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Preferred Skin Color Rendition for Self-Representative Faces and Avatars in Augmented Reality

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Abstract

Optical see-through augmented reality (OST-AR) is a technology that allows humans to superimpose graphical elements over the natural environment through a transparent medium. When graphical elements are dark or ambient light is bright, color blending can cause graphical elements to appear transparent. In particular, graphical human faces that have darker skin tones appear more transparent than those with lighter skin tones, introducing both perceptual and social challenges. In this work, a psychophysical experiment assesses observers' preferred renderings of skin tones in OST-AR. Observers were asked to adjust the lightness of faces superimposed by OST-AR glasses under a bright ambient lighting condition. The stimuli comprised photos of real faces, their corresponding digital avatars, and included those representing the observer and zero-acquaintance targets. We found that observers tended to increase lightness more as faces became darker for both real faces and avatars, but that this pattern was not evident when adjusting photos of their own faces. These results indicate that color preferences for facial color in OST-AR may operate differently depending on familiarity with the target being evaluated, indicating a need for further research involving self-representative stimuli.

Introduction

Augmented reality (AR) is a technology that enables humans to superimpose visual elements over the 'real world'. One common implementation of AR technology is optical see-through AR (OST-AR) in which the surrounding environment is viewed directly through a transparent medium, while also displaying graphical elements via reflection. However, OST-AR faces a major challenge in color appearance: the additive light mixture results in color blending where light in the environment impacts the appearance of the graphical elements [1]. This can cause graphical elements to be perceived as transparent, especially in environments with high luminance or when the graphical elements are dark [2]. Graphical elements require 40 to 60 times as much luminance on the OST-AR display than in the background to eliminate all perceived transparency, which is physically challenging as ambient luminance increases [3].

Virtual humans appear in a wide range of OST-AR applications, including medical training [4][5], socialization [6][7], education [8][9], assistive technology [9], police training [10], and entertainment [11]. The challenge of color appearance in OST-AR disproportionately affects rendering humans having different skin tones; people having darker skin may appear more transparent than people with lighter skin in the same viewing environment. This can lead to a dehumanization effect in which transparent individuals are perceived as less human than those who are opaque [12], potentially creating unintentional biases in OST-AR social applications.

Some research has been done to understand what kinds of adjustments are needed to address OST-AR's challenges with color reproduction for skin. In color matching tasks, individuals with darker skin need a greater lightness increase to match the appearance of emissive faces than individuals with lighter skin [13][14]. The increase in lightness helps to mitigate the perceived transparency, however, such adjustments may impede preferred appearance [13]. Further, it has been demonstrated that some perceived transparency may sometimes be preferred to achieve a fidelitous appearance given varying ambient environments [15].

Color appearance of skin is used in daily life for a wide range of evaluations, including to assess health [16], identify disorders [17], estimate age [18], determine emotional state [19], and evaluate attractiveness [18]. Melanin content—which largely impacts skin tone—varies greatly both within and between geographic demographics [20]. As such, skin tone is commonly used as a primary indicator of race [21], though often incorrectly [22]. Addressing the color blending for facial stimuli in OST-AR is especially important because people are more sensitive to changes in facial color than colors viewed in isolation [23][24][25], suggesting that color is particularly salient when evaluating faces.

The vast majority of face perception research involves participants perceiving and evaluating faces belonging to zero-acquaintance targets (i.e., faces of strangers garnered from external databases). To our knowledge, research on color appearance of facial stimuli that represent the self (i.e., faces of the individuals evaluating them) is extremely limited. However, self-representative faces hold a special status; the ability for an individual to recognize oneself is a primitive form of self-awareness [26], and our own faces are part of what allows us to establish our identity [27]. Indeed, people pay more attention to self-representative face stimuli than they do faces of others [28], can recognize their own faces faster than they can recognize faces of close friends and family [29], and hold a higher concern for self-appearance than that of others [30]. Self-recognition has a unique neural representation as well. Facial recognition typically takes place in the fusiform face area [31], while recognition of self is correlated with right prefrontal cortex activity [32]. Considering the future of OST-AR as a medium for telepresence, the significance of self-representative faces, and the challenges of color reproduction in OST-AR, it is critical to better understand user preferences for OST-AR face appearance.

