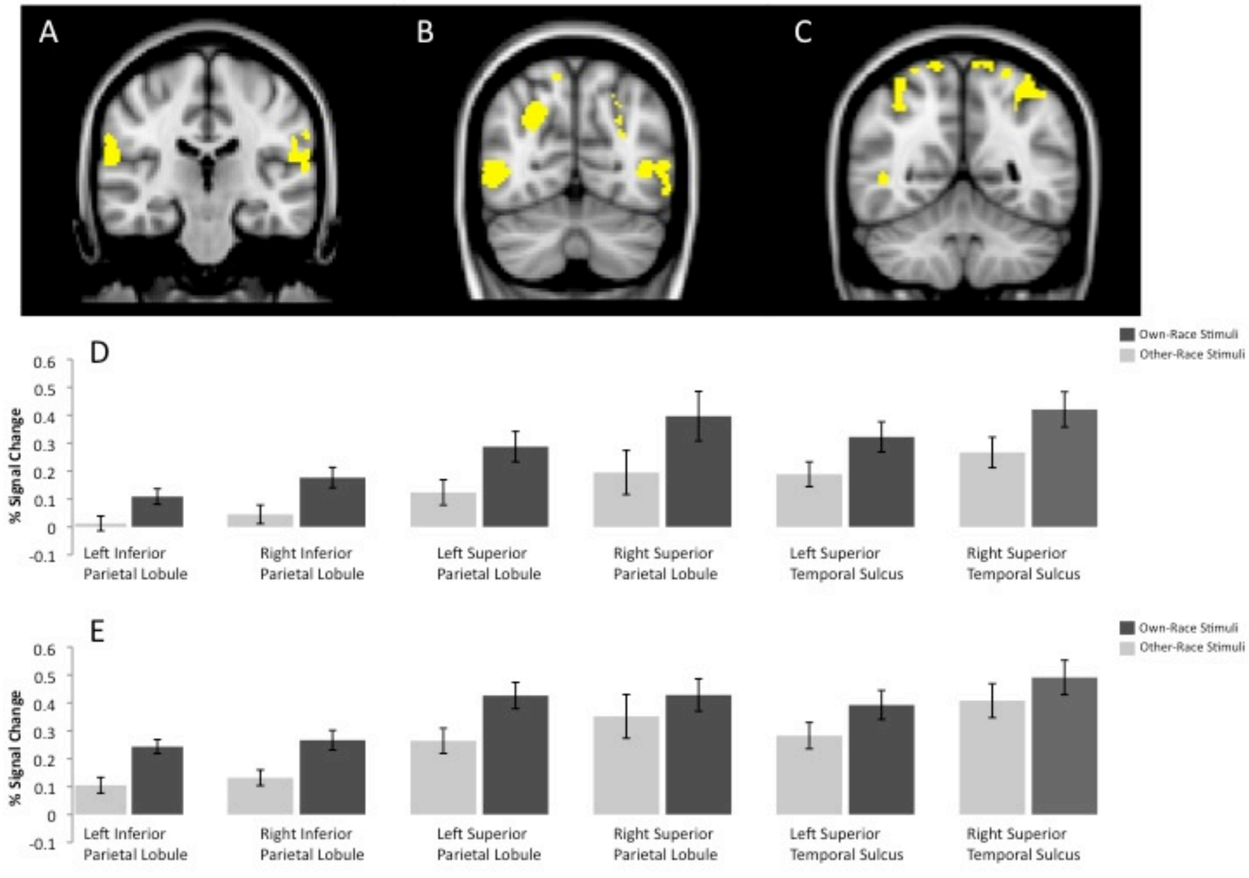

Figure 16. A) Areas of the bilateral IPL where imitation and observation evoked increased activation for own-race relative to other-race stimuli. B) Areas of the bilateral STS where imitation and observation evoked increased activation for own-race relative to other-race stimuli. C) Areas of the bilateral SPL where imitation and observation evoked increases activation for own-race relative to other-race stimuli. D) Percent signal change for bilateral IPL, STS, and SPL while observing own- and other-race stimuli. E) Percent signal change for bilateral IPL, STS, and SPL while imitating own- and other-race stimuli.

