ADAPTATION TO RACIAL CONTENT OF EMERGENT RACE FACES: GRADIENT SHIFT OR PEAK SHIFT?

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Abstract

At the heart of stereotypes, attitudes, and misidentifications involving race is the question of how faces are initially categorized according to race. We examined racial classification using a continuum of morphed faces resulting from African-American and Caucasian 'parent' faces whereas an emergent Hispanic race is perceived at the center of the continuum. Using the method of adaptation, observers adapted to either a novel African-American or a Caucasian face prior to classifying race. A peak shift was found similar to stimulus discrimination training in animal subjects (Hanson, 1959). These results were unexpected as it has been commonly thought that adaptation to faces results in a gradient shift (MacLin & Webster, 2001), and the fact that no discrimination training was used to acquire the peak shift. Results are discussed in terms of Helson's (1964) adaptation level theory. The authors conclude that psychophysics can be effectively used to answer social psychological questions.

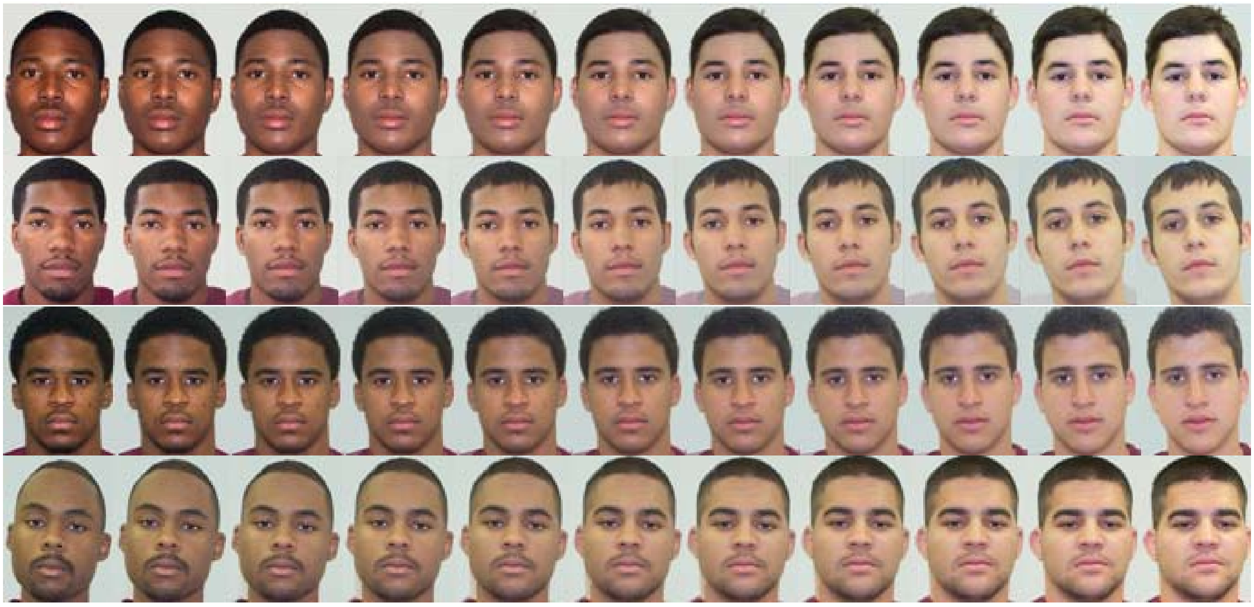
At the heart of stereotypes, attitudes, and misidentifications involving race is how faces are initially categorized according to race. From an applied perspective, issues surrounding race, ethnicity, and out-group membership are important. However, we have been examining the perceptual processes that underlie higher-order cognitive processes such as racial classification that may lead to social problems such as prejudice. A cognitive gating model we have developed (MacLin & MacLin, in press), is based on the premise that the brain is actively seeking facial properties that are characteristic of other-race faces. We have been examining the basic cognitive processes underlying face perception which in turn provides the basis for racial classification, using psychophysical methods.

Given that psychophysics is the study of how humans (in particular) detect events and stimuli in their environment, one can imagine that psychophysical methods could be used to study how humans detect social events and stimuli in the environment (Gescheider, 1997). Instead of lights, tones, and colors, social stimuli (such as faces) can be studied using psychophysics. Given the need for continuous stimuli, we morphed two face images to create a facial stimulus continuum, and then designed studies using psychophysical methodology and specialized software to collect participant responses (MacLin, MacLin, Peterson, Chowdhry, & Joshi, 2009).