Virtual avatars have seen widespread use in extended reality environments, but how people assess and interact with avatars appears to be distinct from how they assess and interact with photographic and videographic representations of humans. Trustworthiness, a core component of social interaction, is more difficult for people to predict in avatars than in humans. Further, people engage the medial frontal cortex more with humans than with avatars [33], a region of the brain that's significant for determining trustworthiness [34]. When tasked with identifying emotions, people are quicker to recognize emotions in human faces than in avatar faces, and activation in the fusiform face area is significantly greater with human faces [35]. This might indicate that our brains employ different mechanisms when identifying and perceiving avatars. However, there also exist similarities between face and avatar perception. Perceived attractiveness for avatars appears to be consistent with perceived attractiveness for faces. Avatars with more anthropomorphic features have been found to be perceived as more attractive and trustworthy [36][37], and real-world attractiveness norms appear to carry over to avatars [38]. Like faces, people pay significantly more attention to their own avatars than to avatars of others [27]. People also maintain less physical distance from self-representative avatars than avatars of others, and are more willing to perform embarrassing acts in front of them [39]. These similarities and differences indicate that a greater understanding about preferences for color appearance between faces and avatars is needed.

The present experiment aims to evaluate (1) preferred color appearance (lightness) of faces in OST-AR, (2) how ambient lighting affects those preferred renderings, (3) if observers treat their own face differently than they do the faces of zero-acquaintance targets, and (4) whether those preferences differ between faces and avatars.

Observers

A total of 41 volunteers participated in this experiment. Observers were students or local members of the community. Observers were tested for color vision deficiency (CVD) using Ishihara plates prior to taking the experiment, and also indicated CVDs via self-report. One observer's results were excluded due to a red-green color vision deficiency. Another observer's results were excluded due to a technical error that was not raised until after the experiment was complete. Two observers were partially excluded due to a malfunction with the room's lights for a subset of the lighting conditions. One observer was excluded due to multivariate outliers that exerted substantial influence on the results. Data from the remaining 38 participants (Age_{mean} = 25.71, Age_{SD} = 8.58; 22 females, 14 males, 2 non-binary; 9 Asian, 22 White, 1 Black or African American, 1 Alaska Native or Indigenous American, 3 multiracial, and 2 other, and 1 preferred not to respond) were used in the final analyses. This experiment was approved by the Human Subjects Research Office at Rochester Institute of Technology.

Stimuli

The faces of zero-acquaintance stimuli were obtained from The Chicago Faces Database [40]. Individual typology angle (ITA) was used as a continuous metric to quantify relative melanin content from skin color [41]. ITA was computed for each of the 597 faces in the Chicago Faces Database using the formula, $ITA = \tan^{-1}(\frac{L^{*}-50}{b^{*}})$. L* and b* were obtained from the average CIELAB value from a rectangular region containing the forehead on each photo. The distribution of ITA in the Chicago Faces Database is plotted in (Figure 1). Eight faces were selected from this distribution to cover a large range of skin tones with priority given to images with little to no facial hair. The selected images were given a transparent background, cropped, and resized to 1920x1080 pixels.

