The Fusiform Face Area Responds Differently to African American and Caucasian Faces in Emotional Contexts

Emma Schifsky ‘16, Demontre Rich ‘21, Damien Fair, Binyam Nardos

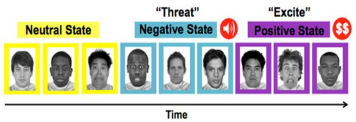
Oregon Health & Science Behavioral Neuroscience Department, Lewis & Clark College

Introduction

The United States is currently divided about the presence and severity of racial discrimination, specifically towards African Americans. The **Black Lives Matter** movement was sparked by the rise of viral videos exposing the impulsivity of police officers to use lethal force disproportionately towards African Americans, yet this movement was discredited with the response that **All Lives Matter**, which refutes the notion that police officers and society view black people differently than white people. If the latter is true, then citizens in emotionally arousing contexts, those typical of police officers on duty, should react the same to black and white citizens, which leads to our main question:

Is there a difference in behavior and brain activity after viewing a black or white face under different emotional contexts?

Methods



Participants Healthy, right-handed African-Americans (N=17, ages 19-25, 8 male) and Caucasians (N=39, ages 18-25, 15 male)

Experimental Task Cognitive Control Under Emotion (CCUE) task

- rapid emotional go/no-go impulse control task
  - a face cue appears for 500 ms followed by a jittered intertrial interval (2-7 s)
- participants press a button to one of three face cues under different emotional contexts
  - face cues: happy face, fearful face, calm face
    - cue race: equal amount of African American and Caucasian faces
  - emotional contexts: cued by a colored background
    - negative: “threat” anticipation of an aversive noise
    - positive: “excite” anticipation of a monetary reward
    - neutral: no anticipation of an aversive noise or reward
- NOGO trials investigated
  - withholding button-press responses to other two nonspecified face cues

fMRI Data Processing CCUE task completed in a Siemens Magnetom Trio 3.0 Tesla scanner while fMRI data was being collected

- voxelwise analysis using a general linear model (GLM) approach
- time as a seven level factor (7 frames following stimulus presentation) and blood-oxygen-level-dependent (BOLD) response modeled over a period of ~ 17.5s (7 frames, 2.5 s per frame)
- voxelwise analysis of variance conducted using cue race and emotional context as within-subject factors

Black and white participants are more impulsive to black faces

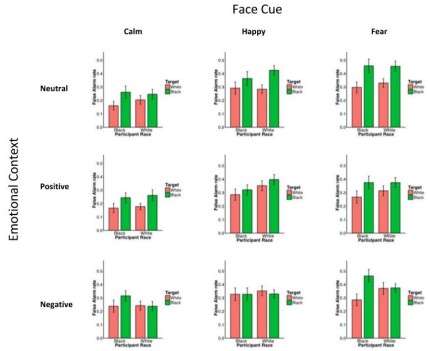


Figure 1. In the GO/NO-GO task conducted across a variety of emotional contexts, both black and white participants exhibit higher false alarm rates for black faces, particularly when instructed to detect fearful faces. False alarm rates are compared across emotional contexts (positive, negative, neutral), face cue (calm, happy, fearful), and participant race (African American, Caucasian). False alarms are the percentage of trials in which participants incorrectly press a button for a non-instructed face cue type. Face cues are separately shown for black (green) and white (red) target faces.[1]

The Fusiform Face Area shows significant interactions between cue race and emotional context

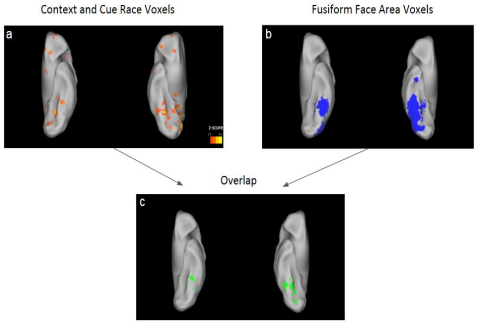


Figure 3. Voxels exhibiting significant interactions between cue race and emotional context overlap with voxels acquired from an independent meta-analysis conducted to identify the fusiform face area. (a) A ventral view of the voxelwise cue race X context z-stat map shown in Figure 2 **(b)** Voxels identified using the search string “FFA” and a reverse-inference meta-analytic approach from the Neurosynth database[7] **(c)** Voxels that overlap between the maps shown in (a) and (b).

Multiple regions show significant interactions between cue race and emotional context