One method we use is adaptation. Perceptual adaptation occurs as the perceptual system adjusts to new environmental conditions (Wade & Verstraten, 2005). Researchers suggest that we are under a constant state of adaptation with our perception of faces dynamically altered by experience with the environment. Thus, our perception of faces and face space is altered by the faces we see (MacLin & Webster, 1996; Rhodes, et al., 2005; Webster et al., 2004). The first study to demonstrate that adaptation could be used to study complex visual patterns such as faces was carried out by Webster and MacLin (1999) (also see MacLin & Webster, 1996, 1998, 2001). A staircase method was used by MacLin and Webster (2001) to evaluate how adaptation affects the perception of face space. In this study, the face images were distorted by expanding or contracting the frontal-view image of the face relative to a midpoint on the nose. Observers were presented with a facial image and asked to report whether the face was

“Normal” or “Distorted.” If the observation report was “Normal,” a face located farther out in the Cartesian space was presented. However, if the image was reported “Distorted,” an image closer to the center of the space was presented. MacLin and Webster (2001) found that the perceptual space shifts away from the adapting stimulus in a manner similar to how adapting to color shifts the perceptual color space (Webster & Mollon, 1995). In color space, adapting to the color white produces no shift because it represents the center of the perceptual space. MacLin and Webster (2001) found similar results with little to no shift occurring for the average, non-distorted face.

In our initial studies using morphed facial continua, we assumed that faces in the center of the continuum would be ambiguous as to race. We quickly found however, that faces in the middle of the continuum are readily categorized as a race different from either of the two starting images used to create the continuum (Chowdhry, Joshi, Fantroy, Peterson, MacLin, & MacLin, 2008). Specifically, when observers are given a 3-AFC task allowing them to classify the face as “African-American,” “Caucasian,” or “Hispanic,” they often classify faces in the center of the continuum as Hispanic. Two racial boundaries can now be defined ‘African-American / Hispanic’ and Hispanic / Caucasian.’ Example images from various continua created in our laboratory are displayed below. Anchor images denote the images from each preliminary racial category morphed to create images along the resulting continua. Middle images along each of the continua represent the mathematical average from the combination of each anchor image.



While we know the racial boundary shifts (MacLin & Webster, 2001; Webster, Kaping, Mizokami, & Dunamel, 2004), how are the other faces in the continuum affected by adaptation? For example do the faces previously classified as Caucasian, look more Caucasian after adaptation to an African-American face? In other words is the shift systematic or is only the perception of the faces around the racial boundary affected? If a systematic shift occurs, an equivalent shift should be evident for both racial boundaries.

Method

Stimuli were created using one Caucasian and one African American face from a database courtesy of Christian Meissner at the University of Texas, El Paso. The Caucasian image and

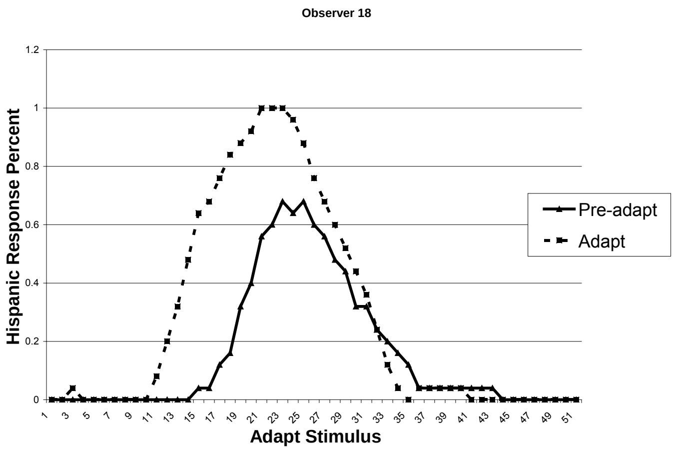
African American image were both cropped to maintain a 3:4 aspect ratio, prior to morphing these two images using Abrosoft's FantaMorph 3.0. A morph movie consisting of 100 frames was created from which we captured one image at an interval of every 2 frames within the movie by exporting and saving each image as a bitmap file, resulting in a total of 51 color images along the created stimulus continuum (eleven faces are shown below; the middle image is the mathematical average between the anchor African American image and Caucasian image).

The order of the images displayed was randomized throughout a total of 10 presentations (5 during pre-adaptation; 5 during post-adaptation) of each of the 51 facial images along the continuum. Combined with this psychophysical method of constant stimuli, a three alternative forced-choice paradigm was used in which each observer categorized facial images, presented within an area of 300 by 375 pixels via a Dell 17 inch computer monitor, as Caucasian, African American, or Hispanic using buttons, each labeled as one of the three ethnic category response options.