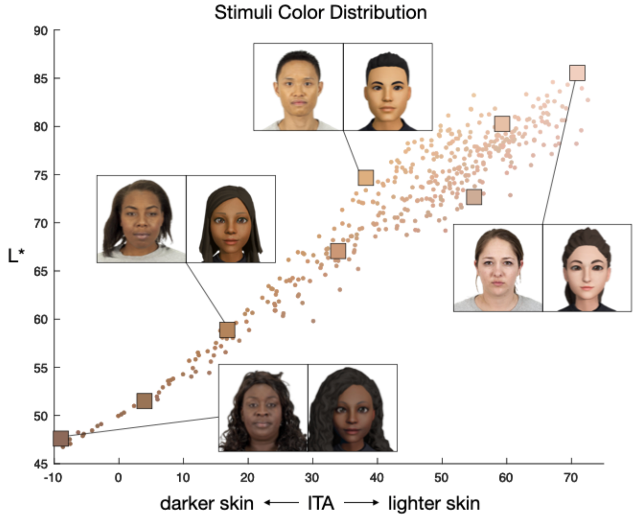

Figure 1. Plot of ITA distribution in Chicago faces database. Larger squares represent the 8 faces selected as stimuli for this experiment. Four of the selected photos and their corresponding avatars are shown.

Virtual avatars were created to represent these eight photos using ReadyPlayerMe, an avatar creation tool. 2D versions of the photos were rendered in Blender. Then, the skin tone was adjusted so that the L*a*b* of the forehead area of the avatar matched the L*a*b* of the forehead area of the corresponding photo. These stimuli were the same across all observers.

Two stimuli in the experiment were different between observers: a self-representative photo and self-representative avatar. Before the observer took the experiment, these two images were created and embedded into the experiment. For the self-representative photo, the observer's face was diffusely lit by overhead LED lights and a ring light. The observer was instructed to maintain a neutral expression and to look directly at the camera, a Canon EOS 5D Mark III. The photo was white balanced using a MacBeth ColorChecker and given a transparent background. The photo was cropped to center on the face and resized to 1920x1080 so that the observer's face would take up approximately the same amount of screen size as the photos selected from the Chicago Faces Database. Observers were allowed to view and approve this image for use in the experiment.

After the photo was taken, the observer was given access to the ReadyPlayerMe avatar creation tool. They were asked to create an avatar that represented them as closely as possible, maintaining the default clothing and choosing the skin tone, hair style, and other facial features that best matched their own. After completion, their avatar was processed in the same way as for the strangers' stimuli to create a 2D avatar whose L*a*b* of the forehead area matched the L*a*b* of the forehead area of their color balanced photo. This pipeline took approximately 15 minutes and was completed in the same session as the experiment.

Experimental Procedure

The observer was seated in a chair 200 cm away from an achromatic checkerboard pattern mounted on a wall. The checkerboard pattern was 76x110 cm and was printed using matte ink on Epson Doubleweight Matte Paper. The measured XYZ's of the alternating light and dark tiles were XYZ_{light} = (76.4, 79.4, 89.7) and XYZ_{dark} = (66.0, 68.6, 77.3) under the D65 Bright setting.

The observer wore XREAL Air 2 Pro glasses to implement the OST-AR environment. The experiment was coded in MATLAB 2024b. Stimuli were projected onto the observer's field of view through the OST-AR glasses. The images were anchored in the center of the checkerboard pattern using an XREAL Beam device.

When starting the experiment, the observer was presented with a screen that showed all stimuli that they would see throughout the experiment (i.e., all 9 facial photos and avatars, including the self-representative ones). At this time, observers were given an 8BitDo controller and received instructions on how to use the controller to modify the color appearance of the faces. The controller could increase and decrease the L* of the image in intervals of 5 units and the C* in intervals of 2 units. The starting value of L* was offset by -10, -5, 0, 5, or 10 and the starting value of C* was offset -4, -2, 0, 2, or 4, selected randomly for each stimulus. Button presses and response times for each trial were recorded. Observers were instructed to adjust the color of the faces to match their preferred appearance, and were told that there were no wrong answers. Observers were instructed to ignore artifacts (i.e., hair appearing transparent) if it was not the stimulus' skin. Once the observer was ready, they used the controller to proceed to the first trial. Observers had unlimited time to respond to each trial.

