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Cross-Race Effect Reduction: Insights from Eye-Tracking and Social Background Analyses

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Abstract

The cross-race effect (CRE) is a phenomenon where people are better able to remember faces of their own race. Studies show that the CRE can be reduced by making participants aware of the effect, and by asking them to pay close attention to cross-race faces during the encoding phase. The objectives of this study were to reduce the CRE effect, to track eye movement, and to gather information of social background to further understand the CRE process. Data collected from 77 participants confirmed the CRE. However, the manipulation applied to the experimental group failed to improve the recognition performance of cross-race faces, suggesting that participants engaged in an ineffective encoding process. Eye tracker data confirmed previous findings and showed: less and longer fixations when looking at cross-race faces, and higher number of fixations in the areas of the eyes, nose, and mouth. Finally, the relationship between incremental experience with cross-race faces and a reduction of the CRE was inconclusive due to self-reporting issues.

Cross-Race Effect Reduction:

Insights from Eye-Tracking and Social Background Analyses

The cross-race effect (CRE) is a well-known phenomenon where people are better at remembering faces of their own race. There has been a lot of research performed on this topic since it was first introduced by Feingold (1914). Feingold asserted that cross-race faces tend to look alike, unless people are familiarized, usually from a young age, with faces of other races. Furthermore, own-race faces are generally perceived as being more memorable and familiar than faces of other races, and these subjective appreciations, though automatic and unconscious, activate different encoding processes that produce differential recognition abilities between own- and other-race faces (Meissner, Brigham, & Butz, 2005).

The CRE has received a lot of attention partly because it advances the understanding of the different mechanisms that people use to process faces (Arizpe, Kravitz, Walsh, Yovel, & Baker, 2016). It is also important in the field of criminal justice because it exposes the challenges associated with eyewitness identification during lineups—especially when the eyewitness and the suspect are from different races (Lindsay, Mansour, Bertrand, Kalmet, & Melsom, 2011).

The literature shows that the CRE has been explained through different mechanisms which include a perceptual narrowing due to experience (Kelly et al., 2009), failure to generalize perceptual encodings (Levin, 2000), differences between holistic and featural processing (Tanaka, Kiefer, & Bukach, 2004), social-cognitive processes of categorization (Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008), among others. The CRE has proven to be a complex phenomenon that is affected by many variables, a process that is reliable, but challenging to study because its effects are dependent upon the different experimental paradigms and method of analysis that are used. However, despite its convoluted nature, the CRE has been detected as early as in the first few months of life.

Indeed, Kelly et al. (2009) documented the evolution of the CRE in Asian babies. The authors demonstrated that a) 3-month-old Asian babies recognize Asian, Caucasian, and African faces, b) that six-month-old Asian babies recognize Asian faces, are able to perform marginal recognition of Caucasian faces, and are not able to recognize African faces, and c) that 9-month-old Asian babies only recognize Asian faces. The authors concluded that the CRE supports the perceptual narrowing hypothesis, which argues that during the developmental process, the brain uses the stimuli that are most commonly encountered in the environment to shape and fine-tune the perceptual systems (Hadley, Rost, Fava, & Scott, 2014). In this way, just as the auditory system rapidly adapts to perceive the phonetic properties of the particular language that is spoken around babies, the visual system performs a similar feat by becoming more sensitive to the facial features that are more commonly seen.

Furthermore, a study done in kindergarten, 3rd graders and young adults showed that the CRE remains present and stable as individuals grow up (Pezdek, Blandon-Gitlin, & Moore, 2003). However, just as with language, the face recognition system seems to remain plastic during the first years of life as it adapts to changes in the social environment of individuals. For instance, Korean children who were adopted when they were between three and nine years old, and who moved out of Korea to be raised in Europe by Caucasian families, showed a cross-race effect while looking at Korean faces when they were tested in adolescence—lowered ability to remember Korean faces compared to Caucasian faces (Sangrigoli, Pallier, Argenti, Ventureyra, & Schonen, 2005). This study shows how expertise gained with cross-race faces can reduce or even revert the cross-race effect.

The mechanisms underlying the CRE are heavily debated in the literature. Some authors suggest that the effect is the result of a failure to generalize the perceptual mechanisms that are used for same-race encoding, and to effectively use these mechanisms to process cross-race faces (Levin, 2000). The deficit is believed to be the result of the subconscious and automatic act of emphasizing race information when processing cross-race faces at the expense of performing an individuation of facial features. Correll, Hudson, Guillermo, and Earls (2016) suggest that differential experience with in-group faces promotes a higher perceptual enrichment for these faces, thus allowing people to create richer and better integrated mental representations of same-race faces. According to this, same-race faces are normative, and through top-down processes, race not only structures the social environment, but also structures mental representations, influences visual processing, perceptual learning, and predictive coding.

Indeed, a study that considered this hypothesis found a significant effect when participants were asked to individuate the information of cross-race faces, as opposed to just categorize faces by race (Rhodes, Locke, Ewing, & Evangelista, 2009). The authors concluded that the poor recognition of faces of other races could also be the result of a process that starts with a reduced perceptual expertise of other-race faces in addition to a reduced motivation to individuate out-group faces. Additionally, other authors have noted that incremental experience helps people to better differentiate both individual facial features and the spatial relationships between these features, thus leading to a reduced CRE (Maurer, Le Grand, & Mondloch, 2002).

Further studies suggest that holistic processing of faces increase the CRE as a result of a high familiarity with same-race faces (Tanaka et al., 2004). Researchers Tanaka and Farah (1993) describe holistic processing as a mechanism by which the encoding process of facial features is based on the information of the spatial relationships between all the main features of the face. Tanaka et al. (2004) report a direct correlation between holistic processing and the relative experience of the subjects with own- and cross-race faces, with Caucasians showing more holistic processing when viewing own-race faces. However, holistic processing does not seem to be a universal processing mode for own-race faces as the authors also found that Asians rely on holistic processing when viewing both Asian and Caucasian faces.

Hayward, Crookes and Rhodes (2013) explain holistic coding as the ability of an individual to process the configural information of a face by processing the distances between all the main features of the face, thus creating an exemplar that is stored as a deviation from the typical dimensions of a referential face. The referential face is a statistical construct stored in the brain which has been created by the countless times that an individual has come across the faces of a particular race. The holistic processing is deemed functionally advantageous because it is effortless and automatic as it allows the observer to a) process all the configural relationships between all the face features at the same time, b) compare the spatial ratios of the face being viewed with a referential face of the same race, and c) consciously detect, if necessary, what differentiates the face from the norm.

Conversely, during featural processing, the observer processes facial characteristics relatively independently, paying attention to distinctive features and tagging the face with mental notes that help in later recognition, as for example: mole on left cheek, small ears, square-shaped face, etc. Hummel and Biederman (1992) report that featural processing seems to be the standard process used by humans to process objects in the world. However, Hayward et al. (2013) notes that featural processing is less useful in faces because all the exemplars are composed of the same elements (eyes, nose, mouth), thus the tendency of the brain to process faces using the pattern recognition analysis particular of holistic coding. Yet, for the brain to be able to use holistic processing, a person needs to have significant experience leading to the brain mapping of a referential face for a particular race.

Further, when Hayward et al. (2013) reviewed previous studies where researchers manipulated configural and featural components of the target faces, they found that Caucasian and Asian participants still perform better with own-race faces when forced by the experiment to use featural processing. The authors concluded that improved encoding of own-race faces is not necessarily tied to holistic processing because participants consistently showed a better performance encoding own-race faces regardless of using holistic or featural processing. Thus, the stronger reliance of holistic processing for own-race faces encoding may be the result of greater perceptual experience with own-race faces, which might be triggering the brain to use an energy saving strategy since featural processing requires the allocation of more focused attention to detect, to process, and to store the specific features that make a face unique.

Other studies have shown that when participants are made aware of the CRE and are encouraged to pay extra attention during the process of memorizing cross-race faces, these participants do not show the CRE (Hugenberg, Miller, & Claypool, 2007). This indicates that there are ways to reduce the encoding deficiencies when processing cross-race faces, in this case, by instructing participants to individuate faces during the encoding process, which incidentally, increased eye movement while encoding cross-race faces. Indeed, eye movement during the encoding process is important and leads to better memory results. A study with an eye-tracker showed that a condition of free viewing while encoding faces, where participants move their eyes as they wish during the learning phase, is more beneficial than a restricted viewing condition while encoding, where participants are instructed not to move their gaze from a fixed point on the screen (Henderson, Williams, & Falk, 2005).

Research of eye movement and pupillometry has shown that when looking at faces of other races, people make fewer and longer fixations, people look at different facial features, and pupils become more dilated (Goldinger, He, & Papesh, 2009). These patterns are consistent with featural processing where participants need to make a stronger effort to memorize the salient characteristics of a face. This explains the fewer and longer fixations, the different sets of features looked at, and the dilation of the pupils, which suggests that the person is engaged in an effortful visual activity. The authors also found that over many trials, participants reduce their overall effort when encoding cross-race faces. This shows that encoding cross-race faces is a process that is more demanding than encoding same-race faces, thus leading to a reduced vigilance as a way to lower the cognitive load of the individual. Research done by Pannasch, Helmert, Roth, Herbold, and Walter (2008) shows that during the process of free viewing of pictures and scenes, there is a strong temporal relationship between fixation duration and saccade amplitudes—fixation duration increases while saccade amplitudes are reduced. The authors also report that people consistently engage in automatic processes during the first two seconds of visual inspection, while the next four to six seconds are spent largely in voluntary, top-down processes.

Another eye tracker study that used a change blindness paradigm found that even when participants give the same level of attention to own- and other-race faces, as measured by the number, order, and duration of fixations, people are still better at detecting changes in same-race faces (Hirose & Hancock, 2007). This finding suggests that even without attentional bias to own-race faces, people are still better at detecting changes in faces of their own race. This effect can also be explained by differential face processing: the authors did not find a statistically significant difference of number, order, or duration of fixations when looking at same- versus cross-race faces, yet the use of configural processing for same-race faces seems to enable participants to find the differences faster than when using featural processing for cross-race faces.

Other studies have shown that participants involved in the process of learning, categorization and recognition of faces, show a systematic and consistent triangular pattern of fixation between the eyes, nose and mouth. The authors note that faces seem to elicit a universal pattern for extracting information that seems to be determined biologically (Blais, Jack, Scheepers, Fiset, & Caldara, 2008). Malcolm and Henderson (2010) argue that this biological mechanism incorporates top-down processes, directed by both expectations and memories, which help people to find useful information through the rapid detection and processing of important facial features.

McDonnell, Bornstein, Laub, Mills, and Dodd (2014) noted that fixation patterns are very complex, as these depend on both the race of the participant, and the race of the person that is being observed. The authors argue that previous studies are yet to provide definite gaze patterns. For example, in the McDonnell et al. (2014) study, White participants made faster and longer fixations on the upper part of the face when looking at pictures of White individuals. When looking at Black faces, White participants fixated longer on the lower part of the face. When participants were told to pay extra attention to Black faces, this pattern of looking at the lower part of the face increased even further.

A study by Shepherd and Deregowski (1981) suggests that White European faces have more variability in the upper area of the face, specially hair color and hair style. Conversely, the authors note that in the case of Black African faces there is more variability in the lower part of the face, as in the nose and mouth. These distinctions may be driving the results that were found by McDonnell et al. (2014).