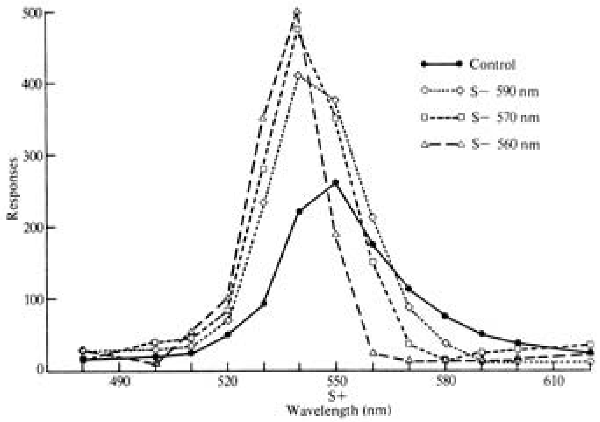
In a pre-adaptation phase of the experiment, every observer first viewed a grey uniform area (300 by 375 pixels) for 180 s prior to viewing the 5 randomized presentations of each facial image along the stimulus continuum. A 2.5 s inter stimulus interval immediately followed the presentation of each facial image. The inter stimulus interval consisted of a 250 ms visual mask followed by a 2 s top-up presentation of the adaptation image (i.e., grey uniform area during pre-adaptation) followed by the initial visual mask, again for 250 ms. Then, in the post-adaptation phase of the experiment, observers either viewed an African American or Caucasian facial image (different from the two original faces used to create the stimulus continuum), for 180 s prior to viewing 5 randomized presentations of each facial image along the stimulus continuum. With one exception, the 2.5 s inter stimulus interval between each facial image during the post-adaptation phase of the experiment was identical to the inter stimulus interval used in the pre-adaptation phase. In the post-adaptation phase, the 2 s top-up presentation of the adaptation image consisted of either the African American or Caucasian image which was initially presented at the beginning of the post-adaptation phase. Instructions to all observers included mention of the importance of directing their full attention toward the facial images presented on their computer monitor at all times during the experiment.

Results

We found after adapting to an African-American face, only the African-American / Hispanic racial boundary was affected ($t(17)=8.46$, $p < .001$). No significant shift was found for the Hispanic / Caucasian racial boundary ($t(17)=1.25$, not significant (NS)) . Additionally, we found what is referred to in the behavioral literature as a 'peak shift' ($t(17)=2.97$, $p < .01$) (see figure below).



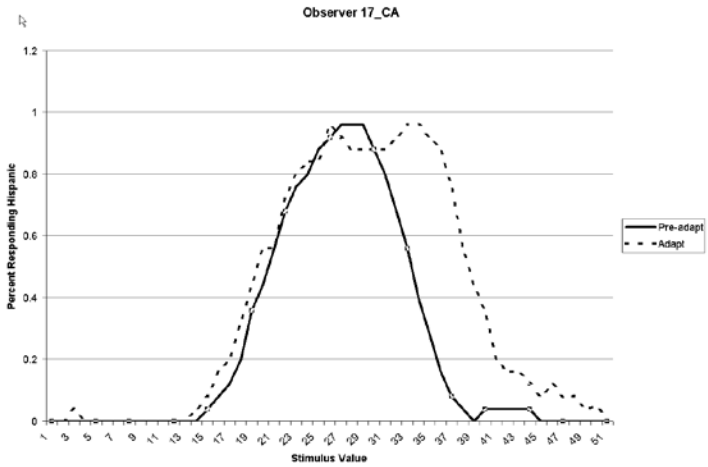
Peak shift occurs after discrimination training in animals where they are reinforced for responding to a particular stimulus property (s+) and not reinforced for responding to another nearby property (S-) (Hanson, 1959). With peak shift, not only is the boundary on the S+ side shifted away from the S- during testing trials, but responding to adjacent values on the S+ side are higher as well (see figure below).



This asymmetric pattern of responding is exactly what we have found in observer responses in the absence of discrimination training, and would argue that the discriminations were learned naturally. One explanation for peak shift in the behavioral literature is the adaptation level theory which hypothesizes that the shift occurs as a result of adaptation to the test values (Helson, 1947). Values that have no impact on subsequently viewed stimuli are thought to be at the adaptation level, whereas values above or below the adaptation level cause shifts in either appropriate direction when encountering novel stimuli. Moreover, Helson’s (1947) adaptation-level theory states that while the stimuli presented during experimental procedures factor into the adaptation level, all other previously viewed stimuli of interest (e.g., faces) also play a role. As such, the natural learning process of exposure to, in this case, faces in various environments may factor into the seemingly constant process of re-calibration of the adaptation level. Researchers have attempted to test the adaptation level theory on humans using faces as stimuli (Spetch, Cheng, & Clifford, 2004; Lewis & Johnston, 1999; Verbeek, Spetch, Cheng, & Clifford, 2006) with mixed results.

We next had a second group of observers complete the study by adapting to a Caucasian face. If a peak shift does occur, will it be located along the African-American / Hispanic racial boundary or the Hispanic / Caucasian racial boundary? When observers adapted to a

Caucasian face, the shift occurred along the Caucasian / Hispanic racial boundary ($t(21)=4.43$, $p < .001$). No significant shift was found along the African-American / Hispanic boundary ($t(22)=0.13$, NS). A significant shift in the peak was also found ($t(21)=2.61$, $p < .05$). Clearly the shift is not symmetric and it occurs along the boundary nearest to the adapting stimulus (see figure below).