Stimuli were presented five times, once in each of the five lighting conditions approximating the chromaticity of standard illuminants at different luminance levels: black (lights off), illuminant D65 bright ($CCT = 62701, Y = 109.80$), illuminant D65 dim ($CCT = 62084, Y = 55.27$), illuminant A bright ($CCT = 27032, Y = 111.90$), and illuminant A dim ($CCT = 26995, Y = 56.18$). The black condition was always shown first. The order of the remaining lighting conditions was randomized. Observers underwent a 20 second adaptation period each time the lighting condition changed, where they were instructed to simply look at the checkerboard pattern. The stimuli in each lighting condition were identical, but the order of presentation was randomized.

There were a total of 90 trials. This part of the experiment took approximately 20 minutes to complete. Upon completion, the observer was presented with a survey that included a demographic questionnaire and additional questions about their strategies during the color adjustment task.

Results

In this experiment, observers completed the task under five different ambient conditions that included combinations of standard illuminants and chromaticities. The current analysis will describe one condition that was to simulate D65 with a luminance of 109.80. In this analysis, ΔL^* is computed as $L^*_{D65} - L^*_{black}$, where L^*_{D65} was the observer's L* adjustment to the stimulus in the D65 lighting condition and L^*_{black} was the observer's adjustment to the same stimulus in the black condition (the ambient condition where the lights were completely off). This computation was made to account for individual variability in responses before introducing a more complex ambient lighting condition. The ΔL^*_{D65} computation compares how much that observer's response changes as a function of the increased ambient luminance of the viewing environment.

Zero-Acquaintance Stimuli

A linear mixed-effect model was conducted with ITA and image type (photo or avatar) as independent variables and ΔL^* as the dependent variable on zero-acquaintance stimuli (Figure 2).

There was no effect of image type on ΔL^*, $F(1,36) = 3.79$, $p = 0.060$, indicating that whether the image was of an avatar or a photo did not have an effect on lightness overall. There was a main effect of ITA ($B = -0.08$, $SE = 0.021$), $F(1,36) = 14.32$, $p < 0.001$ on ΔL^*, indicating that as skin tones became darker, observers tended to increase lightness more. Finally, there was a significant interaction between image type and ITA, $F(1,36) = 4.46$, $p = 0.041$, suggesting that the effect of ITA on ΔL^* differed as a function of image type. Follow up analyses indicated that as ITA increased, ΔL^* decreased for both avatars ($B = -0.13$, $SE = 0.002$, $p < 0.001$) and photos ($B = -0.08$, $SE = 0.016$, $p < 0.001$). These combined suggest that while the general effect of skin tone on lightness adjustments was observed for both zero-acquaintance image types, the effect was greater for avatars than for photos.

Self-Representative Stimuli

A linear mixed-effect model was conducted with ITA and image type (photo or avatar) as independent variables and ΔL^* as the dependent variable on self-representative stimuli (Figure 2).

There was a main effect of image type on ΔL^*, $F(1,35) = 6.76$, $p = 0.014$, showing that observers generally tended to increase lightness for their avatar more than they did for their photo. There was no significant effect of ITA ($B = 0.012$, $SE = 0.100$), $F(1,57) = 0.01$, $p = 0.908$ on ΔL^*, meaning that skin tone had no impact on the lightness adjustment overall. However, there was a significant interaction between image type and ITA, $F(1,35) = 8.99$, $p = 0.005$, suggesting that the effect of ITA on ΔL^* differed as a function of image type. Follow up analyses indicated that as ITA increased, ΔL^* decreased for avatars ($B = -0.297$, $SE = 0.091$, $p = 0.002$), but not for photos ($B = 0.012$, $SE = 0.108$, $p = 0.915$). This means that observers tended to increase their avatar's lightness more when their avatar's skin color was darker, but did not follow this pattern for their own photos.

Response Times

Response times (RTs) were recorded to evaluate how long observers took to make each of their adjustments. RTs that were greater than 3 SDs from the mean were clipped to that maximum value to reduce the potential influence of extreme outliers.

