Thatcherization impacts the processing of own-race faces more so than other-race faces: An ERP study

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Thatcherization impacts the processing of own-race faces more so than other-race faces: An ERP study

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It has been suggested that differential use of configural processing strategies may underlie racially based recognition deficits (known as the “other-race effect”). By employing a well-known configural manipulation (Thatcherization, i.e., rotating the eyes and mouth by 180°), we aimed to demonstrate, electrophysiologically, that configural processing is used to a greater extent when viewing same-race faces than when viewing other-race faces. Face-related event-related potential (ERP) responses were measured for participants viewing normal and Thatcherized faces of their own race (Caucasian) and of another race (African-American). The P1 and N170 components were modulated to a greater extent by Thatcherization for same-race faces, suggesting that the processing of these faces is, in fact, more reliant on configural information than other-race faces. Thatcherization also affected the P250 component more so for same-race faces independently of orientation. The race-dependent effects of Thatcherization as early as P1 suggest that configural encoding may be occurring much earlier than the well-cited N170.

Keywords: N170; P100 (P1); Thatcher; Race; Holistic processing.

For many, the faces of one’s own race are easier to recognize than faces of another race (Chiroro & Valentine, 1995; Malpass & Kravitz, 1969; Meissner & Brigham, 2001; Walker & Hewstone, 2006). This phenomenon, known as the “other-race effect,” has been demonstrated in a number of studies using behavioral paradigms (e.g., Bothwell, Brigham, & Malpass, 1989; Brigham & Malpass, 1985; Michel, Rossion, Han, Chung, & Caldara, 2006b; Tanaka, Kiefer, & Bukach, 2004; Walker & Tanaka, 2003). More recent work utilizing eye-tracking (e.g., Blais, Jack, Scheepers, Fiset, & Caldara, 2008; Levin, 2000), functional imaging (Cunningham et al., 2003; Cunningham et al., 2004; Golby, Gabrieli, Chiao, & Eberhardt, 2001; Hart et al., 2000), and electrophysiological measures (Ito & Urland, 2003, 2005; James, Johnstone, & Hayward, 2001; Walker, Silvert, Hewstone, & Nobre, 2008) has indicated that own-race bias in recognition rates may be the result of differential face processing based on race.

The expertise theory posits that this differential processing is the result of increased exposure to faces of one’s own race; specifically, it has been suggested that when viewing own-race faces, observers are better able to extract configural information about the spatial relations between individual facial features (Diamond & Carey, 1986; Lindsay, Jack, & Christian, 1991; Rhodes, Brake, Taylor, & Tan, 1989). Conversely, a lack of expertise with other-race faces may result in reduced ability to encode this configural information and a greater need to rely on featurally based processing strategies, thus affecting processing and recognition abilities (Michel, Caldara, & Rossion, 2006a; Michel, Rossion, Han, Chung, & Caldara, 2006b; Tanaka et al., 2004).

1Also referred to as the “own-race bias”, “own-race effect,” or “own-race advantage.”

2The expertise theory is also referred to as the “contact theory” in some literature.
Configural manipulations, such as the well-established face inversion effect, have been invaluable for investigating the mechanisms underlying face processing. In contrast to non-face objects, faces are significantly more difficult to process and recognize when inverted (Freire, Lee, & Symons, 2000; Rossion et al., 2000; Yin, 1969). Processing deficits following face inversion are thought to be due to configural disruption—that is, disruption of the ability to process features configurally or holistically (Farah, Tanaka, & Drain, 1995; Young, Hellaowell, & Hay, 1987)—because the configuration of individual features is processed in an orientation-specific manner (Oram & Perrett, 1992; Perrett, Heitanen, Oram, & Benson, 1992). For example, when a face is inverted, the horizontal and vertical distances between the eyes and nose are no longer apparent, because the eyes are no longer above the nose and mouth (Goffaux & Rossion, 2007). Recognition rates for faces are disproportionately impaired, because we rely on configural processing to a greater extent when viewing faces than when viewing non-face objects. Another commonly used manipulation of configural information is Thatcherization (Thompson, 1980), in which the eye and mouth regions of a face are rotated by 180°, resulting in a grotesque appearance. This grotesqueness is reduced by inversion, implying that role of configural information in the phenomenon (Bartlett & Searcy, 1993; Boutsen & Humphreys, 2003; Boutsen, Humphreys, Praamstra, & Wartrick, 2006).