In the case of White and Asian participants, Goldinger, He, and Papesh (2009) report a similar case where the authors found a preference to look at the upper part of the face when looking at own-race faces, and the lower part of the face when looking at other-race faces. However, this pattern does not seem to be universal. Elis, Deregowski, and Shepherd (1975) found that African Americans tend to look to the lower part of the face when looking at own-race faces compared to when they looked to White faces.

Contrary to the findings by Goldinger, He, and Papesh (2009), Fu, Hu, Wang, Quinn, and Lee (2012) found out that Chinese participants paid more attention to the upper part of the face when looking at Caucasian faces, and paid more attention the lower part of the face when looking at Asian faces. However, this difference may be culturally driven. Goldinger et al. (2009) conducted the study in the United States, while Fu et al. (2012) conducted their study in China, where is socially inappropriate to pursue excessive eye contact.

Arizpe et al. (2016) concur that many CRE studies using eye-tracking technology show inconsistent results on fixation patterns. The authors note that this might be due to differences in the studies such as: duration of the encoding phase, location of the fixation point before the face is presented, differences in the stimuli presented such as emotional versus neutral faces, frontal versus rotated faces, race of the participant, race of the person in the picture, eye tracker measurement differences, as well as different analysis methods like areas of interest versus spatial density maps.

Indeed, a methods section review of the CRE studies that have used eye-tracking technology reveal significant differences in the way that the experiments where setup, which might be contributing to the inconsistencies that have been found between studies. For instance, out of the studies that were researched for this study, the following differences were noticed: picture size varied from 382x390 pixels (57 cm monitor distance) (Blais et al., 2008) to 600x890 pixels (60 cm monitor distance) (Goldinger et al., 2009); presentation time varied from 2000 ms (Nakabayashi, Lloyd-Jones, Butcher, & Liu, 2012) to 10000 ms (Goldinger et al., 2009); monitor distance varied from 57 cm (Blais et al., 2008) to 90 cm (Wu, Laeng, & Magnussen, 2012); and the sampling rate of the eye-tracker software varied from 50 Hz (Goldinger et al., 2009) to 1000 Hz (Kawakami et al., 2014).

In their study, Arizpe et al. (2016) validated the significant but inconsistent differences in fixation patters and eye movement that have been reported in studies that use areas of interest. However, the authors also showed that these patterns were not statistically significant when using spatial density map analysis. It is important to mention that most CRE studies using eye-tracking have been performed using areas of interest, where researchers manually define a few areas, usually around four or five, where information is pooled and processed. These areas are usually rectangles of fixed dimensions that are placed around the right eye, the left eye, the nose, and the mouth. All fixations inside a specific area are processed as data related to that particular facial feature. For example, considering the right eye area of interest, all fixations in this area of interest are pooled as if the individual looked at the center of the right eye; therefore, there is no discrimination of the participant looking at other nearby features such as the eyebrow, eyelashes, or other features that might be salient as wrinkles at the corners of the eye, puffy bags under the eye, etc. This pooling of data is what Arizpe et al. (2016) showed that produces statistically significant fixation patters. Conversely, when using a heatmap analysis, the authors showed that the statistical sensitivity is reduced to a point that no longer reflects significant differences.

Hence, the authors showed an important shortcoming of previous studies, namely that the findings are analysis-dependent and related to the way in which each experiment is set up. The authors also found that their findings are consistent with previous studies, whereas most studies using eye-tracking that have failed to find significant differences in fixation patterns have been done using spatial density analyses.

As for a comprehensive model of the CRE, Hugenberg, Young, Bernstein, and Sacco (2010) proposed a theory that encompasses the main theoretical frameworks into what was called The Categorization-Individuation Model. This model is based on three independent factors that are thought to work together to produce the CRE. The factors are social categorization, perceptual experience, and motivated individuation.

According to Hugenberg et al. (2010), social categorization is an ongoing process that affects face encoding and later face recognition. The authors argue that social categorization is a process that is automatic, fast, and effortless. During CRE experiments, when participants are presented with pictures of faces, they immediately extract information about race, sex, and age. This information is then used by the brain to activate the different cognitive processes available to encode the images. Furthermore, several theories have been proposed to explain the effects of social categorization on the cross-race effect.

For instance, Levin (1996, 2000) suggested that a feature-selection model drives participants to individuate same-race faces and to categorize cross-race faces, which leads to encoding asymmetries that result in marked differential performances during recognition tasks. Additionally, Rodin (1987) presented the cognitive disregard model which is driven by a lack of attention to outgroup members that reduces the encoding efficacy and the subsequent ability to recognize other-race faces. Furthermore, Marcon, Susa, and Meissner (2009) argue that when viewing a face of an out-group member, participants are usually satisfied with just acquiring a sense of familiarity with the face. On the contrary, when participants see an in-group face, they allocate more resources and employ more motivated recall strategies.

Next, perceptual experience is usually accepted as one of the main drivers of the CRE. This factor is based on the fact that most people have marked differences in their expertise of encoding same-race versus cross-race faces, which is known to trigger different cognitive processing (Michel, Rossion, Han, Chung & Caldara, 2006). According to previous studies, a higher experience processing same-race faces leads to automated configural processing, while a lower experience with cross-race faces leads to a more effortful feature-based processing (Rhodes, Brake, Taylor & Tan, 1989).

Lastly, motivated individuation is based on a process where participants focus their attention on face characteristics that are identity-diagnostic, instead of characteristics that are category-diagnostic (Hugenberg et al. 2010). Thus, motivated individuation is about finding the differences between the exemplars of a category. In the case of a CRE task, participants focus their attention on finding the differences of the faces of the same race in order to try to determine what makes a face unique, thus enhancing the encoding process.

Accordingly, the Categorization-Individuation Model explains the CRE as a complex process where: a) social categorization induces individuation of same-race faces and categorization of faces of other races, b) perceptual experience activates configural processing of same-race faces and feature-based processing of cross-race faces, and c) motivated individuation prompts identity-diagnostic processing of same-race faces and category-diagnostic processing of faces of other races (Hugenberg et al. 2010). However, Wan, Crookes, Reynolds, Irons and McKone (2015) argue that social categorization is not a reliable variable affecting the CRE.

Considering the previous research that has concluded that automatic categorization of in-group versus out-group faces produces different encoding processes, Wan et al. (2015) argued that this might be the case only in particular settings such as a White learner of a high socio-economic status looking at Black faces of lower socio-economic status. The authors tested the CRE paradigm in a more equal socio-economic status, where Asian and Caucasian participants looked at pictures of people of their own race and their same socio-economic status. The authors concluded that the social-motivation component did not influence the CRE. Wan et al. (2015) also found that the CRE was mainly predicted by perceptual experience with the other race, thus proposing that the main factors producing the CRE are lack of motivation to encode the faces and lack of experience with the other-race.

Although the CRE has been consistently replicated, previous studies have shown both contradictory evidence and small effect sizes. A study by Wan et al. (2017) revealed an underlying factor that might be producing the modest size of the CRE and the inconsistencies in results. In their study, the researchers found that out of 550 participants, 8.1% of Caucasians and Asians raised in majority same-race areas, met the criteria for clinical-level impairment for recognizing other-race faces. Furthermore, they found added risk factors for face blindness in other participants that may significantly impair their performance in other-race face recognition. One of the main factors is being at the lower levels of face recognition ability; which means, that even if a person is not in the 8.1% who is clinically face-blind, there may be significant amounts of people whose overall face recognition abilities are so poor, that they may be skewing the results of the CRE studies by creating fixation patterns and recognition results that are not representative of the normal population.

Other studies suggest that social-cognitive mechanisms have a greater weight on the CRE than differential racial expertise (Shriver et al., 2008). The authors of this study found cross-race effects that are not related to race, but to group membership. For example, White middle-class participants were better able to recognize the faces of same-race individuals if these individuals appeared in a wealthy context, meaning that an impoverished context led to a categorization of out-group membership and therefore, it activated the CRE. Similarly, the authors found a CRE based on university affiliation. Participants that looked at same-race pictures that included an in-group or an out-group categorization via a university affiliation (the name of the university written at the bottom of the picture) were better able to recognize the faces of the in-group university affiliation.

Regarding the CRE and the effects of prejudice, Hansen, Rakhshan, Ho & Pannasch (2015) found that the fixation pattern displayed by people when examining faces changes systematically according not only to their level of racial prejudice, but also to kind of prejudice. Indeed, people with high explicit racial prejudice exhibited less consistency in fixation patterns and were more prone to prolonged fixations on the mouth area of Black faces. It is worth noting that this pattern was present during the first two seconds of the visual inspection of the faces, which Pannasch et al. (2008) deemed as an automatic process, as well as during the rest of the viewing time which is driven by voluntary eye movements. On the other hand, people with high implicit racial prejudice were more likely to look at the region between the eyes in both own- and other-race target faces. The authors concluded that differences in racial prejudice activate different fixation patterns when viewing faces of different races during both automatic and voluntary processes.

The objective of this study is to further analyze the CRE by performing conceptual replications and extensions of several studies mentioned before. The study attempts to eliminate the cross-race effect by informing participants that people are usually better at remembering faces of their own race, and by asking them to pay extra attention to faces of other races. The study also tracks eye movement to gather information of fixation patterns during the encoding process. Additionally, using a questionnaire, the study collects social background data, internal and external motivations to respond without prejudice, and attitudes about race (racial bias).

Consequently, several hypotheses are considered: 1) making participants aware of the CRE, and asking them to pay closer attention to cross-race faces, will increase their recognition performance of cross-race faces, 2) asking participants to pay extra attention to cross-race faces will provoke an individuation encoding, which will be detected as a higher number of eye fixations, and a longer distance travelled by the eyes while encoding the faces, 3) White participants with greater exposure to Black schoolmates, peers, and friends, will show a higher performance with cross-race faces during the recognition task, 4) participants with higher levels of internal motivation to respond without prejudice will have a higher performance with cross-race faces in the recognition task, 5) participants with higher levels of external motivation to respond without prejudice will have a lower performance with cross-race faces in the recognition task, and 6) participants with higher scores of racial bias will have a lower performance with cross-race faces in the recognition task.

Methods

Participants

A total of 96 undergraduate students from the University of Colorado Boulder participated in the study. Nineteen students were excluded because of their ethnicity (non-Caucasians).

Therefore, the data of 77 participants was processed as part of this study (57 females, 20 males). The age of participants was (*M*=18.57, *SD*=0.95). Forty-one students participated in the control group, while 36 students participated in the experimental group. Students were recruited through the University of Colorado Psychology Department SONA System for research participation, and received course credit.

Design

The study was designed as a 2 (target race) x 2 (instructions) mixed-model ANOVA with repeated-measures on the first factor. The independent variables were: target race (2: Black; White) within subjects, CRE instructions (2: control; experimental) between subjects. The dependent variables were accuracy of face recognition (d'), number of eye fixations, and total eye distance travelled while encoding. The dependent variable was also analyzed against several composite values of social background data (continuous variables).