A repeated-measures ANOVA was conducted with image type (photo or avatar) and image identity (self-representative or zero-acquaintance) as independent variables and RTs as the dependent variable.

There were no main effects of image type $F(1,36) = 3.97$, $p = 0.054$ or image identity $F(1,36) = 1.55$, $p = 0.221$. However, there was a significant interaction between image type and image identity, $F(1,36) = 8.21$, $p = 0.006$, suggesting that the effect of image type on response time differed as a function of image identity. Pairwise comparisons revealed that observers spent significantly more time looking at their own photo ($M = 16.2, SE = 1.6$) than looking at photos of zero-acquaintance targets ($M = 12.0, SE = 0.9$), $t(36) = -3.20, p = 0.002$. But, there was no significant difference in response times between their own avatars $(M = 12.5, SE = 1.4)$ and avatars of zero-acquaintance targets $(M = 13.3, SE = 1.0), t(36) = 0.67, p = 0.506$. (Figure 3).

Discussion

In the present work, we observed that preferences for OST-AR face stimuli (zero-acquaintance photos, and all avatars studied) required greater lightness increases as skin tones became darker. This pattern of results is consistent with previous findings that similar lightness adjustments are required to achieve skin color matches, particularly in bright ambient conditions [13][14].

However, we found that self-representative photos did not generally follow these patterns; skin tone appeared to have no impact on preferred lightness adjustments when conducted on their own photos. This could indicate that observers have different preferences for self-appearance and perhaps employ different strategies when evaluating photos of themselves. Past research has indicated that self-representative photos are evaluated uniquely [27], and people likely spend more time and attention to these stimuli. This was supported by our results demonstrating that observers spent more time to adjust photos of their own faces relative to all other stimulus types. It is perhaps surprising that observers with darker skin tones made similar lightness adjustments as observers with lighter skin tones, as the photos with darker skin would have appeared more transparent, which has been shown to negatively impact appearance [12]. One possible explanation is that substantial increases in lightness may have resulted in the face's color to appear too light to be able to accurately represent the observer's skin, which is likely more salient to one's own identity. Past work has also shown that the lightness increases needed to compensate for ambient light can sometimes negatively impact preference [13]. This tradeoff may have been acceptable when evaluating zero-acquaintance faces, but not for self-representative ones. It is also possible that some transparency was considered acceptable to make the face appear to be physically present together with the ambient environment [15].

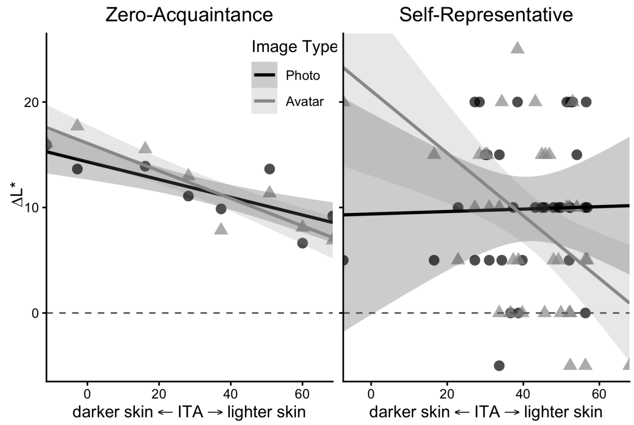

Figure 2. *For zero-acquaintance stimuli (left), observers tended to adjust lightness more (vs. less) as skin tone became darker (vs. lighter), for both avatars and photos. For self-representative stimuli (right), observers tended to adjust lightness more (vs. less) if their avatar had darker (vs. lighter) skin, but this pattern was not evident for photos of their faces.*