These techniques have also shed light on the other-race effect. Previous behavioral work utilizing the inversion effect (Rhodes, Brake, Taylor, & Tan, 1989; Vizzioli, Foreman, Rousselet, & Caldara, 2010) and the Thatcher effect (Murray, Rhodes, & Schuchinsky, 2003) has demonstrated that configural disruptions are stronger for same-race faces than other-race faces, suggesting that configural processing strategies are utilized to a greater extent for faces of one’s own race. Moreover, the relative contribution of configural and featural processing changes as a function of experience during development (Carey & Diamond, 1977), and expertise in identifying specific objects (Gauthier & Tarr, 1997), indicating that experience plays an important role. The other-race effect has been shown to develop as a function of age, with adults demonstrating a clear bias for recognizing own-race faces that is absent in children (Chance, Turner, & Goldstein, 1982; Goodman et al., 2007). These findings suggest that experience with own-race faces is responsible for the development of differential processing strategies. Most notably, other-race studies using part (featural) versus whole (configural) recognition paradigms have also shown that individuals living in an other-race environment can develop the expertise necessary to use configural processing strategies similar to when viewing faces of their own race (Tanaka et al., 2004).

Electroencephalography (EEG) is a valuable tool for investigating the neural basis of face processing and expertise. A growing number of studies have revealed several “face-related,” event-related potential (ERP) components typically centered over occipitotemporal scalp locations that include the P100 (P1), N170, P250 (P2), and late positive component (LPC) (Bentin, Allison, Puce, Perez, & McCarthy, 1996). The early components (i.e., P1 and N170) reflect the structural encoding stage of face processing, while later components (i.e., P250 and LPC) reflect stimulus categorization and/or attention to motivationally relevant information (e.g., race, gender, identity). These components can be affected by facial manipulations such as inversion, contrast reversal, and other configural alterations (Bentin et al., 1996; Eimer, 1998, 2000a, 2000b; Itier, Herdman, George, Cheyne, & Taylor, 2006; Itier & Taylor, 2002, 2004; Linkenkaer-Hansen et al., 1998). The P1, P2, and LPC components are not considered face-specific because their peak amplitude and latencies typically do not differ between faces and other objects (cf. Itier & Taylor, 2004). However, they are still of interest in understanding the neural basis of face processing.

The early P1 component (100–150 ms) is sensitive to the physical characteristics of stimuli, particularly low-level visual properties such as luminance and contrast (Halgren, Raji, Marinkovic, Jousmaki, & Hari, 2000; Rebai, Poiroux, Bernard, & Lalonde, 2001; Rossion, Joyce, Cottrell, & Tarr, 2003), and may be modulated by affective responses to stimuli (Halit, de Haan, & Johnson, 2000; Pizzagalli, Regard, & Lehmann, 1999; Pizzagalli, Lehmann, Koenig, Regard, & Pascual-Marqui, 2000; Pizzagalli et al., 2002). Although not considered face-specific, the P1 has been shown to be sensitive to facial manipulations such as inversion and contrast reversal (Jacques & Rossion, 2007; Itier & Taylor, 2002, 2004; Linkenkaer-Hansen et al., 1998). Itier and Taylor (2004) argue that the P1 likely reflects the holistic processing of a face as a face while the “face-specific” N170 is involved in processing specific face configuration (i.e., the spatial relations between individual features).

Of particular interest is the “face-specific” N170. This negative deflection reaches peak amplitude

3Note that these components exist for non-face stimuli as well. As such, they are not considered to be face-specific, but rather indices of visual processing.
approximately 150–200 ms post-stimulus, and is consistently larger in amplitude to faces than to other objects (Bentin et al., 1996; Bötzel, Schulze, & Stodieck, 1995; McCarthy, Puce, Belger, & Allison, 1999). On the basis of its sensitivity to inversion, it has been suggested that the N170 reflects a structural encoding stage of face processing (Eimer, 2000a).

The N170 component seems to be particularly sensitive to configurational disruptions, suggesting that it may act as an index of configural processing. Inversion has been demonstrated to increase the amplitude and delay the latency of the N170 (Bentin et al., 1996; Rebai et al., 2001). It is possible that increased N170 amplitude may represent an increase in the difficulty of extracting the configural information from a face. Similarly, delays to the N170 latency may reflect the increased time necessary to successfully process the altered stimulus. It is also possible that these N170 responses are not face-specific, but are due to increased experience with a class of visual objects (i.e., faces). For example, in trained greeble experts, viewing greebles results in a larger N170 response and can interfere with the N170 to faces when faces and greebles are presented together (Rossion, Kung, & Tarr, 2004), suggesting that the N170 may be expertise-specific rather than face-specific.