A 2 (actor race: black/white) X 2 (condition: imitate/observe) repeated measures ANOVA was conducted on each area. Panel A shows the differences in the right IPL (MNI coordinates x =58, y=-26, z=28), race F(1,19),= 42.255, p<0.001, condition F(1,19) = 22.382, p<0.001 and left IPL (MNI coordinates, left: x=-58, y=-30, z=26), race F(19)=30.192, p<0.001, condition F(1,19)=28.279, p<0.001. Panel B shows the differences in the right STS (MNI coordinates x=46, y=-68, z=2), race F(1,19)=29.103,

$p<0.001$, condition $F(1,19)=18.331$, $p<0.001$, and left STS (MNI coordinates x=-46, y=-72, z=4), race $F(1,19)=32.943$, $p<0.001$, condition $F(1,19)=12.284$, $p<0.01$. Panel C shows the differences in the left SPL (MNI coordinates x=-30, y=-46, z=44), race $F(1,19)=25.298$, $p<0.001$, condition $F(1,19)=15.649$, $p=0.001$. No areas were found in which higher activation was evoked for Black relative to White actors.

Discussion

In this study, I have extended the effects of race on perception by demonstrating that regions of the neural action observation/imitation network show differential activation based on stimulus race. Using a simple imitation paradigm in which the race of the model actor was manipulated, differential activation was found in three of the key areas of the previously defined action observation/imitation network: the IPL, the SPL, and the STS. Each of these regions has been shown to be involved in action observation, imitation and social interactions and is thought to have a unique function. Both the IPL and SPL are involved in spatial orientation and goal-directed preparation (Salmi, Rinne, Degerman, Salonen & Alho, 2007). The SPL is involved in maintaining an internal representation of one’s bodily state (Wolpert, Goodbody & Husain, 1998). The right IPL is active when one mentally simulates the actions of another person (Ruby & Decenty, 2001) and adopts another’s perspective (Ruby & Decenty, 2003). Interestingly, direct cortical simulation of the right IPL in neurological patients induces the experience of dissociation of self from the body, or an “out-of-body experience” (Blanke, Ortigue, Landis, & Seeck, 2002). The STS is associated with active representation of the correspondence between the one’s own and other’s actions (Molenberghs, Brander, Mattingley & Cunnington, 2010). The STS has been shown to be associated with a variety of social functions. It has been posited that the STS is the host brain region for theory of mind and social perception (Saxe, 2006; Zibovicious, Meresse, Chabane, Brunelle, Samson, & Boddaert, 2006; Gallagher & Frith, 2003), biological motion processing (Puce & Perrett, 2003; Allison, Puce & McCarthy, 2000), and is involved in the context-specific (e.g. goal- or non-goal-directed) analysis of the intentions of others' actions (Pelphrey, Morris & McCarthy, 2004). The current study is the first to show that each of these regions is sensitive to race-related features when imitating and observing the actions of others.

It is important to note that not every region involved in the previously defined action observation/imitation network showed differential activation based on stimulus race. Rather, several regions, specifically the bilateral STS, bilateral IPL, and right SPL are sensitive to race-related features when observing and imitating the actions of others. This suggests that each region may serve a unique role in observing and imitating the actions of others, and only specific regions are sensitive to cues of physical similarity between the self of the observed other.