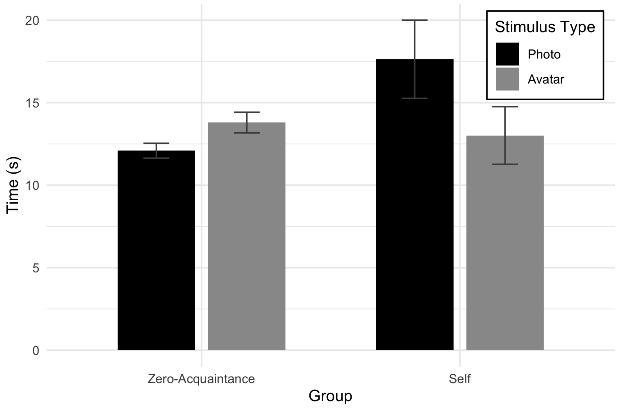

Figure 3. *Mean response time (SE) by image type. Observers spent more time adjusting self-representative photos than zero-acquaintance stimuli and self-representative avatars.*

Observers did not appear to apply such strategies to their own avatars, treating them similarly to avatars of others. In the literature, avatars are known to exist in a fidelity spectrum [42][43], and the way we interact with avatars is highly dependent on their fidelity [44]; avatars that are more human-like are processed more similarly to human stimuli [42]. Since the avatars used in this experiment were somewhat low in fidelity, it is possible that observers did not personally identify with their avatars, and indeed some observers reported difficulty in recognizing their avatars during the experiment. Exploring the impact of avatar fidelity would be a valuable next step for future work.

Overall, observers tended to choose lighter colors in the D65 condition than in the black condition where all lights were off for all categories of stimuli. This is consistent with previous findings that lighter ambient conditions require greater lightness adjustments to combat the color blending that results in perceived transparency [1][2][3].

A limitation of this experiment was the distribution of skin tones among observers. The majority of observers had skin tones in the medium to light range, with few observers comprising skin tones commensurate with the lowest ITA stimuli of the zero-acquaintance targets used in the current experiment. For this reason, direct statistical comparisons were conducted within zero-acquaintance and self-representative samples separately (rather than between them). Thus, inferences made between these samples should be considered with this limitation in mind.

Conclusion

The present experiment was designed to better understand facial color preferences for humans and avatars across a diverse range of skin tones and ambient environments in OST-AR. Observers preferred to increase lightness for zero-acquaintance targets and self-representative avatars more as facial skin tones became darker, which is consistent with previous work. However, this pattern was not evident when observers evaluated and adjusted their own photos, even though they spent significantly more time making their adjustments. These findings suggest that observers evaluate their own photo differently than they do for others, highlighting a greater need for self-representative stimuli in color appearance experiments, and perception research more broadly. Better understanding of facial appearance preferences dependent on diverse skin tones and self-representative stimuli can facilitate the development of social extended reality systems that are inclusive to the needs of all users.

References

[1] A. Erickson et al., “A Review of Visual Perception Research in Optical See-Through Augmented Reality,” in Eurographics Symposium on Virtual Environments, 2020.

[2] J. L. Gabbard, J. E. Swan, and A. Zarger, “Color blending in outdoor optical see-through AR: The effect of real-world backgrounds on user interface color,” in 2013 IEEE Virtual Reality (VR), 2013, pg. 157–158.

[3] J. Liu et al., “How bright should a virtual object be to appear opaque in optical see-through AR?,” in Proceedings - 2022 IEEE International Symposium on Mixed and Augmented Reality, ISMAR 2022, 2022, pg. 676–684.

[4] M. A. Zielke et al., “Exploring medical cyberlearning for work at the human/technology frontier with the mixed-reality emotive virtual human system platform,” in 2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH), 2018, pg. 1–8.

[5] N. Archip et al., “Non-rigid alignment of pre-operative MRI, fMRI, and DT-MRI with intra-operative MRI for enhanced visualization and navigation in image-guided neurosurgery,” NeuroImage, vol. 35, no. 2, pp. 609–624, 2007.

[6] M. R. Miller et al., “Social interaction in augmented reality,” PLoS ONE, vol. 14, no. 5, 2019.