The late occurring ERP components reflect a more meaning-based processing of visual stimuli. The P250 component (230–300 ms) is related to semantic processing of face (and other) stimuli and likely reflects higher-level processing such as familiarity (Marzi & Viggiano, 2006). The LPC (300–600 ms) is also involved in higher-order processing and may reflect attentional (Ashley, Vuilleumier, & Swick, 2004), emotional (Eimer & Holmes, 2002; Schutter, de Haan, & van Honk, 2004; Werheid, Alpay, Jentzsch, & Sommer, 2005), or aesthetic (Höfels & Jacobsen, 2007; Johnston & Oliver-Rodriguez, 1997; Oliver-Rodriguez, Guan, & Johnston, 1999) responses to stimuli.

Evidence from several ERP studies suggests that Thatcherization impacts the face-related ERP components, and that the N170 component, in particular, is susceptible to this face-distortion technique (Boutsen et al., 2006; Carbon, Schweinberger, Kaufmann, & Leder, 2005; Milivojevic, Clapp, Johnson, & Corballis, 2003). However, this type of distortion may have broader effects than those well documented in the N170 literature. Milivojevic et al. (2003) found that the P1 component was also modulated by Thatcherization. Both P1 and N170 amplitudes were significantly larger for Thatcherized faces than normal faces. Boutsen et al. (2006) compared the effects of Thatcherization on a range of stimulus classes (faces, houses, and chairs). Although an inversion effect occurred for P1 amplitude (face stimuli only), there was no Thatcher effect. The amplitude and latency of the N170 were both modulated by Thatcherization. The exact nature of the relationship between Thatcherization and P1 modulation remains to be determined.

Because of its sensitivity to configural processing, the N170 may provide insight into the neural underpinnings of the other-race effect. While behavioral studies have yielded relatively consistent findings with respect to the other-race effect, ERP studies of the N170 have provided conflicting results. Halit et al. (2000) demonstrated that the N170 component was larger (in amplitude) for atypical faces than typical faces (faces were made to look “atypical” by vertically stretching the face and distorting its appearance). Since other-race faces are more atypical to observers than faces of their own race, it seems the N170 should be larger in amplitude for other-race faces. In support, several studies have demonstrated an increased N170 amplitude for other-race faces (Herrmann et al., 2007; James, Johnstone, & Hayward, 2001; Stahl, Wiese, & Schweinberger, 2008; Walker et al., 2008). However, the N170 has also been demonstrated to increase as a result of expertise (Rossion et al., 2000), suggesting that the N170 should be larger for same-race faces than other-race faces since we are “experts” with our own race. A number of studies have, in fact, demonstrated larger N170 amplitudes in response to same-race faces as compared to other-race faces (Caldara et al., 2003; Itô & Urdland, 2005; Tanaka & Curran, 2001). There is yet a third class of ERP studies that have demonstrated that the N170 is not race-sensitive (Caldara et al., 2002; Caldara, Rossion, Bovet, & Hauert, 2004). To date, the mechanisms by which race may modulate the N170 response remain unclear.

In the present study, we aimed to demonstrate that configural processing strategies are utilized to a greater extent for own-race faces than other-race faces, by measuring the effect of Thatcherization electrophysiologically. Because the N170 response is modulated by expertise, we hypothesized that the change in the N170 response following Thatcherization (i.e., configural disruption) would be larger for same-race faces than other-race faces, thus supporting the expertise theory of the other-race effect. Previous studies have shown the N170 amplitude both to increase (Milivojevic et al., 2003) and decrease (Boutsen et al., 2006) following Thatcherization. We predicted that the magnitude

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4Greebles are a class of novel stimuli that have been utilized to investigate the role of expertise and configural processing in face perception studies because, like faces, they have a number of small components arranged in a common configuration.
of change in terms of N170 peak amplitude would be larger for same-race than other-race faces, regardless of the direction of this change. The P1 response was predicted to be affected by low-level stimulus characteristics of our displays (e.g., brightness), but was unlikely to be affected by expertise or Thatcherization (Stahl et al., 2008). Halit et al. (2000) found differences in the P250 response when comparing typical to atypical faces. Their atypical faces were created by altering the spatial configuration of “normal” faces, suggesting that Thatcherization could have an impact on P250 amplitudes. However, we did not anticipate an interaction between race and Thatcherization for the P250.

**METHOD**

**Participants**

Nineteen students from Western Washington University (12 female) were recruited from an introductory psychology subject pool to participate in the present study. Volunteers received course credit and were recruited on the basis that they were of Caucasian descent and had been raised by Caucasian parents. All participants were between 18 and 25 years of age and reported right-handedness as well as normal or corrected-to-normal vision. Prior to taking part in the study, all participants gave informed, written consent.