Measures

As part of a questionnaire, social background data was gathered covering demographics, motivations to respond without prejudice, and attitudes about race (racial bias). The questionnaire contained eight questions about social background, divided in three areas. First, percentage of school students that belonged to other races (Asian, Black, Latino, White, Other) in elementary school (age 6-12), as well as in middle and high school (age 12-18). Second, percentage of peer acquaintances of other races as a young child (age 0-6), as an older child (age 6-12), and as an adolescent (age 12-18). Third, percentage of friends of other races as a young child (age 0-6), as an older child (age 6-12), and as an adolescent (age 12-18).

Responses to these questions were aggregated in three variables that represented differential racial exposure to Whites and Blacks, each variable covering the age range from 6 to

18 years old: 1) average percentage of Whites minus Blacks schoolmates, 2) average percentage of White minus Black peers, and 3) average percentage of White minus Black friends. Furthermore, these three latter variables were aggregated together into another variable that represented a single racial differential exposure value (Whites – Blacks) for each participant. Additionally, the three zip codes provided by the participants for where they lived during ages 0-6, 6-12, and 12-18 were used to gather demographic data from the United States Census Bureau (U.S. Census Bureau, 2010). Indeed, the census data reported on the General Population and Housing Characteristics report was used to create a “real” racial difference exposure variable (Whites – Blacks) for each participant.

Furthermore, motivation to respond without prejudice was collected using the Internal Motivation to Respond Without Prejudice Scale (IMS) and the External Motivation to Respond Without Prejudice Scale (EMS) (Plant & Devine, 1998). These two scales were combined into a ten-item questionnaire where participants answered using a 9-point Likert scale (1=strongly disagree, 9=strongly agree). The scale includes statements such as, “Because of today’s PC (politically correct) standards, I try to appear nonprejudiced toward Black people,” and “I am personally motivated by my beliefs to be nonprejudiced toward Black people.” Responses to these questions were aggregated into two individual scores per participant: overall score on external motivations to respond without prejudice, and overall score on internal motivations to respond without prejudice.

Finally, attitudes about race were assessed using the Modern Racism Scale (McConahay, 1986). This eleven-item scale provides an explicit self-report for racial bias and includes statements such as, “Discrimination against Blacks is no longer a problem in the United States,” and “Blacks are ultimately responsible for the state of race relations in this country.” Participants responded using a 9-point Likert scale (1=strongly disagree, 9=strongly agree) and the answers were aggregated to create an individual racial bias score. A Cronbach's alpha analysis (RStudio Team, 2015) was performed to assess the internal reliability of the ten sub-measures of prejudice ($\alpha = .76$), and the eleven sub-measures of attitudes about race ($\alpha = .92$). Both measures show good internal reliability.

Procedure

Participants were randomly assigned to the control or the experimental group. The experiment consisted of three stages: 1) a learning phase, 2) a five-minute unrelated distractor task, and 3) a recognition phase (memory test). During the learning phase, 32 male faces were randomly presented (16 Black; 16 White) with a seven-second display rate per face. The learning phase was programmed using the SR Research Eye Link Experiment Builder software (SR Research Ltd, 2010). After a five-minute period of performing a distractor task, participants were presented with the recognition task, in which a total of 64 male faces were randomly presented. Thirty-two of these pictures had already been presented during the encoding phase, and 32 were new faces. Thirty-two were Black faces and 32 were White faces. Participants responded by clicking with the mouse on one of two options "I have seen this face," or "I have not seen this face." There was no time restriction to answer, so participants had as much time as needed to respond. The software PsychoPy (Peirce, 2007) was used for the distractor task and the recognition task. Eye movement was recorded using the EyeLink 1000 eye tracker hardware with its desktop mount camera.

The faces used for the study were selected from The Chicago Face Database Version 2.0 (Ma, Correll, & Wittenbrink, 2015). A total of 64 faces were selected from the database, 32 of White males and 32 of Black males. Using the norming data and codebook of the database, the faces were selected based on several factors such as the percentage of people who classified the face as White or Black (higher percentages selected), and the ratings on how prototypical a face is compared to other faces of that race (higher percentages selected). Additionally, unusual, threatening, angry, and happy faces were selected against. The idea was to select faces that were highly representative of the race and that were physically and emotionally neutral. Once the faces were selected, the size of each image was modified so all faces would measure 16 cm from the bottom of the hairline to the bottom of the chin, on a monitor with a 1280 x 1024 resolution. This resulted in an average picture size of 1125 x 791 pixels. Once rescaled, the color pictures were turned into grayscale with mean luminance matching on the whole image using MATLAB's software SHINE toolbox (The MathWorks Inc, 2017).

Next, nine interest areas were manually created for each face using the SR Research Eye Link Experiment Builder software (SR Research Ltd, 2010). The interest areas corresponded to the following areas: 1) left eye, 2) upper nose, 3) right eye, 4) lower nose, 5) mouth, 6) lower part of the face (from the bottom of the mouth's interest area down), 7) upper part of the face (from the top of the eyes interest area up), 8) left ear, and 9) right ear. Interest areas one through five were created with standardized dimensions that were equal for all the faces. Figure 1 shows two sample faces that were used in the experiment with its corresponding areas of interest.

The computer monitor (DELL 1704FTP at 1280x1024 resolution) was positioned 70 cm away from the eyes of the participants. The monitor distance/face height ratio was calculated to produce a visual angle similar to the one encountered in a typical face-to-face social interaction. The EyeLink 1000 Desktop Mount camera was placed 53 cm from the eyes. The sampling rate of the eye tracker was set to 1,000 Hz. A chin-rest device was used to keep the head of the participant steady during the learning phase, and it was dismounted for the other phases of the experiment.

The complete procedure of the study was: 1) signing of the informed consent form, 2) brief description of the study, 3) identification of the dominant eye, 4) adjustment of the height of the chair and chin-rest, 5) calibration of the eye tracker, 6) learning phase, 7) five-minute distractor task (questionnaire on the computer), 8) recognition phase (memory test), 9) demographics and social background questionnaire, and 10) debriefing. The procedure lasted approximately 45 minutes.

Participants in the control group were kept unaware of the objective of the study. They were only informed about the CRE during the debriefing. On the contrary, participants in the experimental group were told about the CRE before the learning phase, and were instructed to make a strong effort to memorize cross-race faces to reduce the effects of the CRE. For this, participants in the experimental group were read the following script right before the beginning of the learning phase: “You are participating in a face recognition task. First, you will be shown multiple faces of White and Black people. Your task is to remember these faces because your memory will be tested later in the experiment. Previous research has shown what is known as the Cross-Race Effect when learning faces. Basically, people are better at remembering faces of their own race. For example, a White learner is better at remembering White faces, while a Black learner is better at remembering Black faces. Now that you know this, we would like you to do your VERY BEST to learn and remember BLACK faces. This doesn't mean that you will not be paying attention to the White faces; on the contrary, LEARN the White faces, but pay EXTRA ATTENTION to the BLACK faces, so you do a great job at learning and remembering both kinds of faces. At the end, we will review your memory and recognition performance, especially at remembering BLACK faces, and will compare it with the results of other participants."

Results

Figure 2 shows the recognition accuracy in the form of sensitivity (d'), as a function of target race (Black or White faces) and instruction (control or experimental group). The sensitivity values were as follows: White faces control group (*M*= 2.12, *SD*= 0.70), White faces experimental group (*M*= 1.96, *SD*= 0.88), Black faces control group (*M*= 1.60, *SD*= 0.58), Black faces experimental group (*M*= 1.59, *SD*= 0.71). A regression analysis does not show a significant main effect of instruction on sensitivity values; Figure 3 shows that the average sensitivity values for White and Black faces were not significantly different in the control and experimental groups $t(75)= -0.65$, $p=.517$. However, there was a significant main effect of target race on sensitivity values. Figure 4 shows that the average sensitivity for White faces, across both conditions, was significantly higher than the average sensitivity for Black faces $t(75)=5.08$, $p<.001$. Figure 5 shows how single effects of the CRE were significant on both the control $t(75)=4.35$, $p<.001$, and the experimental group $t(75)=2.89$, $p=.005$. However, there was no significant interaction between instruction and target race on sensitivity $t(75)= -0.86$, $p=.391$. Thus, the magnitude of the CRE (White d' > Black d') did not change as a function of condition.

Figure 6 shows the total eye distance travelled in pixels as a function of target race and instruction. Values of total eye distance traveled were as follows: White faces control group (*M*= 9151.44, *SD*= 2536.16), White faces experimental group (*M*= 8455.34, *SD*= 2707.10), Black faces control group (*M*= 8975.46, *SD*= 2631.03), Black faces experimental group (*M*= 8372.29, *SD*= 2571.69). A regression analysis showed no significant main effect of instruction on distance traveled; Figure 7 shows that the average total distance traveled for White and Black faces was not significantly different in the control and experimental groups $t(75)= -1.11$, $p=.273$. Also, there was not a significant main effect of target race on distance traveled. Figure 8 shows how the average distance traveled for White faces, across both conditions, was not significantly different than the average distance traveled for Black faces $t(75)=1.30$, $p=.197$. As seen on Figure 9, there was not a significant single effect of total distance traveled in both the control condition $t(75)=1.29$, $p=.200$, and the experimental condition $t(75)=0.57$, $p=.569$. Additionally, the analysis shows that there was not a significant interaction between instruction and target race on distance traveled $t(75)= -0.46$, $p=.642$.

Figure 10 shows the total number of fixations as a function of target race and instructions. The total number of fixations were as follows: White faces in the control group ($M= 21.52$, $SD= 3.18$), White faces in the experimental group ($M= 20.40$, $SD= 4.20$), Black faces in the control group ($M= 20.87$, $SD= 3.24$), Black faces in the experimental group ($M= 20.17$, $SD= 3.91$).
A regression analysis does not show a significant main effect of instruction on number of fixations; Figure 11 shows that the average number of fixations for White and Black faces was not significantly different in the control and experimental groups $t(75)= -1.12$, $p=.268$. However, there was a significant main effect of target race on number of fixations. As seen on Figure 12, the average number of fixations across both conditions were significantly different for White and Black faces $t(75)=2.78$, $p=.007$. Figure 13 shows a significant single effect of total number of fixations on the control group $t(75)=3.01$, $p=.003$, and that this effect was not significant in the experimental group $t(75)= 0.09$, $p=.324$. Furthermore, the analysis shows that there is not a significant interaction between instruction and target race on number of fixations $t(75)= -1.33$, $p=.186$.

Regarding the areas of interest, the average number of fixations per interest area per face is as follows: Black eyes (M= 8.04, SD= 2.93), White eyes (M= 8.67, SD= 2.96), Black nose (M= 7.59, SD= 1.80), White nose (M= 7.44, SD= 1.91), Black mouth (M= 1.90, SD= 1.03), White mouth (M= 1.73, SD= 1.02), Black forehead (M= 1.34, SD= 1.00), White forehead (M= 1.60, SD= 1.19), Black ears (M= 0.51, SD= 0.44), White ears (M= 0.40, SD= 0.37), and Black shirt (M= 0.34, SD= 0.38), White shirt (M= 0.36, SD= 0.32). Figure 14 shows the average fixations per area of interest for White and Black faces, where fixations for the eyes $t(75)$=4.50, p<.001, mouth $t(75)$= –2.97, p=.004, forehead $t(75)$=3.23, p=.001, and ears $t(75)$= –3.14, p=.002 were significantly different for each race. However, the number of fixations for nose $t(75)$= –1.33, p=.188, and shirt $t(75)$=0.57, p=.572, were not significantly different. Furthermore, Figure 15 shows the main effect of instructions on number of fixations in each interest area based on the differential fixations of Whites minus Blacks. The number of fixations in the mouth $t(75)$=–2.16, p=.034 showed a significant difference with change of instructions. The other areas of interest, eyes $t(75)$=0.36, p=.719, nose $t(75)$= –0.93, p=.354, forehead $t(75)$= –0.06, p=.949, ears $t(75)$= –1.05, p=.296, and shirt $t(75)$= –0.73, p=.467 did not show a significant difference between the control and the experimental groups.