Discussion

Here we show that the perceptual shift is sometimes asymmetric in the form of a ‘peak shift’ once thought only to a product of discrimination training. We also show that the stimulus properties of race do not always follow a continuum; in fact a third emergent race is often perceived in the center of the stimulus continuum. Although all the faces along the continuum contain information from an African American and a Caucasian face, there is no perception of “African American” at for example, the Hispanic to Caucasian boundary along the continuum. If there were, the data would not have indicated an asymmetric shift along this border dependent upon the adaptation stimulus (i.e., either Caucasian or African American). Thus, it appears that the adaptation occurs categorically and is ultimately dependent upon the amount of racial information in the face present. If enough facial information is available characteristic to a particular racial category, this will drive subsequent processes such as racial categorization. These findings suggest that the perceptual shift resulting from adaptation is not symmetric as we once thought, that the perception of race does not follow the mathematical properties of the face, and that peak shift can occur in humans without discrimination training.

References

Chowdhry, O., Joshi, P., Fantroy, E., Peterson, D., MacLin, M. K., & MacLin, O. (2008). *Perceptual discontinuities in the perception of other race faces: Implications for examining the cross-race effect*. Paper presented at the American Psychology-Law Society Annual Conference, Jacksonville, FL.

Gescheider, G. A. (1997). *Psychophysics: The fundamentals*, (3rd ed). Mahwah, NJ: Lawrence Erlbaum Associates.

Hanson, H. M. (1959). The effects of discrimination training on stimulus generalization. *Journal of Experimental Psychology, 58,* 321-334.

Helson, H. (1947). Adaptation-level as a frame of reference for prediction of psychophysical data. *The American Journal of Psychology, 60,* 1-29.

Lewis, M. B., & Johnston, R. A. (1999). Are caricatures special? Evidence of peak shift in face recognition. *European Journal of Cognitive Psychology*, 11, 105-117.

MacLin, O. H., & MacLin, M. K. (in press) The role of racial markers in race perception and racial categorization. In R. Adams, N. Ambady, K. Nakayama, & S. Shimojo (Eds.). *People watching: The social ecology of visual perception*. Oxford University Press.

MacLin, O. H., & Webster M. A. (1998). Visual adaptation and the perception of distortions in natural images. In B. E. Rogowitz and T. N. Pappas (Eds.) *Human vision and electronic imaging III, SPIE 3299,* 264-273.

MacLin, O. H., & Webster, M. A. (2001). The influence of adaptation on the perception of distortions in natural images. *Journal of Electronic Imaging special section on Human Vision and Electronic Imaging*, 10, 100-109.

MacLin, O. H., & Webster, M. A. (June, 1996). *Adaptation and face recognition.* Proceedings of the 77th Annual Conference of the American Association for the Advancement of Science - Pacific Division, San Jose, CA. [Abstract published in proceedings].

MacLin, O. H., MacLin, M. K., Peterson, D., Chowdhry, O., & Joshi, P. (2009). Social psychophysics: Using psychophysics to answer “social“ questions with PsychoPro. *Behavior Research Methods*, 41, 623-632.

Rhodes, G., Robbins, R., Jaquet, E., McKone, E., Jeffery, L., & Clifford, W. G. (2005). Adaptation and face perception – How aftereffects implicate norm-based coding for faces. In C. Clifford, & G. Rhodes (Eds.). *Fitting the mind to the world*. University Press: Oxford.

Spetch, M. L., Cheng, K., & Clifford, C. W. G. (2004). Peak shift but not range effects in recognition of faces. *Learning & Motivation*, 35, 221-241.

Verbeek, E. L., Spetch, M. L., Cheng, K., & Clifford, C. W. G. (2006). Determinants of range effects in face recognition. *Learning and Behavior, 34*(3), 229-240.

Wade, N. J. & Verstraten, F. A. J. (2005). Accommodating the past: a selective history of adaptation. In C. Clifford & G. Rhodes (Eds) *Fitting the Mind to the World: Adaptation and Aftereffects in High-Level Vision. Volume 2, Advances in Visual Cognition Series*. Oxford University Press.

Webster M. A., & Mollon, J. D. (1995). Color constancy influenced by contrast adaptation. *Nature*, *373*(23), 694-698.

Webster, M. A., & MacLin, O. H. (1999). Figural after-effects in the perception of faces. *Psychonomic Bulletin and Review*, *6*, 647-653.

Webster, M. A., Kaping, D., Mizokami, Y., & Dunamel, P. (2004). Adaptation to natural facial categories. *Nature, 428,* 557-561.