**Measures**

A racial contact survey, the Social Experience Questionnaire (SEQ), developed by Brigham and colleagues (J. Brigham, personal communication, 23 January 2009), was used as a measure of other-race contact. The SEQ contains 56 questions pertaining to level of contact with African-Americans across various stages of the life span (including business setting, personal settings, and intimate settings). The SEQ assesses both the extent and quality of interactions with members of another race. Participants completed the entire three-part questionnaire; however, only the general information section of the SEQ was used for data analysis because this section deals only with amount of contact. Scores for this section of the survey can range from 0 (no contact) to 9 (very high levels of contact) and are calculated by the average response across all questions.

**Stimuli**

Stimuli consisted of 28 digitally manipulated color photographs of human faces. Photographs of 14 Caucasian (same-race) faces (7 female) and 14 African-American (other-race) faces (7 female) were obtained from the CAL/PAL Face Database (Minear & Park, 2004). All faces obtained were classified as emotionally neutral (visible teeth are not necessary to produce the Thatcher Illusion; Lewis & Johnston, 1997). The 28 original photographs were edited with Adobe Photoshop. Each image was cropped to 349×437 pixels and included the person’s face and neck. The backgrounds were all replaced with a solid white background. Each of these newly manipulated photographs was used to create four different test conditions: normal upright, normal inverted, Thatcherized upright, and Thatcherized inverted (Figure 1). Thatcherizing the digital images consisted of rotating the eyes and the mouth by 180° and then blending the manipulated regions to ensure that they appeared to be a natural part of the face. Because the Thatcher illusion is orientation-dependent, the inverted condition was included as a control to verify the illusion. In total, 112 different test faces were used. These consisted of 28 faces of each race. Each of these faces was presented both as Thatcherized and as normal, and each of these was presented both upright and inverted.

![Figure 1. Example stimuli in normal and thatcherized versions.](Image)
**EEG apparatus, recording, data processing, and analysis**

Stimuli were presented in full color on a 19-inch Dell LCD monitor. Stimulus presentation and response recording were controlled by in-house software written in Visual Basic. All responses were made with a Cedrus 8-button box (Cedrus Corporation, San Pedro, CA, USA). EEG was continuously recorded from 64 scalp sites, using BioSemi ActiveTwo Ag/AgCl electrodes and hardware (Biosemi, Amsterdam, The Netherlands). The electrodes were placed according to the 10-5 electrode system (Oostenveld & Praamstra, 2001), using a nylon electrode cap. EEG signals were amplified with a bandpass of DC-104 Hz by BioSemi Active-Two amplifiers, sampled at 512 Hz. Off-line segmentation and averaging of EEG signals was performed with EEGLab v6.01b, running on Matlab 7.3.0 (Mathworks, Inc., Natick, MA, USA). In a small number of cases, a single channel demonstrated excessive noise and was replaced by a new channel derived by spherical interpolation of the surrounding channels. Data were then filtered by a high-pass of 1 Hz and a low-pass of 12 Hz. The continuous EEG recording was segmented into epochs extending from −100 to 500 ms around the onset of each stimulus. Trials containing artifacts were detected by the EEGLab automatic epoch rejection tool and visually confirmed by us before removal. Trials with values outside of the range −40 to +40 μV were rejected.

Visual inspection of the grand-averaged visually evoked responses indicated that electrodes PO7, PO8, P8, P6, P9, and P10 best demonstrated the classic face-related potentials (including the P1, N170, P2, and LPC) and showed maximum peak N170 amplitudes (Figure 2). The occipital temporal location of face-specific ERPs is in keeping with extensive previous literature (Bentin et al., 1996; Caldara et al., 2002, 2004; Carbon et al., 2005; Eimer, 2000a, 2000b; Stahl et al., 2008), and, as such, all further analysis was restricted to these six electrode sites. Dependent measures of the neural response were the average N170 amplitude and latency for each of the 19 participants across each of the six electrode sites.

**Procedure**

Participants first completed the SEQ survey. Prior to completing the experimental trials, participants were given a practice task consisting of five Thatcherized and five normal faces in order to familiarize them to the experimental task. Participants were instructed to...
rate each face in terms of the bizarreness or grotesqueness of its appearance. Because Thatcherization causes a face to appear bizarre or grotesque, these grotesqueness ratings can be interpreted as an index of the configural disruption caused by Thatcherization. Participants were also asked to refrain from blinking or making any extraneous movements while viewing photographs.

EEG data were collected over three blocks. Within a block, each of the 112 faces was presented twice (for a total of 224 trials per block). Each trial began with the presentation of a black fixation cross at the center of the screen on a gray background for 1500 ms. A face then appeared in the center of the screen for 1000 ms. The face was then removed from the screen and replaced by the rating task. Participants were given 5000 ms to rate its “grotesqueness” on a 5-point Likert scale, where 1 corresponded to “not at all grotesque” and 5 corresponded to “very grotesque,” by pressing the corresponding key on a response box. A trial ended when a rating was made. Trials were separated by a 1000-ms interstimulus interval. Participants were given a short (1–2 min) break between blocks.