It has been proposed that the shared neural circuitry between action and observation stems from embodied simulation of observed biological motion (Gallese, 2009). Indeed, it has been demonstrated that the more similar an observed action is to the way the observer would perform the action, the higher the activation in the neural action observation network. For example, higher neural activation in these areas is found when dancers viewed movements that they had been trained on relative to movement they had not (Calvo-Merino, Glaser, Grezes, Passingham & Haggard, 2005). This gives evidence that actions are simulated by the observer, but does not address whether perceived similarity between the actor and observer impacts this ability to simulate. Gutsell and Inzlicht addressed this issue and found differential perception-action coupling based on group membership. Using electroencephalography (EEG), differential mu rhythm suppression was shown during action observation based on the race of the observed actor, giving evidence of group effects on shared neural circuitry (Gutsell & Inzlicht, 2010). The current study supports this finding, showing that the similarity between the observed actor and the self can impact embodied simulation, and is the first to show the specific neural areas involved in this effect.

The impacts of race on the processing of others have been well documented in the face recognition literature. However, social interactions involve more than just the ability to accurately identify faces. The ability to understand the actions and intentions of others seems to be rooted in a co-opted system by mapping observations onto one's motor repertoire (Uddin, Iacoboni, Lange & Keenan, 2007). We have now shown that this mapping, much like accurate face recognition, is dependant upon perceived similarity of the self and others.

In sum, this experiment found differential activation of the action observation and imitation network based on stimulus race. The results show higher activation in the left SPL, bilateral IPL, and bilateral STS for own-race imitation relative to other-race imitation. This finding demonstrates the importance of perceived group membership during biological motion perception.

Chapter 6

6 General Discussion and Conclusions.

6.1 Summary of studies.

The aim of this dissertation was to examine how perceiving another to be similar to the self impacts the processing of others. In a series of experiments, I demonstrated that both physical and non-physical cues group membership cues impact the processing of others. In Experiment 1, I found that both the physical cue of race and the non-physical but relevant cue of team membership impact face processing, but do so at different stages. In Experiment 2, I found that a variety of foreign accents presented prior to face encoding did not impact processing. Experiment 3 found that although non-physical, malleable grouping cues do impact very early stages of face processing, race certainly matters and is not “overridden”. Finally, in Experiment 4 I extended the research beyond face recognition and showed that perceived group membership impacts biological motion perception while observing and imitating the actions of others. The specific findings for each study are discussed below.

Experiment 1 demonstrated two key findings: first, motivation can impact face processing at very early stages, prior to what has been suggested is the earliest that the structure of a face is encoded. The majority of studies assessing face processing have focused on the N170 component, occurring approximately 170ms after the face has been presented. It has be suggested, and generally accepted, that the N170 is the first component that is sensitive to face processing. Few studies have demonstrated that the earlier P100 component is also sensitive to face processing. This experiment not only demonstrated the P100 sensitivity to faces, but also showed that this sensitivity is reflective of motivated perception. Second, relevant, non-physical grouping cues do impact face processing; however, these cues do not “override” the effects of race. Rather, the effects of race occur at later stages of processing.

The results of Experiment 2 were inconclusive. The primary aims of Experiment 2 were to assess 1) whether accent is an effective grouping cue, and 2) whether detection of a grouping cue prior to see a face impacts face processing. As the accent manipulation was ineffective in eliciting perceived group membership, this experiment was unable to examine the second aim. However, I addressed this shortcoming this in Experiment 3.

Experiment 3 demonstrated that knowledge of group membership impacts subsequent face processing, and that physical and non-physical cues interact during early stages of encoding. The aims of Experiment 3 were to examine 1) how faces are processed prior to detection of the relevant grouping cue, 2) whether detection of a grouping cue prior to seeing a face impacts face processing, and 3) the differences in ERP components between original encoding and subsequent recognition of faces. The results indicate that, when one knows that a processed face is either an in-group or out-group member on a relevant dimension, but does not know which, there are no differences in very early processing based on the race of the face. However, knowledge of group membership prior to seeing a face does impact processing. Specifically, when one expects the face to be an in-group member and then an out-group cue is detected (such as other-race), there is a switch in early face processing strategy reflected by an increase in P100 amplitude for the other-race face relative to the own-race face. The opposite pattern is observed when one expects the face to be an out-group member and then an in-group cue is detected. The modulation of P100 amplitude, likely indexing degree to strategic shift, is also correlated with the ability to accurately categorize the faces as in-group or out-group members. The amplitude of the P100 and N170 components, and how these amplitudes are modulated by group membership, is different during encoding relative to retrieval. This is an important distinction to make, given that previous research, which has generally focused on the N170 component, either measured this component during recognition or did not specify whether the component peak amplitude was averaged across both encoding and recognition. This experiment is the first to show the important distinction between the two. Early processing during encoding, rather than recognition, is correlated with behavior.