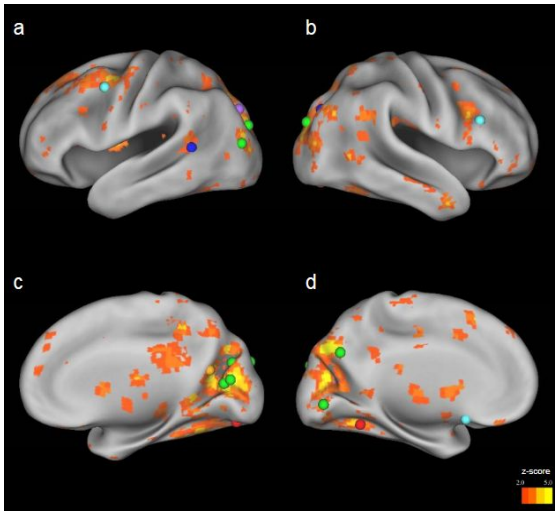


Figure 2. Based on a whole-brain voxelwise ANOVA conducted on NO-GO trials in which participants were expected to inhibit a button-press response, 17 regions were identified showing significant interactions between cue race and emotional context. Displayed on a CARET surface[5,6] is the voxelwise z-statistic ANOVA map showing voxels, color-coded by z-scores ($2 < Z < 5$), that showed interactions between cue race (black, white) and emotional context (positive, negative, neutral). Overlaid on the voxelwise image are the 17 regions, extracted using an in-house peak-extracting algorithm, in which the cue race X emotional context X time (7 MR frames) was statistically significant ($z > 3$, $p < 0.05$) after correction for multiple comparisons. Regions are represented as spheres and colored by lobes: occipital, parietal, temporal, limbic, frontal, and cerebellum. Panels show lateral (**a**,**b**) and medial (**c**,**d**) surfaces of the left (**a**,**d**) and right hemispheres (**b**,**c**).

The FFA elicits different levels of activity to black and white faces in positive and negative contexts

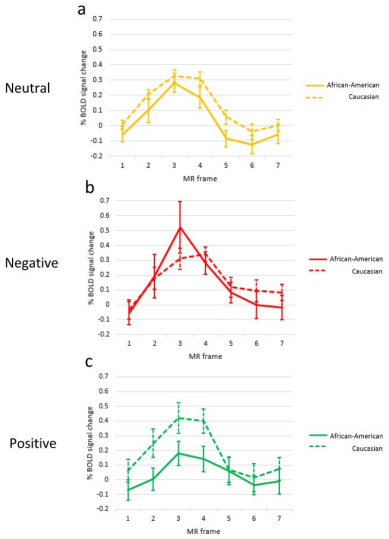


Figure 4. Fusiform Face Area BOLD activity for African-American and Caucasian faces is similar in a neutral context, but differs in positive and negative contexts. The exemplar region is in the Fusiform Face Area (FFA) and corresponds to the Talairach atlas coordinates +41 -50 -21. BOLD response is modeled over a period of ~ 17.5s (7 frames, 2.5 s per MR frame). Emotional contexts include (**a**) neutral (no anticipation of an aversive noise or reward), (**b**) negative (threat: anticipation of an aversive noise), and (**c**) positive (excitement: anticipation of a reward).

Conclusion

There is a difference in behavior and brain activity after viewing black or white faces under different emotional contexts

Both black and white participants were more impulsive to black faces especially when told to react to a fearful face (Fig.1), which suggests **emotional processing is involved in race perception.** Multiple regions showing significant interactions between cue race and emotional context were identified (Fig.2). In one exemplar region in the Fusiform Face Area (FFA), black and white faces elicited similar levels of activity in a neutral context (Fig.4a), while exhibiting differential levels in emotional contexts. In the positive context, greater activity was elicited for Caucasian faces (Fig.4c) whereas in the negative context greater activity was elicited for African-American faces (Fig.4b). This suggests **inherent differences in how the brain responds to race that is linked to the emotional context in which it was perceived**. Most of the identified regions are associated with visual perception (Fig.2), including the FFA (Fig.3), which prior research has shown to be involved in characterizing facial features including race[2,3,4]. The FFA responds oppositely to black and white faces in positive and negative contexts (Fig 4), which suggests that the **Fusiform Face Area processes physical characteristics like race in an emotional context-dependent manner.**

Future Studies

Is there a difference in brain activity after viewing a black or white face under different emotional context

- for GO trials?
- with more participants?
- with an equal distribution of participant race?
- between participant races?
- related to false alarm rates?

References

1. Cohen *et al.* (2016) *MacArthur Work Groups on Adolescence and Threat Perception Joint Coll.* Unpublished
2. Contreras JM *et al.* (2013) *Multivoxel Patterns in Fusiform Face Area Differentiate Faces by Sex and Race.* PLoS ONE 8(7)
3. Kim JS *et al.* (2006) *Racial distinction of the unknown facial identity recognition mechanism by event-related fMRI.* Neuroscience Letters 397(3): 279-284
4. Ratner *et al.* (2012) *Is race erased? Decoding race from patterns of neural activity when skin color is not diagnostic of group boundaries.* Soc Cogn Affect Neurosci.
5. Van Essen et al. (2001) *An Integrated Software System for Surface-based Analyses of Cerebral Cortex.* Journal of American Medical Informatics Association. 8(5): 443-459
6. Van Essen, D.C. (2002) *Windows on the brain: The emerging role of atlases and databases in neuroscience.* Curr. Op. Neurobiol. 12: 574-579
7. Yarkoni et al. (2011) *Large-scale automated synthesis of human functional neuroimaging data.* Nature Methods 8(8): 665-670

Acknowledgments

Community Engagement & Leadership in Science (CELS) Summer Research Program

MacArthur Foundation Research Network on Law and Neuroscience

John S. Rogers Science Research Program

James F. and Marion L. Miller Foundation