As for the relationship between social background and the CRE, a regression analysis with the reported exposure to racial differences does not show a significant relationship between the percentage of White minus Black schoolmates and differential sensitivity to White and Black faces in the CRE task with $t(75)$= –1.58, p=.117 (Figure 16). Similar results were found between differential sensitivity and White minus Black peers $t(75)$= –0.93, p=.356 (Figure 16), and between differential sensitivity and White minus Black friends $t(75)$= –0.76, p=.449 (Figure 17). As expected, a composite of all reported racial differences (White minus Black schoolmates, peers, and friends) does not give a significant relationship with differential sensitivity to White and Black faces $t(75) = -1.18$, $p = .242$. Additionally, demographic data gathered by the experimenter from the US Census Bureau, using the zip codes reported by the participants from early childhood to adolescence, shows that there is not a significant association between White minus Black population difference in their area of residence and differential sensitivity for White and Black faces in the CRE task $t(75) = 0.42$, $p = .676$ (Figure 18). Furthermore, the difference between the reported racial difference composite (Whites minus Blacks) schoolmates, peers, and friends, and the overall demographic exposure calculated from the US Census Bureau (Whites minus Blacks), is significant $t(76) = 4.95$, $p < .001$ (Figure 18).

Figure 19 shows results of the CRE as function of the motivations to respond without prejudice. Differential sensitivity for White and Black faces was not correlated with external motivations to respond without prejudice $t(75) = 0.28$, $p = .777$, and was also not correlated with internal motivations $t(75) = -1.32$, $p = .192$. Figure 20 shows the relationship between the differential racial exposure (Whites – Blacks) of the participants as gathered from the US Census Bureau and motivations to respond without prejudice. For both external motivations $t(75) = -0.13$, $p = .893$ and internal motivations $t(75) = -0.78$, $p = .437$, the association was not significant.

As for the relationship between differential sensitivities for White and Black faces and the results of the Modern Racism Scale, Figure 21 shows that there is no significant correlation between these two variables, $t(75) = 0.01$, $p = .999$. Figure 21 also shows no significant association between the Modern Racism Scale and the differential racial exposure (Whites – Blacks) as per the US Census Bureau with $t(75) = -0.88$, $p = .381$. However, Figure 22 shows a strong correlation between the Modern Racism Scale and both external motivations to respond without prejudice $t(75) = 2.36$, $p = .021$, and internal motivations to respond without prejudice $t(75) = -4.80$, $p < .001$.

Discussion

The hypotheses of the study were: 1) that the act of explaining the CRE phenomenon and telling participants to pay extra attention to cross-race faces would result in an increased cross-race performance in the recognition task, 2) that the experimental group would encode cross-race faces by a process of enhanced individualization, which would be detected by a higher number of eye fixations and longer distance travelled by the eyes, 3) that participants with a greater cross-race interaction background would show a higher performance with cross-race faces in the recognition task, 4) that participants with higher internal motivations to respond without prejudice would have a better performance with cross-race faces in the recognition task, 5) that participants with higher external motivations to respond without prejudice would have a lower performance with cross-race faces in the recognition task, and 6) that participants with higher levels of racial bias would have a lower performance with cross-race faces in the recognition task.

The cross-race effect was confirmed by the significant difference of sensitivities between White and Black faces in the control group. Even with the manipulation applied to the experimental group, the CRE remained present, thus showing that recognition of own-race faces in both groups was significantly higher than the recognition of cross-race faces. However, making participants aware of the CRE, and asking them to pay extra attention to Black faces in the experimental group, was not enough to increase the sensitivity to Black faces in this group. Thus, this study was not able to replicate the results of Hugenberg et al. (2007), where the authors report that the manipulation of the experimental group resulted in an increased sensitivity to Black faces, which was significantly higher than the sensitivity to Black faces of the control group. There are a few important differences between these two experiments that may have caused the failure to replicate the reported effects. For instance, the use of an eye tracker in this study required different experimental conditions. Pictures in the Hugenberg et al. (2007) study were 6x4 cm with a 3 second display time. This study used 30x20 cm pictures displayed during 7 seconds. The conditions of this study may have made it too easy for the participants to remember the faces. Indeed, this can be seen in the average sensitivity for both Black and White faces shown in Figure 4, where the average sensitivities for both kinds of faces are quite high. Therefore, the manipulation of the experimental group may have been insufficient to increase the sensitivity of Black faces, given that the baseline of mean Black face sensitivity was already at a high level.

Furthermore, the manipulation of the experimental group did not result in a process of enhanced individuation as predicted by Hugenberg et al. (2007). Actually, the experimental group showed less fixations and less distance travelled by the eyes for both Black and White faces. According to the authors, increased eye movement leads to better memory results. This was confirmed but by the opposite way, decreased eye movement led to worse memory results for both Black and White faces. However, the eye movement pattern found in this study for both the control and the experimental groups are consistent with previous findings where participants are supposed to make fewer and longer fixations (Goldinger et al., 2009), with lower distance traveled (Pannasch et al., 2008), when looking at cross-race faces.

Additionally, the pattern seen also seems to be consistent with the finding that Caucasian participants perform better with own-race faces even when they are forced by the experimenter to use featural processing (Hayward et al., 2013). However, the question remains as to whether this study was able to force an enhanced featural processing in the experimental group. The number of fixations and distance traveled suggest it did not. Previous research has shown that

Caucasians use holistic processing when viewing own-race faces (Tanaka et al., 2014), and that cross-race faces are mainly processed with featural processing (Rhodes et al., 1989). However, the manipulation of the experimental group in this study may have not been strong enough to create an enhanced featural processing of cross-race faces. The script used in this study may have played a part in this.

The script used by Hugenberg et al. (2007) explicitly asks participants to “pay close attention to what differentiates one particular face from another face of the same race.” With this instruction, it is reasonable to expect that participants would move their eyes more as they engage in the task of finding the differences between faces. Conversely, the script used for this study was written in a way to avoid leading participant as to how they should encode cross-race faces, for they were only asked to pay extra attention to cross-race faces. Therefore, given the freedom, it seems that the participants of this study chose an ineffective encoding approach, and may have tried to apply holistic processing to encode cross-race faces.

Regarding the areas of interest, the data confirms that Caucasians tend to pay more attention to the upper part of the face of own-race faces, and to the lower part of the face of cross-race faces (Goldinger et al., 2009). Indeed, while encoding, participants looked more to the eyes and forehead of White faces, and more to the nose and mouth of Black faces. This coincides with the view that White faces have more variability in the upper area of the face, while Black faces have more variability in the lower part of the face (Shepherd et al., 1981). The data also confirms the notion of the existence of a universal pattern for extracting information from faces, which produces a triangular gaze pattern between the eyes, nose, and mouth (Blais et al., 2008). Indeed, the data shows that these three areas of interest received the highest number of fixations, followed by the forehead, ears, and area below the mouth. However, one interesting finding of this study was that the average number of fixations, for both Black and White faces, were very similar for the mouth and the forehead area.

Next, the cross-race recognition results based on differential racial exposure were largely inconclusive. Using the reported data, differential sensitivity for percentage of Whites minus Blacks schoolmates, percentage of White minus Black peers, and percentage of White minus Black friends showed a reversed trend from what was expected. All three cases showed a trend of better recognition of cross-race (Black) faces as participants had less racial exposure to Blacks. As expected, the composite of these three exposure variables also results in a trend of better recognition of Blacks with less Black exposure. However, none of these correlations were statistically significant. Furthermore, the data collected from the US Census Bureau shows the opposite but expected trend.

Using the differential racial exposure data from the 2010 census, the slope becomes positive: participants with more exposure to Black people show an increased cross-race performance in the recognition task. However, this association was also not statistically significant. This situation highlights a problem with how the background data was collected. It becomes evident that participants overestimated their interaction with Black people as per the self-report questionnaire that they filled out. This may be due to recall bias or to social desirability bias. Furthermore, the difference between what was reported and the demographics of the areas where the participants lived is statistically significant, thus signaling an important problem with the data that was collected.

Regarding the association between motivations to respond without prejudice and differential sensitivity, the analysis shows that, as expected, participants with higher internal motivation to respond without prejudice had a higher performance with cross-race faces in the recognition task. Furthermore, participants with higher external motivation to respond without prejudice had a lower performance with cross-race faces in the recognition task. However, both correlations were not statistically significant.

Starting from the premise that participants with lower levels of prejudice are likely to have a better performance with cross-race faces in the recognition task, then this study suggests that internal motivations to respond without prejudice may be linked to lower levels of prejudice, thus resulting in a better performance with cross-race faces. The study also suggests that external motivations to respond without prejudice may not be linked to lower levels of prejudice, since higher levels of external motivations were associated with better performance with cross-race faces. Furthermore, Figure 20 shows the expected trend between internal motivation to respond without prejudice and differential racial exposure. Participants who scored higher in internal motivation to respond without prejudice had higher exposure to Black people. However, the correlation was also not statistically significant.

Next, attitudes about race were assessed using the Modern Racism Scale, which is an explicit self-report of racial bias. Contrary to what was expected, participants with a higher racial bias did not perform significantly worse with cross-race faces in the recognition task. Furthermore, the regression of racial bias on differential racial exposure shows an inverse relationship than the one expected. According to the data that was collected, the participants that are more racially biased are those who have had more contact with Black people. Finally, the study shows that as external motivations to respond without prejudice increase, racial bias significantly increases. Furthermore, as internal motivations to respond without prejudice increase, racial bias significantly decreases.

Limitations and Future Directions

The results of this study reveal several limitations. First, there is the issue of the high sensitivities for both White and Black faces. In order to replicate the effect of Hugenberg et al. (2007), a future study may need to be designed in a way to make it more difficult for the participants to remember the faces. Picture size needs to remain large due to the need to collect eye movement information with the eye tracker. However, the picture display time could be reduced, more pictures could be presented (40 or 45 pictures instead of 36), and the pictures could be cropped in an oval shape to hide hair, ears, and shirt.

Another issue was the inconclusive results of sensitivity on racial differential exposure. It is clear that biases played a significant role in the misreporting of demographic data. Therefore, a future study could ask participants to take 2 or 3 minutes to look at the demographics of where they lived using the data published by the US Census Bureau, and then to use that information as a reference point for their reporting of Black schoolmates, peers, and friends. Anchoring and adjustment may make it easier for participants to fine-tune the census information to their perceived personal exposure to Blacks, and may result in better data quality.

Next, even though the mean score of racial bias was relatively low, it is worth mentioning that the facilitator of the study was an international student who was likely considered by the participants as a member of an outgroup. This might have influenced the participant's attitude towards the study. Therefore, it is recommended that a similar number of participants be run by a Caucasian facilitator to rule out that the race of the facilitator is acting as an extraneous variable.