[7] I. Hirskyj-Douglas et al., “Social AR: Reimagining and interrogating the role of augmented reality in face to face social interactions,” in Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW, 2020, pg. 457–465.

[8] W. Swartout et al., Designing a Personal Assistant for Life-Long Learning (PAL3), Tech. rep. 2016.

[9] A. Hartholt et al., “Virtual humans in augmented reality: A first step towards real-world embedded virtual roleplayers,” in HAI 2019 - Proceedings of the 7th International Conference on Human-Agent Interaction, 2019, pg. 205–207.

[10] Augmented Reality (AR) Training Systems for First Responders, Tech. rep. Department of Homeland Security, 2024.

[11] K. Kim et al., “Does a Digital Assistant Need a Body? The Influence of Visual Embodiment and Social Behavior on the Perception of Intelligent Virtual Agents in AR,” in 2018 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2018, pg. 105–114.

[12] T. C. Peck et al., “Effects of Transparency on Perceived Humanness: Implications for Rendering Skin Tones Using Optical See-Through Displays,” IEEE Transactions on Visualization and Computer Graphics, vol. 28, no. 5, pp. 2179–2189, 2022.

[13] Y. He and C. A. Thorstenson, “Facial color matching in optical see-through augmented reality,” Journal of Vision, vol. 25, no. 10, p. 16, 2025.

[14] M. Doroodchi et al., “Effects of Optical See-Through Displays on Self-Avatar Appearance in Augmented Reality,” in Proceedings - 2022 IEEE International Symposium on Mixed and Augmented Reality Adjunct, ISMAR-Adjunct 2022, 2022, pg. 352–356.

[15] S. R. Herbeck, M. J. Murdoch, and C. A. Thorstenson, “Adjusting Transparency Toward Optimizing Face Appearance in Optical See-Through Augmented Reality,” in Final Program and Proceedings - IS and T/SID Color Imaging Conference, 2024.

[16] I. D. Stephen et al., “Facial skin coloration affects perceived health of human faces,” International Journal of Primatology, vol. 30, no. 6, pp. 845–857, 2009.

[17] J. de Rigal et al., “The effect of age on skin color and color heterogeneity in four ethnic groups,” Skin Research and Technology, vol. 16, no. 2, pp. 168–178, 2010.

[18] B. Fink, K. Grammer, and P. J. Matts, “Visible skin color distribution plays a role in the perception of age, attractiveness, and health in female faces,” Evolution and Human Behavior, vol. 27, no. 6, pp. 433–442, 2006.

[19] C. F. Benitez-Quiroz, R. Srinivasan, and A. M. Martinez, “Facial color is an efficient mechanism to visually transmit emotion,” Proceedings of the National Academy of Sciences of the United States of America, vol. 115, no. 14, pp. 3581–3586, 2018.

[20] S. Alaluf et al., “Ethnic variation in melanin content and composition in photoexposed and photoprotected human skin,” Pigment Cell Research, vol. 15, no. 2, pp. 112–118, 2002.

[21] C. Feliciano, Shades of Race: How Phenotype and Observer Characteristics Shape Racial Classification, Tech. rep. 2015.

[22] W. D. Roth, “Racial mismatch: The divergence between form and function in data for monitoring racial discrimination of hispanics,” Social Science Quarterly, vol. 91, no. 5, pp. 1288–1311, 2010.

[23] C. A. Thorstenson, “The Social Psychophysics of Human Face Color: Review and Recommendations,” Social Cognition, vol. 36, no. 2, pp. 247–273, 2018.

[24] H. Yoshikawa et al., “Effect of chromatic components on facial skin whiteness,” in Color Research and Application, 2012, pg. 281–291.

[25] K. W. Tan and I. D. Stephen, “Colour detection thresholds in faces and colour patches,” Perception, vol. 42, no. 7, pp. 733–741, 2013.

