Varying Effects of the Absence of Facial Features For Facial Recognition

Andrew Youn, Jenna Leland, and Kristen Tang

University of California, Los Angeles

Abstract

There are several different views as to how faces are perceived. Some think that facial features are viewed and processed as parts but also in relation to one another. Other studies have found evidence suggesting that faces are simply perceived based off the sum of their individual features. In this study, we explore how the brain recognizes particular features and how the omission of certain features, the eyes and mouth, impacts the ability to recognize a face. We looked at this by testing how recognition accuracy differed when these facial features were covered. We found a significant difference in sensitivity when eyes were covered but no significant difference when the mouth was covered, indicating that the eyes are more important in facial recognition than the mouth.

Keywords: Facial recognition, eyes, mouth

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In this study, we tested the roles that different facial features play in facial recognition. We were interested in discovering if facial features is relied on more heavily than others in facial recognition and, if so, which one. Existing research on this topic offers several approaches to how faces are recognized. Some argue that faces are perceived as a whole and that their relative positioning is important (Farah, Wilson, Drain, & Tanaka, 1998). From this viewpoint, face perception is Gestalt in the way that it is a holistic interpretation. However, other research has found that perception of the face is just the sum of its individual parts (Gold, Mundy, & Tijan, 2012). Gold et al. (2012) reports that recall of each individual face is no better than recall of separate features of the face. From this they concluded that perception of faces relies largely on perceiving individual features rather than perceiving features in relation to each other.

With this in mind, we wanted to explore how the omission of certain parts of the face affects the recognition of the face as a whole. To test this, we designed an experiment testing facial recognition when no features were covered, when the eyes were covered, and when the mouth was covered. We expected to find that covering features would make it more difficult to recognize faces and that the feature that is least important in face recognition would have the smallest impact on recognition accuracy. We hypothesized that face recognition would be best when no features were covered and it would be the worst when eyes are covered. This would indicate that eyes are more important in face recognition than the mouth, showing that since the brain relies more on the eyes than other parts of the face, it is harder to differentiate faces when the eyes are not shown.

Methods

Participants

The sample consisted of 18 participants (6 male; 12 female). The age range was 20-22 years old with a mean age of 21.35. All of the participants are currently students at the University of California, Los Angeles (UCLA) and participated for class credit in a Psychophysical Theories and Methods course. All participants were assumed to have normal or corrected normal vision for this experiment.

Design

This was a within-subjects two alternative forced choice experiment testing how the independent variable (part of face being covered) affected the dependent variable (forced choice sensitivity). We used this model to ensure equal variance between <SN> and <NS> trials. Using a two alternative forced choice method provides participants with a simple decision task, restricted to two answers. As two alternatives were presented, participants were forced to make a decision, rather than making a decision about an individual stimuli in isolation. Additionally, using a two alternative forced choice procedure provides a relatively large yield of data, providing sufficient data points for reliable statistical analyses of the data. The independent variable had three conditions: nothing covered, eyes covered, and mouth covered. Each participant was tested on all three conditions. Participants were first flashed the image of an initial face, and then side by side images, of two faces different from one another. They were then asked to identify which image, right or left, was of the original person. Forced choice sensitivity was computed using participants' accuracy in identifying the correct face. Sensitivity was computed in order to find how well participants could differentiate between the image of the same person and the image of the similar but different person.

Materials

Participants independently and simultaneously ran the experiment on computers in a standard computer lab. We built our experiment using a free program called PsychoPy. PsychoPy also gathered data from the experiment and compiled it onto Excel, which we used to analyze our data.

Each trial was made up to three face images. The first image was the original image participants would need to match their choice to. The two corresponding images were a different photo of the original person, either at a different angle or with a different expression, and a photo of a different but similar person. The photos were taken from an online database of public photos (The CNBC Wiki). We had ten trials with a total of 30 images from the Caucasian pool, ten trials with a total of 30 images from the African American pool, ten trials with a total of 30 images from the Asian pool, and ten trials with a total of 30 images from the Hispanic pool. There were equal male and female face trials from each ethnicity set. These added up to 120 images of faces displayed over 40 trials of unique photos.

To create the three conditions, we made two additional copies of each image and edited one set to cover the eyes and the other to cover the mouth. To cover the eyes, a black rectangle was inserted on top of both the eyes and eyebrows. To cover the mouth, a black rectangle was inserted on top of the entire mouth. Between the three conditions, there was total of 360 images which were in 120 sets of three, making 120 total trials.