Accordingly, a way forward could be to run more participants with a Caucasian facilitator, and then re-run the experiment with more pictures, cropped pictures, a shorter exposure time, and participants checking the demographics of the zip codes where they lived before they report their exposure to other races. Additionally, two conditions of the script could be run, one using the Hugenberg et al. (2007) script, which leads participants to move their eyes to find differences between faces of the same race, and one group with the original script of this study, which does not lead the participants in how to pay more attention to the Black faces. If a significant difference in sensitivity values is found using these two scripts, a third study could be run using a very short script that is focused on openly telling participants of the experimental group to "try to move your eyes as much as possible as you look at the Black faces." This will clarify whether the effect that is being observed by Hugenberg et al. (2007) is due to better memory results driven by increased eye movement, instead of the proposed process of individuation that is based on trying to consciously find differences between faces of the same race, and to memorize those differences, to increase performance with cross-race faces in the memory test. Individuation implies more eye movement and the conscious memorization of salient features, this third script would be generating more eye movement without the conscious process of memorization of salient features, thus decoupling the effects of individuation and eye movement.

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Figure 1. Sample of images with the nine areas of interest.

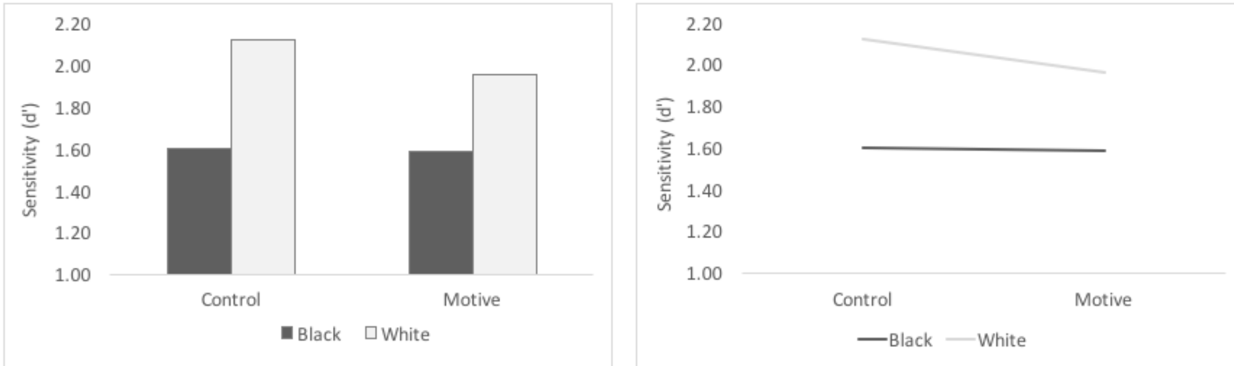

Figure 2. Recognition accuracy in the form of sensitivity (d') as function of target race (Black or White faces) and instruction (control or experimental group).

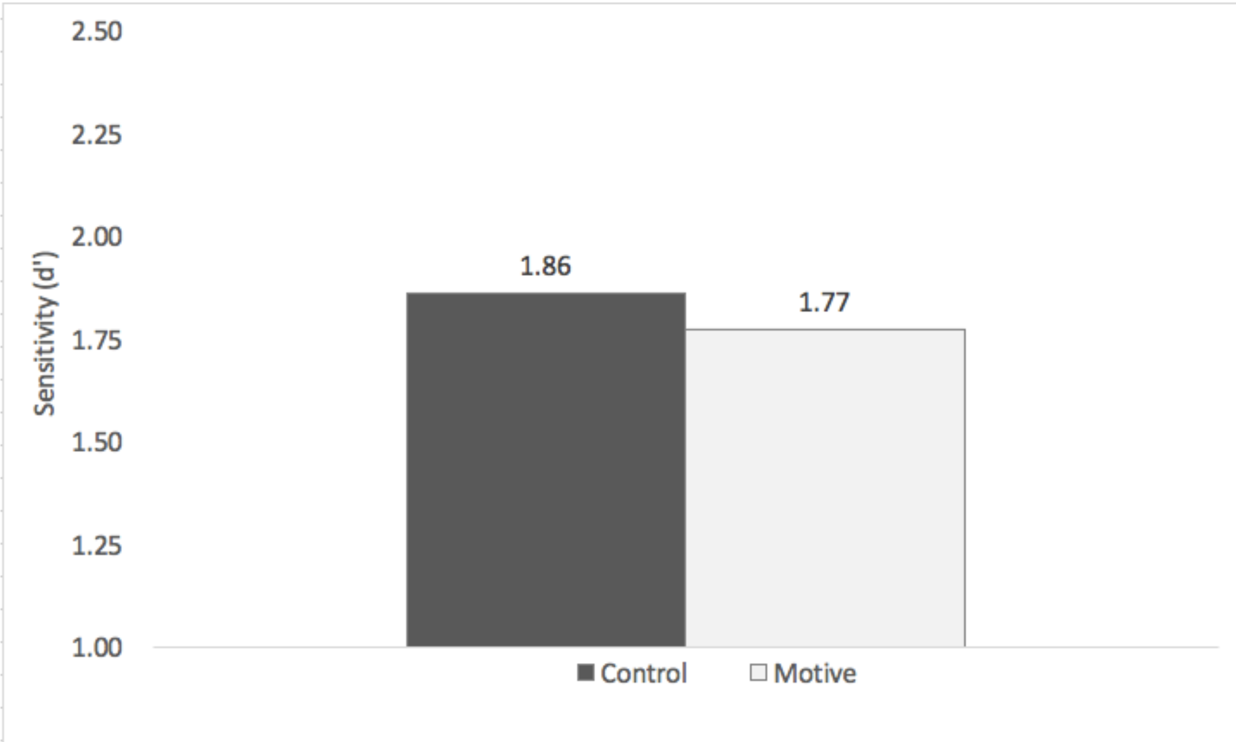

Figure 3. Main effect of instructions on sensitivity.

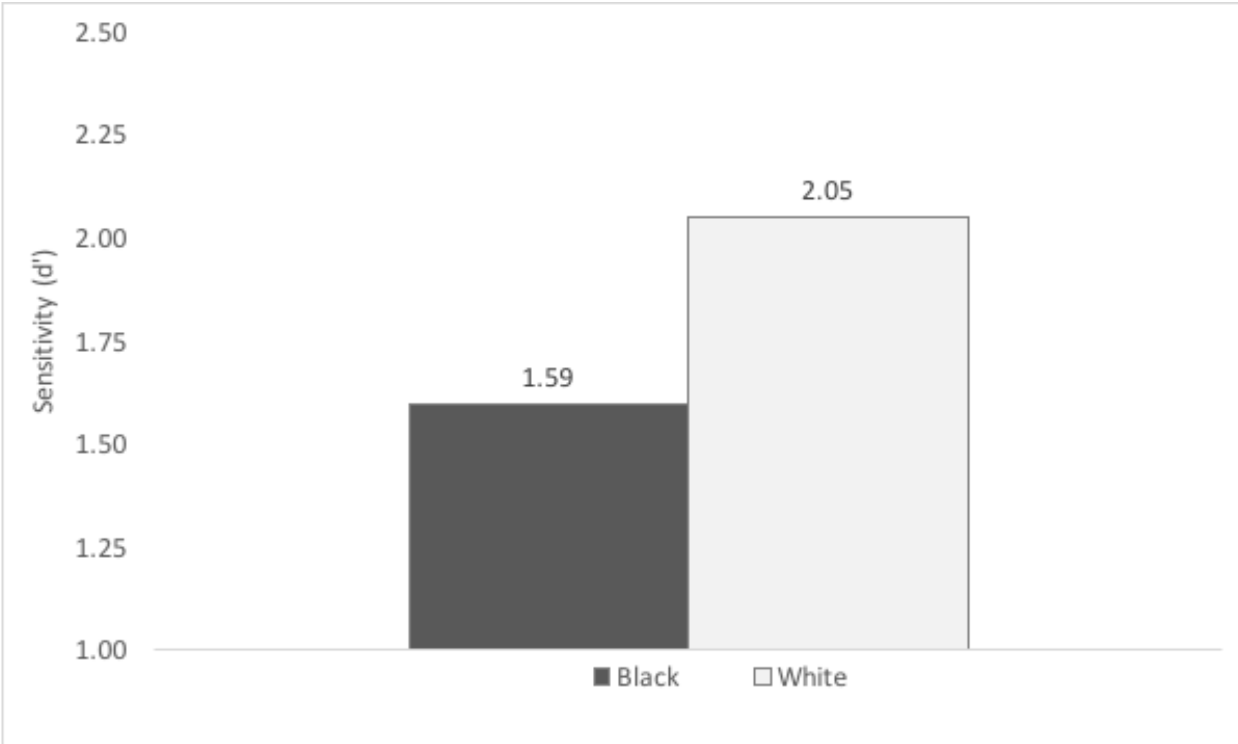

Figure 4. Main effect of race on sensitivity.

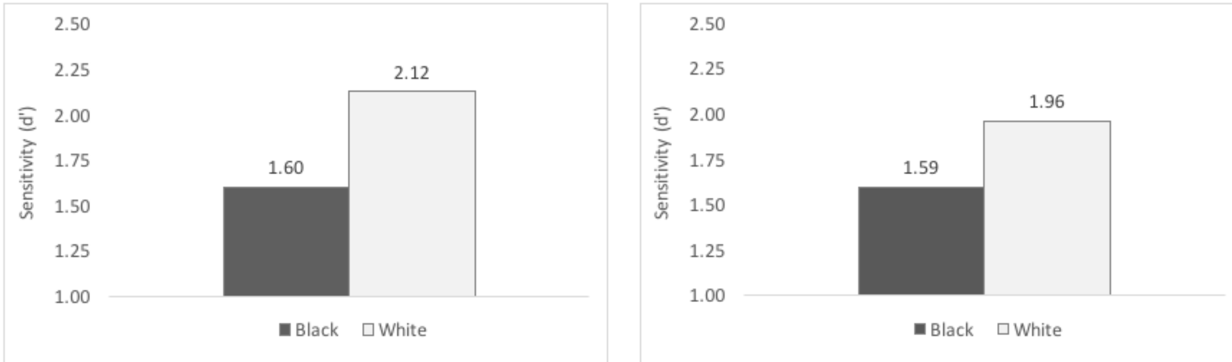

Figure 5. Single effects. CRE in the control condition (left). CRE in the experimental condition (right).