RESULTS

Other-race expertise

Although the possible range of scores on the general information section of the SEQ ranged from 0 to 9, participants’ contact scores ranged only from 0.12 to 5.76 (M = 2.28, SD = 1.43), with only one participant scoring above the midpoint (i.e., 5); this indicates that all participants had little or no experience with African-Americans.

A positive relationship was anticipated between average contact score and the grotesqueness rating scores for the other-race, Thatcherized, upright faces. However, the correlation between average contact score on the SEQ and grotesqueness rating was not significant, r(19) = .202, p = .204. This finding is consistent with Ng and Lindsay (1994) and is likely due to the limited range of contact scores obtained in the present data set.

Grotesqueness ratings

A within-subject ANOVA was carried out on the grotesqueness ratings with factors of Race, Thatcherization, and Orientation. Grotesqueness ratings were affected by Race, F(1, 18) = 6.03, p = .024, MSE = 0.072, ηp² = .25; Thatcherization,

\[ F(1, 18) = 192, p < .001, MSE = 0.307, ηp² = .91; \]

and Orientation, F(1, 18) = 10.3, p = .005, MSE = .233, ηp² = .36. Orientation interacted with both Race, F(1, 18) = 10.8, p = .004, MSE = 0.025, ηp² = .38, and Thatcherization, F(1, 18) = 26.9, p < .001, MSE = 0.225, ηp² = .60. Inversion resulted in a larger decrease in overall grotesqueness rating for other-race faces than it did for same-race faces. Similarly, inversion effects were only apparent in the Thatcherized condition, while non-Thatcherized faces received similar grotesqueness ratings regardless of Orientation. There was no interaction between Race and Thatcherization, F(1, 18) < 1, p = .718, MSE = 0.023, ηp² = .01, suggesting that Thatcherization had an equal impact, overall, on same- and other-race faces. As predicted, a three-way interaction occurred, F(1, 18) = 11.0, p = .004, MSE = 0.019, ηp² = .38. However, as Figure 3 demonstrates, the direction of this interaction was counter to our original prediction; Thatcherization, in the upright condition, had a greater effect on other-race faces, rather than same-race faces.

The P1 component

P1 peak amplitudes were evaluated in a 100–130-ms post-stimulus search window. As seen in Figure 4, peak amplitudes were larger for other-race faces than same-race faces, F(1, 18) = 58.3, p < .001, MSE = 1.02, ηp² = .76, as well as for inverted faces compared to upright faces, F(1, 18) = 11.0, p = .004,
MSE = 8.56, \( \eta_p^2 = .38 \). Amplitudes showed no effect of Thatcherization, \( F(1, 18) = 1.90, p = .185, MSE = 2.00, \eta_p^2 = .10 \). Other-race faces elicited significantly larger peak P1 amplitudes than same-race faces, a result that may reflect differences in low-level visual properties between Caucasian and African-American faces. There was no interaction between Race and Thatcherization, \( F(1, 18) < 1, p = .691, MSE = 2.19, \eta_p^2 = .01 \), nor between Race and Orientation, \( F(1, 18) = 1.77, p = .200, MSE = 2.62, \eta_p^2 = .09 \). Orientation interacted with Thatcherization, \( F(1, 18) = 13.1, p = .002, MSE = 1.26, \eta_p^2 = .42 \), such that Thatcherization resulted in increased P1 amplitudes for the upright condition only, mirroring the behavioral aspects of this illusion. Importantly, there was a significant three-way interaction between Race, Thatcherization, and Orientation, \( F(1, 18) = 9.06, p = .008, MSE = 1.48, \eta_p^2 = .34 \), because the Thatcherization by Orientation interaction was only apparent for the same-race faces. Thus, the P1 was sensitive to configurial manipulations of the same-race but not the other-race faces.

P1 Latencies were not affected by Race, \( F(1, 18) < 1, p = .646, MSE = 15.9, \eta_p^2 = .01 \); Thatcherization (\( F(1, 18) < 1, p = .588, MSE = 4.96, \eta_p^2 = .02 \); or Orientation, \( F(1, 18) = 2.56, p = .127, MSE = 31.5, \eta_p^2 = .13 \). Neither Thatcherization, \( F(1, 18) < 1, p = .756, MSE = 8.30, \eta_p^2 = .01 \), nor Orientation, \( F(1, 18) < 1, p = .879, MSE = 11.1, \eta_p^2 < .01 \), interacted significantly with Race; however, there was a significant interaction between Thatcherization and Orientation, \( F(1, 18) = 7.01, p = .016, MSE = 5.66, \eta_p^2 = .28 \), such that inversion delayed the latency for Thatcherized faces more so than non-Thatcherized faces. There was no three-way interaction, \( F(1, 18) < 1, p = .399, MSE = 11.8, \eta_p^2 = .04 \) (Figure 5).