[26] G. G. Gallup, “Chimpanzees: Self-Recognition,” Science, vol. 167, no. 3914, pp. 86–87, 1970.

[27] Y. Seo et al., “Avatar face recognition and self-presence,” Computers in Human Behavior, vol. 69, pp. 120–127, 2017.

[28] H. Ninomiya et al., “P300 in response to the subject’s own face,” Psychiatry and Clinical Neurosciences, vol. 52, no. 5, pp. 519–522, 1998.

[29] J. Sui and G. W. Humphreys, "The boundaries of self face perception: Response time distributions, perceptual categories, and decision weighting," Visual Cognition, vol. 21, no. 4, pp. 415–445, 2013.

[30] T. Gilovich and K. Savitsky, "The Spotlight Effect and the Illusion of Transparency," Current Directions in Psychological Science, vol. 8, no. 6, pp. 165–168, 1999.

[31] N. Kanwisher, J. McDermott, and M. M. Chun, "The Fusiform Face Area: A Module in Human Extrastriate Cortex Specialized for Face Perception," The Journal of Neuroscience, vol. 17, no. 11, pp. 4302–4311, 1997.

[32] J. P. Keenan et al., "Self-recognition and the right prefrontal cortex," Trends in Cognitive Sciences, vol. 4, no. 9, pp. 338–344, 2000.

[33] R. Riedl et al., "Trusting humans and avatars: A brain imaging study based on evolution theory," Journal of Management Information Systems, vol. 30, no. 4, pp. 83–114, 2014.

[34] R. Riedl and A. Javor, "The biology of trust: Integrating evidence from genetics, endocrinology, and functional brain imaging," Journal of Neuroscience, Psychology, and Economics, vol. 5, no. 2, pp. 63–91, 2012.

[35] E. Moser et al., "Amygdala activation at 3T in response to human and avatar facial expressions of emotions," Journal of Neuroscience Methods, vol. 161, no. 1, pp. 126–133, 2007.

[36] Z. Tao et al., "Impact of virtual avatar appearance realism on perceptual interaction experience: a network meta-analysis," , 2025.

[37] K. L. Nowak and C. Rauh, "The Influence of the Avatar on Online Perceptions of Anthropomorphism, Androgyny, Credibility, Homophily, and Attraction," Journal of Computer-Mediated Communication, vol. 11, no. 1, pp. 153–178, 2005.

[38] S. A. Guan et al., "Beauty in the eye of the beholder? Attractiveness in a virtual world," Cyberpsychology: Journal of Psychosocial Research on Cyberspace, vol. 9, no. 2, 2015.

[39] J. N. Bailenson, J. Blascovich, and R. E. Guadagno, "Self-Representations in Immersive Virtual Environments 1," Journal of Applied Social Psychology, vol. 38, no. 11, pp. 2673–2690, 2008.

[40] D. S. Ma, J. Correll, and B. Wittenbrink, "The Chicago face database: A free stimulus set of faces and norming data," Behavior Research Methods, vol. 47, pp. 1122–1135, 2015.

[41] Y. Wu, T. Tanaka, and M. Akimoto, "Utilization of Individual Typology Angle (ITA) and Hue Angle in the Measurement of Skin Color on Images," bioimages, vol. 28, pp. 1–8, 2020.

[42] A. W. de Borst and B. de Gelder, "Is it the real deal? Perception of virtual characters versus humans: An affective cognitive neuroscience perspective," Frontiers in Psychology, vol. 6, 2015.

[43] D. Hepperle et al., "Aspects of visual avatar appearance: self-representation, display type, and uncanny valley," Visual Computer, vol. 38, no. 4, pp. 1227–1244, 2022.

[44] S. Mansour et al., "The Interactive Effect of Avatar Visual Fidelity and Behavioral Fidelity in the Collaborative Virtual Reality Environment on the Perception of Social Interaction," in Proceedings of the 10th WSEAS International Conference on COMMUNICATIONS, Athens, Greece, 2006, pg. 375–383.

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