Finally, Experiment 4 extended previous research beyond face recognition to a second core tenant of social perception. There has been much research on the effects of perceived group membership in behavior, such as increased liking (Tajfel, 1970) and empathy (Johnson, Simmons, Jordan, Maclean, Taddei, Thomas, Dovidio, & Reed, 2002). However, the overwhelming majority of studies assessing the underlying brain activation while participants are presented with in- and out-group members have focused on face recognition. It is important to assess the impacts of group membership beyond face recognition, as interactions with others involve more than just face processing. Biological motion perception is also a core social perceptual process; social interaction involves representing the actions and intentions of others (e.g. Frith & Frith, 2001). Experiment 4 showed that biological motion perception, specifically the imitation and observation of motions, is differentially processed based on the perceived race of the witnessed individual.

6.2 Addition to the In-group/Out-group model of face processing.

Three of the studies presented in this experiment examined the effects of group membership cues on face processing. As discussed in Chapter 1, there are two models of face recognition that attempt to explain the ORE. The perceptual expertise model posits that differences in recognition accuracy for own- and other-race faces can be accounted for by differences in individuals' expertise in face processing acquired throughout a lifetime. Alternatively, the social categorization model posits that differences in recognition accuracy stem from inefficient processing strategies for out-group members after detection of an out-group cue. Previous research using ambiguous-race faces (MacLin and Malpass, 2001), and minimal group paradigms (e.g. Van Bavel et al., 2008) has demonstrated that perceptual expertise cannot fully account for the ORE. The results of Experiments 1 and 3 support the conclusion that perceptual expertise cannot fully account for the ORE. However, Sporer's (2001) model assumes that the default mode of face processing is that of in-group members, and that out-group detection leads to poor processing strategies, resulting in a decrease in recognition accuracy for out-group members. The experiments presented in this dissertation add to and alter the model in the following ways: 1) rather than detection of an out-group cue leading to a switch in processing strategy, detection of an in-group cue results in increased motivation, which then leads to increased recognition accuracy, and 2) the detection of a grouping cue can occur prior to face detection, and impact subsequent processing. Multiple grouping cues can interact and the sequence of detection of physical and non-physical cues is an important factor in face processing and subsequent recognition. For the additions to the model, see Figure 17.