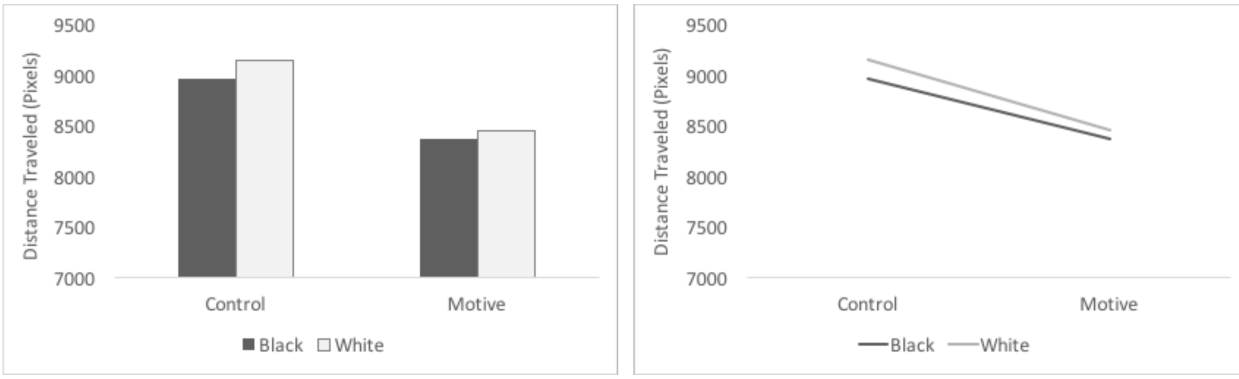

Figure 6. Eye distance traveled as function of target race (Black or White faces) and instruction (control or experimental group).

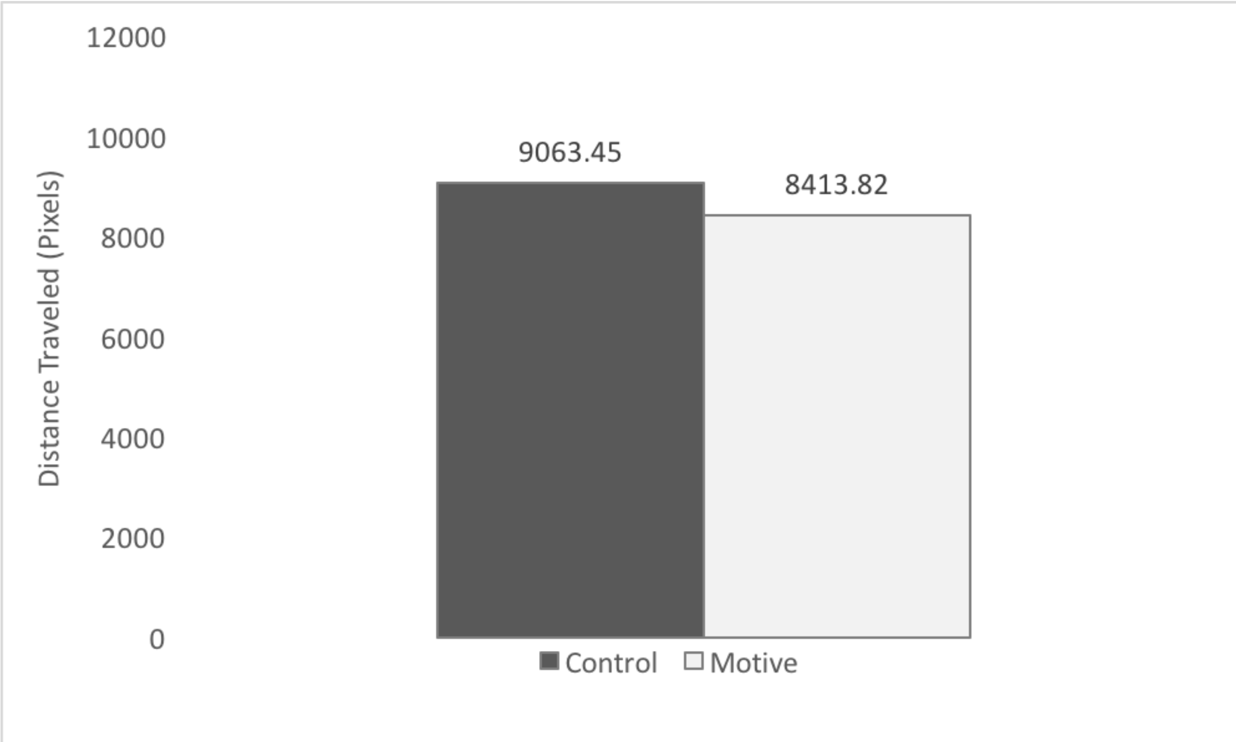

Figure 7. Main effect of instructions on eye distance traveled.

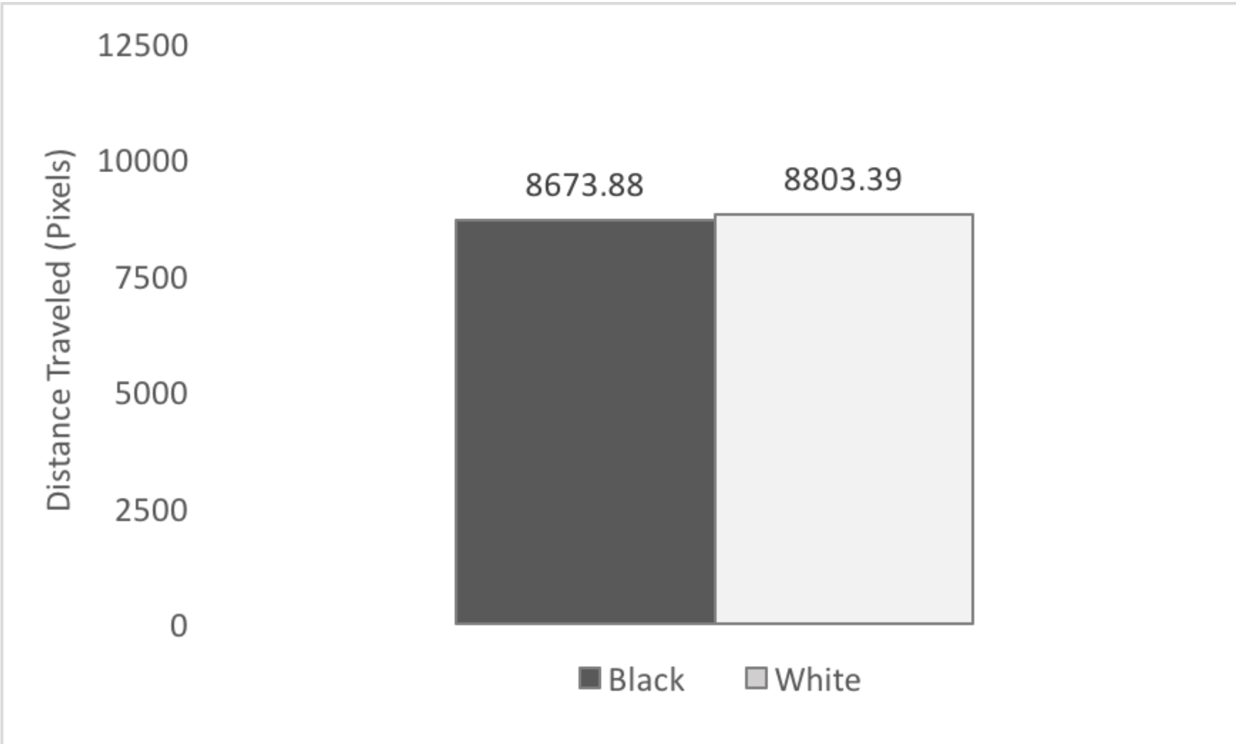

Figure 8. Main effect of race on distance traveled.

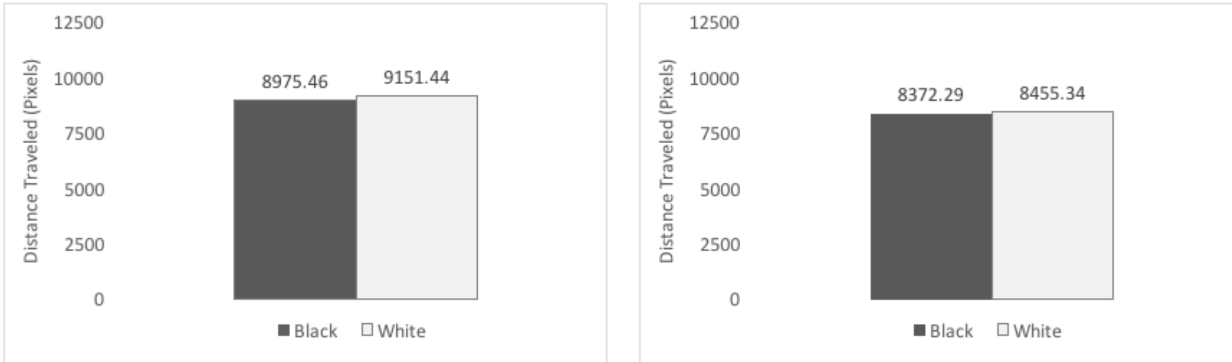

Figure 9. Single effects. Distance traveled in the control condition (left). Distance traveled in the experimental condition (right).

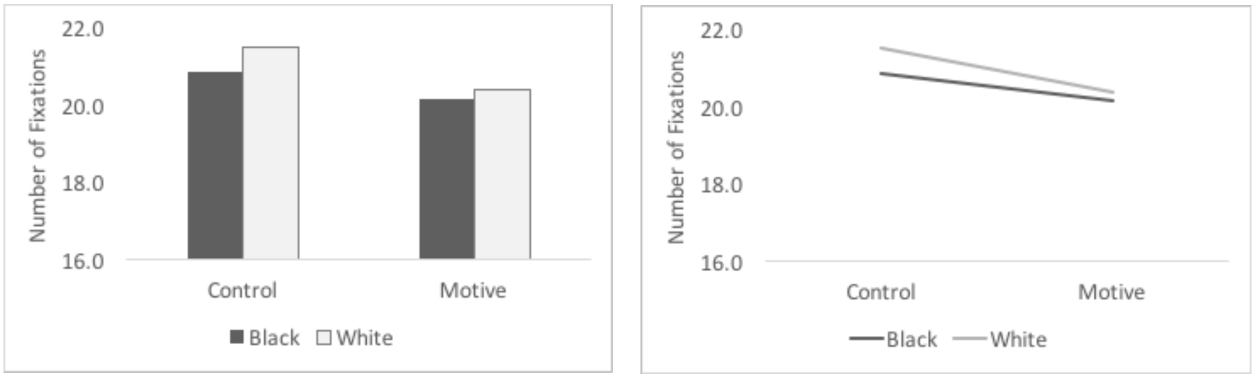

Figure 10. Number of fixations as function of target race (Black or White faces) and instruction (control or experimental group).