The N170 component

Peak N170 amplitude was measured within a post-stimulus window of 140–210 ms. N170 amplitude was significantly increased following inversion, \( F(1, 18) = 47.6, p < .001, MSE = 8.53, \eta_p^2 = .73 \). Other-race faces tended to elicit larger N170 amplitudes, overall, than did same-race faces, \( F(1, 18) = 3.54, p = .076, MSE = 2.19, \eta_p^2 = .16 \), while Thatcherization resulted in slightly decreased N170 amplitudes, \( F(1, 18) = 3.99, p = .061, MSE = 2.17, \eta_p^2 = .18 \). However, the latter effects were only marginally significant. Post-hoc paired comparison t-tests of same-race and other-race faces in the upright normal condition only, indicated that peak N170 amplitudes were not affected by Race alone, \( t(18) = 0.028, p = .978 \), suggesting that the marginally significant main effect of Race was due to differences across experimental conditions rather than differential responses to same- versus other-race faces. Race did not interact with either Thatcherization, \( F(1, 18) = 0.82, p = .378, MSE = 1.27, \eta_p^2 = .04 \), or Orientation, \( F(1, 18) = 0.63, p = .44, MSE = 4.95, \eta_p^2 = .03 \). The interaction between Thatcherization and Orientation failed to reach significance, \( F(1, 18) = 2.34, p = .144, MSE = 3.07, \eta_p^2 = .12 \). The expected three-way interaction was only marginally significant, \( F(1, 18) = 3.32, p = .085, MSE = 3.63, \eta_p^2 = .16 \); however, as predicted, Thatcherization modulated N170 amplitude for same-race faces to a greater extent than for other-race faces in the upright condition (Figure 6).
N170 peak latency was longer for other-race faces than same-race faces, $F(1, 18) = 7.44, p = .014, \text{MSE} = 33.3, \eta_p^2 = .29$. Inversion resulted in a marginally significant delay to peak N170 latency, $F(1, 18) = 4.23, p = .055, \text{MSE} = 128.9, \eta_p^2 = .19$. Surprisingly, N170 latencies were not affected by Thatcherization, $F(1, 18) = 2.11, p = .164, \text{MSE} = 25.2, \eta_p^2 = .11$. There was no two-way interaction between Race and Thatcherization, $F(1, 18) < 1, p = .721, \text{MSE} = 6.85, \eta_p^2 = .01$; Race and Orientation, $F(1, 18) = 2.41, p = .138, \text{MSE} = 41.8, \eta_p^2 = .12$; or Thatcherization and Orientation, $F(1, 18) = 1.21, p = .285, \text{MSE} = 30.9, \eta_p^2 = .06$. There was also no three-way interaction, $F(1, 18) = 1.65, p = .216, \text{MSE} = 62.5, \eta_p^2 = .08$ (Figure 7).

The P250 component

Peak P250 amplitudes were measured during a search window of 220–260 ms post-stimulus onset. Neither Race, $F(1, 18) = 2.58, p = .125, \text{MSE} = 2.30, \eta_p^2 = .13$, nor Thatcherization, $F(1, 18) = 1.43, p = .247, \text{MSE} = 1.40, \eta_p^2 = .07$, impacted P250 amplitudes. Inverted faces had a significantly larger peak amplitude than did upright faces, $F(1, 18) = 16.8, p < .001, \text{MSE} = 6.45, \eta_p^2 = .48$, and Orientation interacted with Thatcherization, $F(1, 18) = 9.57, p = .006, \text{MSE} = 1.60, \eta_p^2 = .35$, such that inversion increased the peak P250 amplitude more so for Thatcherized faces than non-Thatcherized faces. Race did not interact with Orientation, $F(1, 18) = 0.90, p = .354, \text{MSE} = 1.70, \eta_p^2 = .05$; however, a marginally significant interaction occurred between Race and Thatcherization, $F(1, 18) = 3.81, p = .067, \text{MSE} = 1.37, \eta_p^2 = .18$ (Figure 8), such that Thatcherization modulated P250 amplitude to a greater extent for same-race faces than for other-race faces. The three-way interaction, however, failed to reach significance, $F(1, 18) = 1.44, p = .246, \text{MSE} = 1.35, \eta_p^2 = .07$.