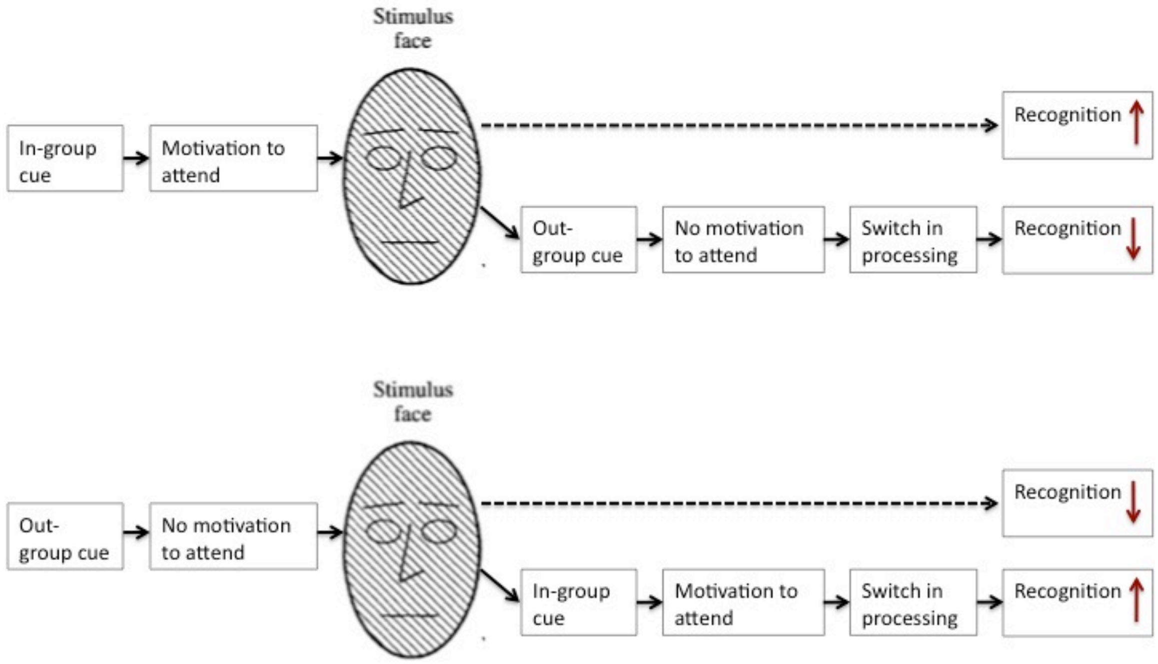

Figure 17. A revised version of Sporer's (2001) in-group/out-group model of face processing that includes how faces are processed when grouping cues are known prior to face detection

6.3 Future Research.

The studies presented in this dissertation have extended the scientific knowledge of the effects of perceived group membership in many ways. Additionally, these findings have opened the door for many potentially useful and enlightening future studies. It is possible that the null results found in Experiment 2 were due to the heterogeneity of the accent stimuli. Therefore, future research is needed to assess whether accent is an effective indicator of group membership when multiple accents from a specific region are presented.

Experiments 1 and 3 demonstrated that both physical and non-physical grouping cues impact early stages of face processing. In Experiment 3, I showed that the preparation to encode an in-group member resulted in a shift in processing when an out-group cue is then detected. Additionally, this shift was correlated with the ability to accurately categorize the faces in a subsequent task. It would be interesting to assess whether non-physical, malleable cues would result in a similar effect. For example, if one was prepared to encode an other-race face and then the presented individual had an own-university cue such as a hat, would a shift in processing strategy occur? Additionally, if one were prepared to encode an individual based on a non-physical cues such as religious affiliation, and then was presented with an out-group cue such as political affiliation, would it result in a detriment to subsequent recognition?

It would also be interesting to see both state level and trait level characteristics could play into this effect. For example, if a person is depressed or constantly feels judged and is presented with faces of judging or accepting looks, will there be a P100 amplitude spike for accepting faces? Or if participants were primed with negative affective stimuli, would a shift in processing occur for positive faces?

Finally, Experiment 4 demonstrated that detection of racially relevant features impacts biological motion perception. However, it is still unclear whether the same discrepancies would occur for detection of non-physical cues. To specify, it is possible that own-race motion is observed and imitated with greater ease based on perceived similarity to one's own movements, a "that hand looks like my hand and therefore it there is more overlap between my own movements and watching the movements of that other individual" effect. Alternatively, it is possible that any grouping cue would impact biological motion processing, given the perceived similarity based on the cue between the actor and the observer. Future research is needed to distinguish between these two possibilities.

6.4 Conclusion.

In conclusion, this dissertation demonstrated that 1) although physical and non-physical grouping cues may result in similar behavioral discrepancies, the processing differences occur at different stages, 2) knowledge of group membership prior to face processing impacts very early stages of processing, while knowledge that a relevant non-physical cue is yet to be detected results in similar processing across racial group membership, and 3) the effects of group membership extend beyond face recognition and impact the processing of biological motion.

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