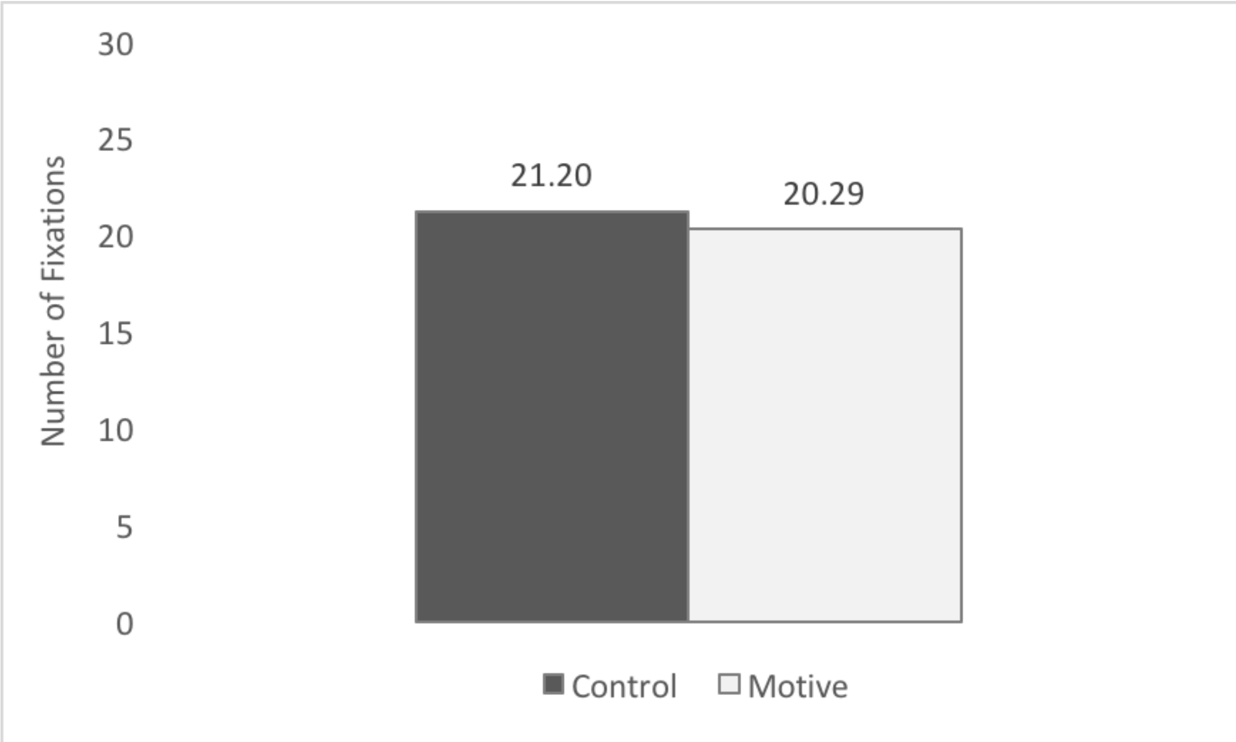

Figure 11. Main effect of instructions on number of fixations.

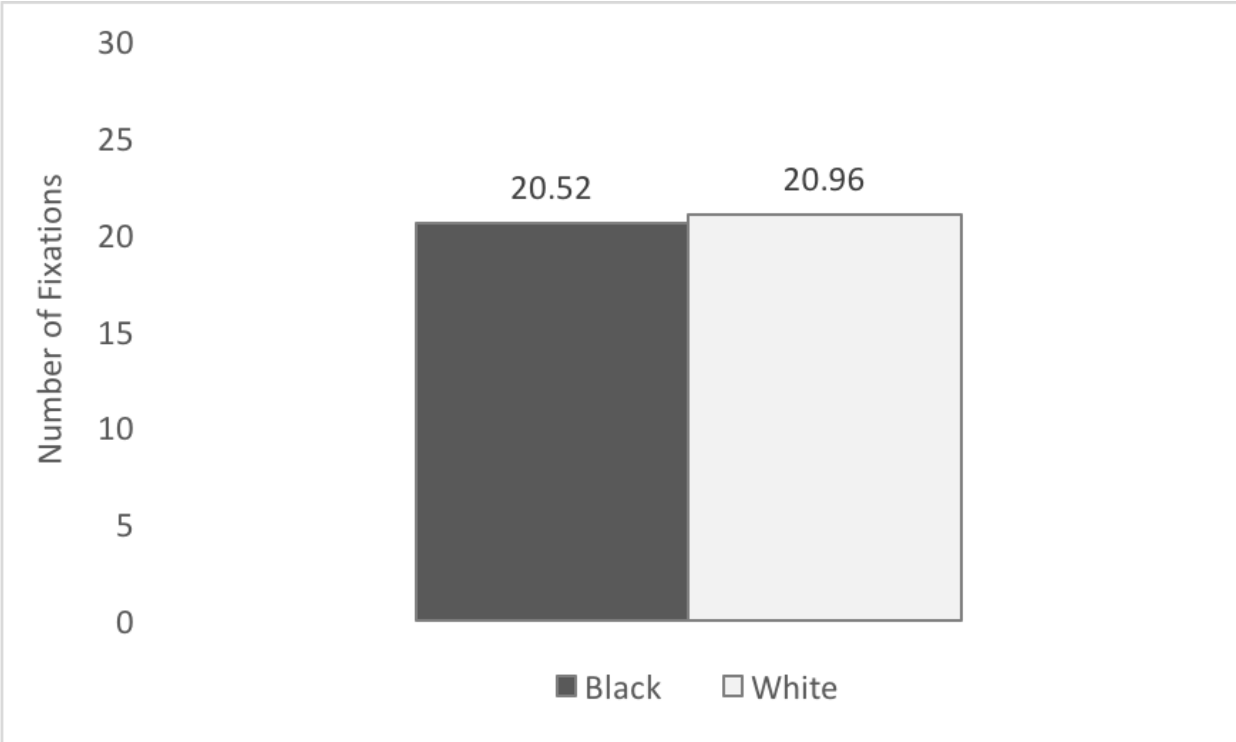

Figure 12. Main effect of race on number of fixations.

Figure 13. Single effects. Number of fixations in the control condition (left). Number of fixations in the experimental condition (right).

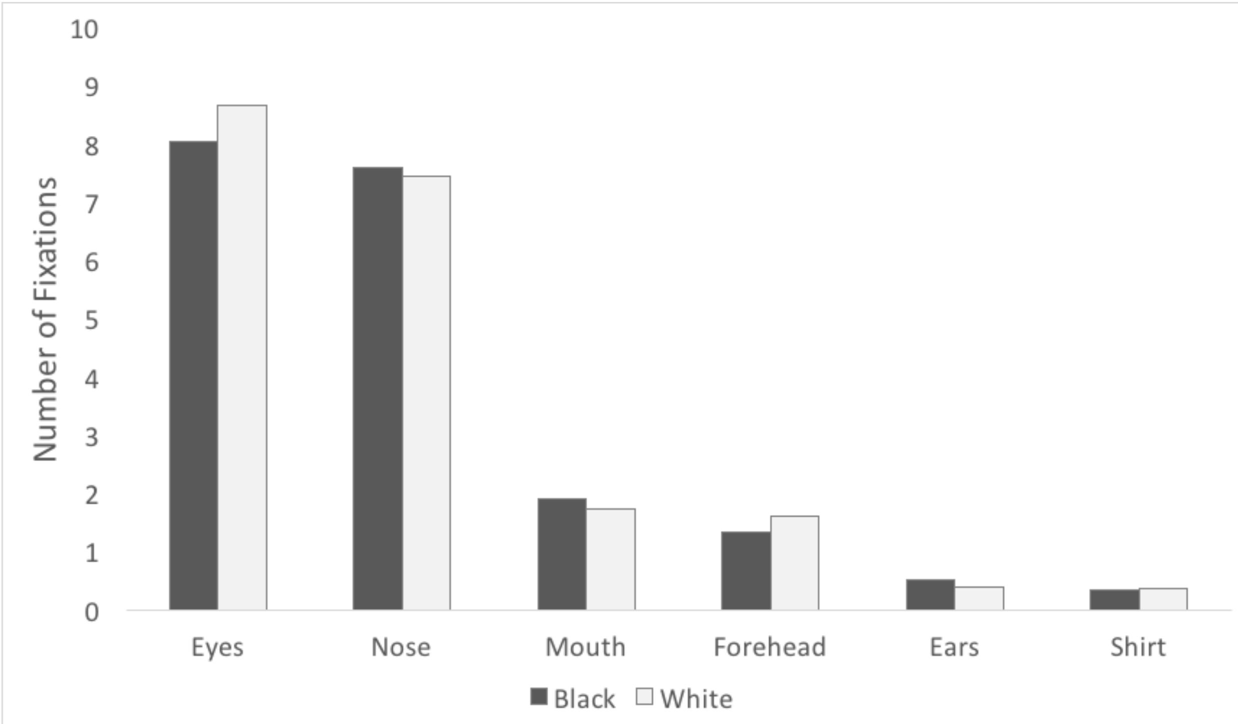

Figure 14. Number of fixations per area of interest per face, for both Black and White faces.

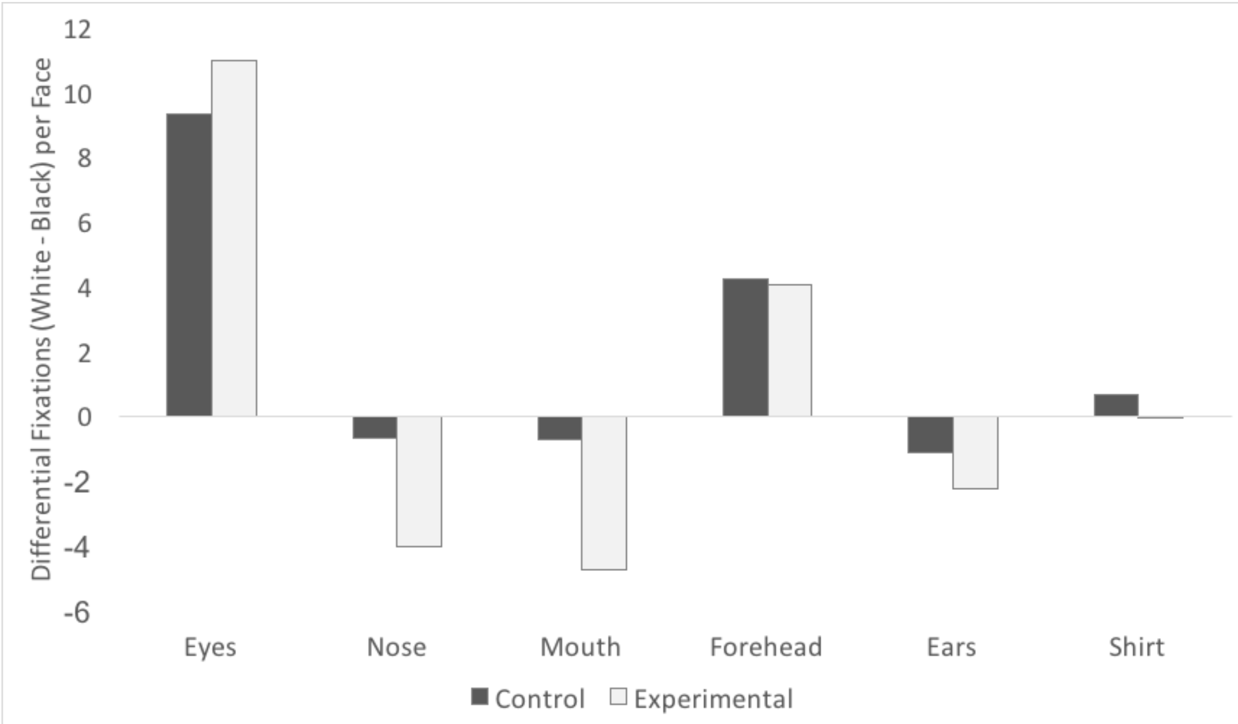

Figure 15. Effect of instructions on differential fixations (White minus Black) per interest area.