Neither Race, $F(1, 18) = 2.52, p = .151, \text{MSE} = 28.4, \eta_p^2 = .11$, nor Thatcherization, $F(1, 18) = .647, p = .432, \text{MSE} = 21.4, \eta_p^2 = .04$, affected P250 latencies. Orientation had a marginally significant effect, $F(1, 18) = 3.93, p = .063, \text{MSE} = 259, \eta_p^2 = .18$, such that inverted faces had a later peak latency than upright faces. Thatcherization did not interact with Race, $F(1, 18) < 1, p = .589, \text{MSE} = 45.7, \eta_p^2 = .02$, or Orientation, $F(1, 18) = 1.31, p = .268, \text{MSE} = .64$.
However, the effect of Thatcherization was larger for same-race faces than other-race faces. Of Thatcherization on grotesqueness ratings would processing strategies, we had predicted that the effect of Thatcherization on grotesqueness would be less pronounced for same-race faces than for other-race faces. Upon further inspection of the data, we think this pattern may be due to the fact that other-race faces were rated as slightly less grotesque when un-Thatcherized and slightly more grotesque when Thatcherized. The pattern of results seen in the grotesqueness-rating data set suggests that the perception of other-race faces is actually more dependent on configural processing as, if not more than, the perception of same-race faces. This finding does not replicate that of Murray et al. (2003). In their study, the effects of component and configural disruptions across races were examined. Using Caucasian participants and Caucasian and Asian faces, they found no differences in susceptibility to component (i.e., featural) distortions based on race. However, configurally disrupted faces were rated as more bizarre in appearance if they were of the same race of the observer than if they were of a different race.

Interestingly, but perhaps not surprisingly, the electrophysiological data do not parallel the grotesqueness-rating data. When dealing with sensitive social issues, such as race, participants may seek to respond in a socially or personally acceptable manner, and this may require suppression of implicit bias and result in reluctance to rate faces of other races as grotesque (as opposed to bizarre). In contrast, the evoked responses may reflect implicit categorization occurring prior to proposed bias detection and control mechanisms (e.g., Stanley, Phelps, & Banaji, 2008). Indeed, this has been demonstrated behaviorally with implicit measures of racism (Greenwald, McGhee, & Schwarz, 1998) and in face-processing studies showing that race-related alteration in the N170 precedes more frontal cortical responses that correlate with implicit bias (He, Johnson, Dovidio, & McCarthy, 2009). Thus, because explicit behavioral responses can be consciously edited, it is possible that the EEG data provide a more accurate insight into differences in facial processing strategies (although, notably, some differences in ERP amplitude and latencies may reflect social bias associated with racial categorization).

Effects on P1

The P1 component may reflect processing of low-level visual properties of stimuli such as shape, contrast, and luminance (Itier & Taylor, 2004). Thus, the greater P1 response in viewing African-American (other-race) faces than Caucasian (same-race) faces may be due in part to race-related differences in contrast and color. We also found that, in the upright condition, Thatcherized faces yielded larger amplitudes and longer latencies. Milivojevic et al. (2003) found a similar Thatcherization effect on P1, which they attributed to an increase in captured attention due to the bizarreness or grotesque appearance of Thatcherized faces. Conversely, Boutsen et al. (2006) failed to show P1 modulation with Thatcherization. They attributed this lack of modulation to the lack of emotional expression in the facial stimuli because they used faces with neutral expressions rather than the smiling faces of Milivojevic et al. (2003).

Surprisingly, Thatcherization affected P1 amplitudes only for own-race faces. This suggests that P1 represents a response that is sensitive to more than just low-level features and attention. In particular, the effect of expertise appears to be present in this very early component. Both same- and other-race faces were rated as equally grotesque when Thatcherized (in the upright condition), yet only same-race faces showed modulation of the P1 component. The current data suggest that same-race faces are being processed more configurally than other-race faces and that while P1 activity may reflect the processing of low-level features and attention, it appears to be also modulated by experience and configural processing. Greater modulation for same-race faces is likely the result of increased use of configural processing strategies (as compared to
other-race faces) and thus reflects a greater disruption of the structural encoding process. A second interesting outcome of the P1 analyses was the apparent disconnect between the P1 responses and the behavioral data. For our behavioral results, Thatcherization did not interact with race, but it did for the P1. This would imply that the P1 response is occurring before the point of bias detection and control (e.g., Stanley et al., 2008).