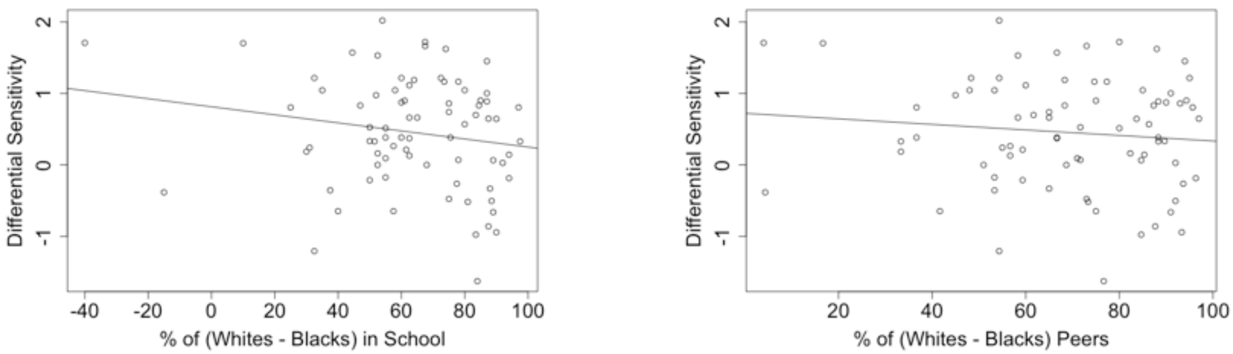

Figure 16. Differential sensitivity to White and Black faces in the CRE task as function of reported exposure to racial differences. Percentage of White minus Blacks schoolmates (left). Percentage of White minus Black peers (right).

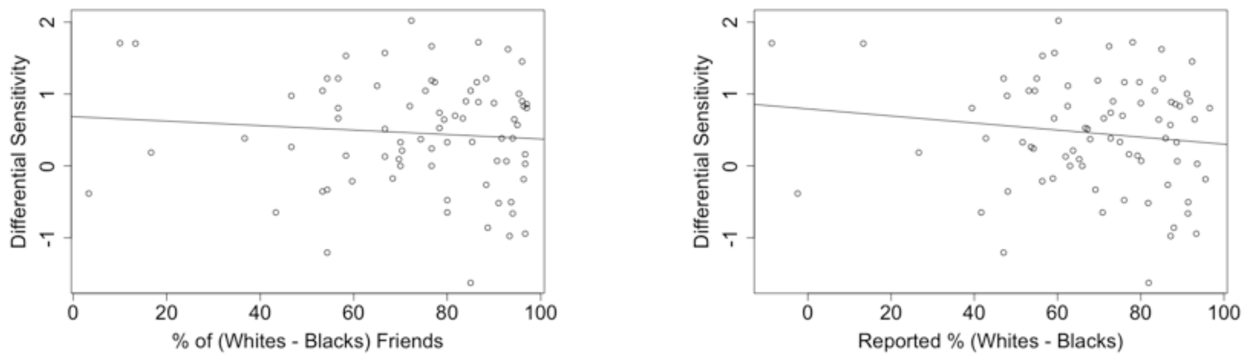

Figure 17. Differential sensitivity to White and Black faces in the CRE task as function of reported exposure to racial differences. Percentage of White minus Blacks friends (left). Composite of all the reported racial differences (White minus Black) schoolmates, peers, and friends (right).

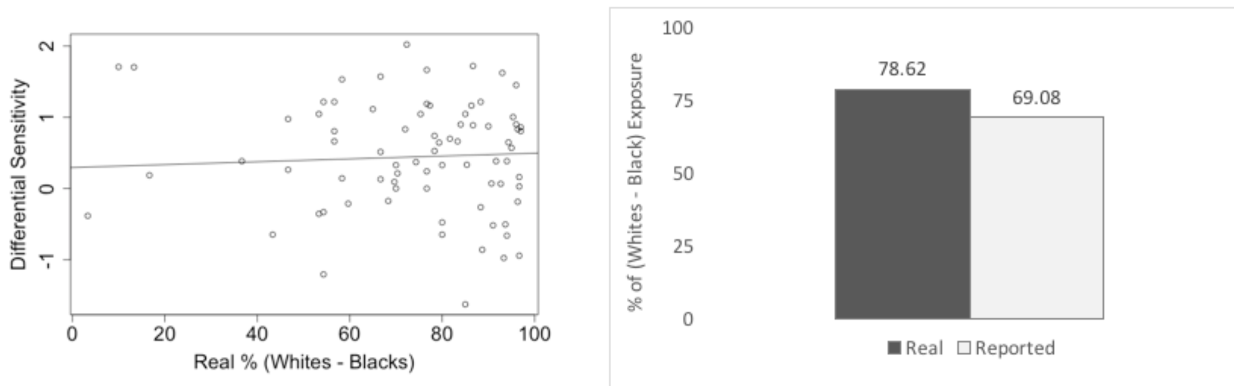

Figure 18. Differential sensitivity to White and Black faces in the CRE task as function of exposure to racial differences (Whites minus Blacks) as per the 2010 General Population and Housing Characteristics Census data (left). Average demographic difference (Whites minus Blacks) between the census data and what was reported by participants (right).

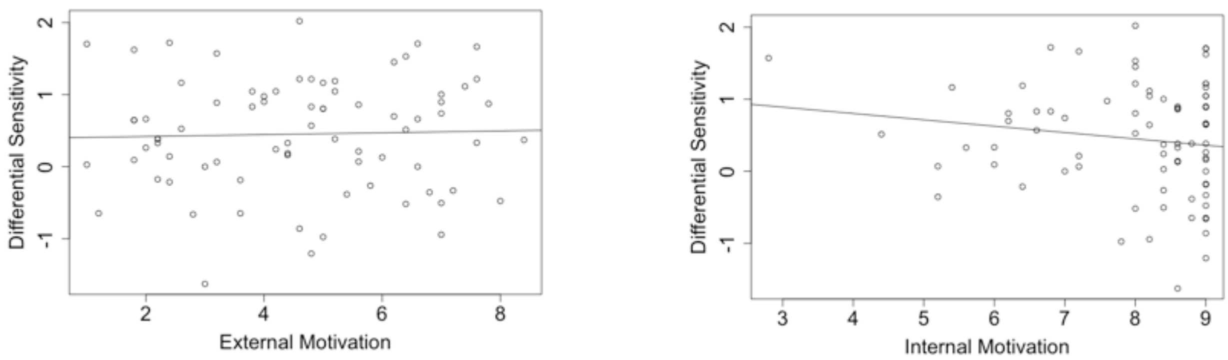

Figure 19. Differential sensitivity to White and Black faces in the CRE task as function of motivations to respond without prejudice. External motivations (left). Internal motivations (right).

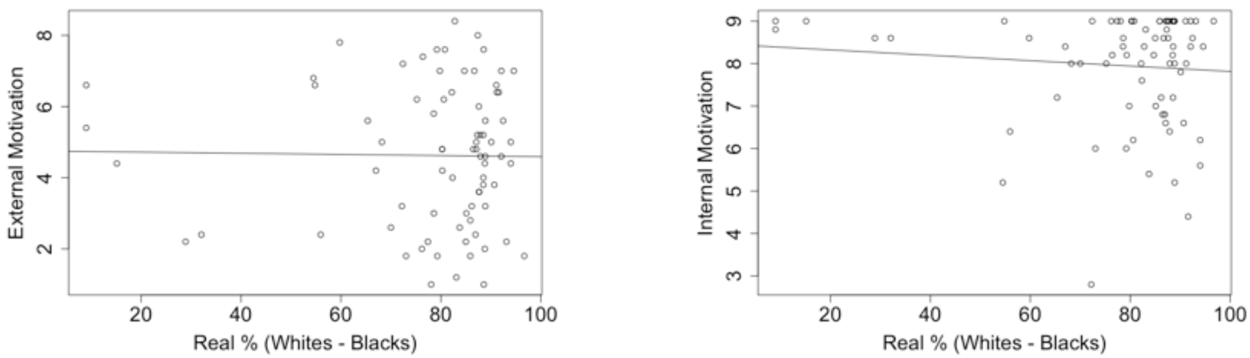

Figure 20. Differential racial exposure (Whites minus Blacks) as per US Census Bureau data versus motivations to respond without prejudice. External motivations (left). Internal motivations (right).

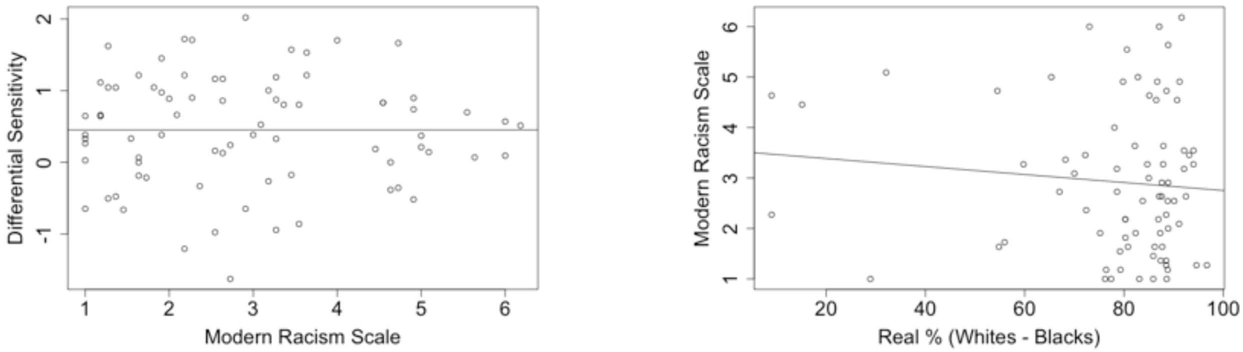

Figure 21. Differential sensitivity to White and Black faces in the CRE task versus Modern Racism Scale (left). Modern Racism Scale as function of differential race exposure (Whites minus Blacks) as per the US Census Bureau data (right).

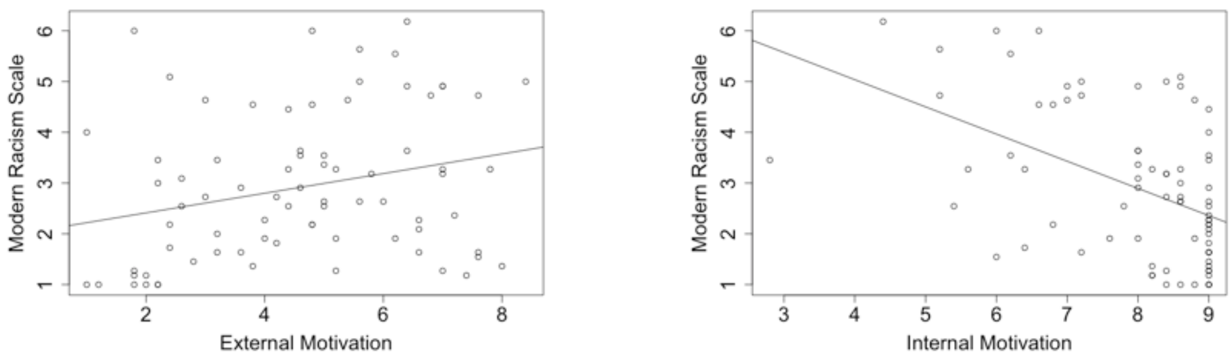

Figure 22. Modern Racism Scale versus motivations to respond without prejudice. External motivations (left). Internal motivations (right).