Effects on N170

N170 amplitudes were marginally reduced in magnitude following Thatcherization, suggesting that the N170 is sensitive to configural processing. Previous research appears mixed with respect to the influence of Thatcherization on the N170 amplitude. A number of studies report that Thatcherization increases N170 amplitude (Carbon et al., 2005; Milivojevic et al., 2003), whereas more recent work and the present study report that Thatcherization decreases N170 amplitude (Boutsen et al., 2006). This difference in direction may be the result of differences in the nature of the Thatcherization manipulation. In many Thatcherization studies to date, the Thatcherized face versions have been created with choppily cut sections and minimal blending once these sections have been inverted. The edges created by this manipulation create extra information. Thus, the observed increases in N170 amplitude may be due to some unspecified extra effort required to analyze this new information. Conversely, when the inverted features have been smoothed and blended, as in the present study, the N170 is affected by only the configural disruption. The switch to featural analysis presumably requires less processing effort, thus resulting in decreased amplitude.

Thatcherization did not have an orientation-dependent effect on N170 amplitudes, although slightly greater changes in amplitude following Thatcherization were seen for upright as compared to inverted faces. A number of previous ERP studies have found similar Thatcherization effects in both upright and inverted faces (Boutsen et al., 2006; Carbon et al., 2005). Boutsen et al. (2006) suggest that Thatcherization affects the encoding of both upright and inverted faces, resulting in modulation of the face-sensitive N170 component. Again, greater modulation in the upright condition is likely due to the increased availability of configural information in upright versus inverted faces.

Thatcherization reduced N170 amplitude more for a face of one’s own race than for another race. Changes in the N170 peak amplitude probably indicate differences in the processing effort required to extract configural information from within faces (Zion-Golumbic & Bentin, 2007) or a switch in processing strategy (from configural to featural) when the configural information has been disrupted to an extent that extraction becomes too difficult (Rossion & Gauthier, 2002). That Thatcherization modulated the N170 amplitude to a greater extent for same-race faces suggests that the processing of same-race faces relies on configural processing strategies more so than the processing of other-race faces, as in our original hypothesis. Previous work utilizing the face inversion effect (FIE) as a configural disruption in same- and other-race faces has yielded complementary evidence (Rhodes, Brake, Taylor, & Tan, 1989; Vizioli, Foreman, Rousselet, & Caldara, 2010). Vizioli and colleagues (2010) have demonstrated that the magnitude of N170 amplitude change due to inversion is larger for same-race faces than other-race faces. While both inversion and Thatcherization are considered configural distortions, Thatcherization may be a stronger test of configural processing strategies, as it involves an explicit manipulation of the configural information of a given face. Because all of our participants had low contact scores, it can be concluded that none of them had sufficient experience with African-Americans to have developed the expertise necessary to utilize configural processing to the same extent as they would with Caucasian faces.

Effects on P250

The effects of inversion and Thatcherization on the P250 component in the present study are in line with a number of previous studies. We found the P250 to be sensitive to face inversion, with inverted faces resulting in larger amplitudes and delayed peak latencies; similar inversion effects on P250 have been described by Boutsen et al. (2006). Thatcherization interacted with orientation in the present data such that Thatcherization resulted in decreased P250 amplitude for the upright condition only. While Boutsen et al. found Thatcherization to lower P250 amplitude independently of orientation, Milivojevic et al. (2003) also demonstrated an orientation-dependent effect of Thatcherization on P250 amplitudes. They argue that negativity of the P250 component likely reflects the processing of configural information. Similarly, Halit et al. (2000) found that stretching faces to appear “atypical” (i.e., distorting the spatial relations among features) decreased P2 amplitudes (analogous to our P250 component). They argued that differences in observed P2 amplitudes
for “typical” versus “atypical” faces were the result of configural information being used to recognize individual faces. The Thatcherization effects on the P250 are, therefore, indicative of disruptions to local configural processing. Most interestingly, an interaction was observed between race and Thatcherization, with Thatcherization resulting in significantly greater amplitude reduction for own-race faces than other-race faces. Following Milivojevic’s argument that modulation of the P250 component is indicative of disruptions to local configural processing, the present findings suggest that configural processing is utilized for the processing of own-race faces more so than for other-race faces.

Conclusions

When considered together, our EEG data appear to agree with previously observed behavioral data (Murray et al., 2003). Taken together, the findings of these studies provide evidence for the expertise theory of the other-race effect. The configural disruption used in the present study impacted the processing of same-race faces more so, overall, than other-race faces. According to Farah, Wilson, Drain, and Tanaka (1998), configural and featural processing strategies for object recognition form a continuum, and the processing of faces lies on the configural end. The present study suggests that while faces hold a position on the configural end of this processing strategy, it is possible to parse out subtle differences in the levels of configural and featural processing utilized for different types of faces, and that these differences may be occurring very early in the structural encoding stage of face processing, rather than later in processing when social judgments are thought to occur.

REFERENCES