Procedures

The experiment began by giving participants instructions. They were given five practice trials, in a random order, with feedback before the actual experiment began. After the practice, participants were reminded of the instructions then allowed to start the experiment. In each trial, participants were shown the original image for 300 milliseconds, then a static noise image maks for 1 second. We chose to flash the control image for 300 milliseconds because previous research has found that face recognition times range from 50 milliseconds up to 200 milliseconds (Rousselet, Macé, & Fabre-Thorpe, 2003). We increased the time to 300 milliseconds so participants had time to register the faces for recognition later. Next, they were shown a screen with the two side by side images for 1 second. The next screen asked them “Left or Right?” prompting them to press the left or right arrow key in response to which image was of the same person as the person in the control image. The experiment consisted of 120 trials a break after the 40th trial and after the 80th trial. PsychoPy randomized the trials randomized for each participant. After 120 trials, they were shown a congratulation screen and the experiment was over.

Results

Figure 1 shows the mean forced choice sensitivity over the three conditions. In this study, sensitivity is the ability to identify a previously shown face and discriminate between that face and a distractor face. It is calculated by subtracting the z score of the probability that the participant answered *left* given that the correct answer was on left and the z score of the probability that the participant answered *left* when the correct answer was on the right. This figure appears to show that eyes covered yields the lowest d’ and that the d’ of nothing covered and the d’ of mouth covered are close. To analyse these data, we performed a within subjects one-way ANOVA. This revealed a significant main effect of the feature covered on the correct identification of faces; $F(2, 34) = 13.93$, $MSE = .14$, $p < .001$.

To compare individual condition means, three t-tests were run as post hoc tests. There was no significant difference in sensitivity between the nothing covered condition (M= 2.41, SD = .92) and the mouth covered condition (M= 2.27, SD = .80); t (17)= .987, p = .337. The comparison of mouth covered versus eyes covered revealed a significantly lower sensitivity in the eyes covered condition (M= 1.78, SD = .69) than in the mouth covered condition; t (17)= 4.22, p = .001. The sensitivity of eyes covered was also significantly lower than the sensitivity of the nothing covered condition; t (17)= 5.32, $p < .001$. Nothing covered led to the best facial recognition, while covering the eyes led to the worst facial recognition.

A chi-squared test was run to test for position biases in the subjects. The test was run on the combination of their data from all trial conditions, as we would expect any biases to remain constant regardless of the condition. We found that four of the 18 subjects did have a position bias, however there were no consistent tendencies for participants to have a bias toward either the right or left side. Figure 2 displays forced choice sensitivities across conditions for each individual participant. Participants with position bias are indicated by bolded font and darkened rows.

Discussion

The significant difference in sensitivity between nothing covered and eyes covered indicates that eyes play a significant role in facial recognition. Since there is no significant difference between the sensitivities for nothing covered and mouth covered, we can conclude that the mouth does not play a significant role in facial recognition. The significant difference in sensitivity between eyes covered and mouth covered indicates that eyes are more instrumental in facial recognition than mouth. From this we also draw the conclusion that the feature being covered, not just the fact that part of the face was being blocked, affected facial recognition ability. This is promising because it indicates internal validity. Sensitivities were affected by the features of the face being covered, not just the fact that part of the face was being blocked regardless of the location. The results that most participants showed no position bias and those that did were not consistent to either side indicate that position bias did not systematically sway our data.

It is important to note some limitations and areas for improvement in our design. First, we only had a limited amount of time with each participant so could not include all conditions that we thought were relevant. Future studies should look at the role of the nose and the role of the eyebrows and eyes separate from each other in facial recognition. Another area of improvement is the length of exposure for the original image. We flashed the image for 300 ms though other studies had said people can register faces in 50-200 ms. Though we got some variation in sensitivities, participants generally had high sensitivities across the board, meaning that the task was slightly too easy. We could have made the experiment a little harder to get a more even spread of sensitivities. To accomplish this, future studies could flash the original face for a shorter period of time or find distractor faces that looked even more similar than the ones we found. Another area for improvement is the editing of the images when adding coverings. Each rectangle was a slightly different size. For greater control in future studies, all coverings should be the same size across conditions and trials.

This research gives us insight into how we recognize faces. Though we can still recognize faces well when features are occluded, we are significantly worse specifically when the eyes are covered. This may help to explain why we have such a difficult time recognizing people without seeing their eyes, such as not recognizing an acquaintance who is wearing sunglasses at first glance. Further research can also help quantify exactly how crucial eyes are for facial recognition, and which features we rely on most when eyes are not visible. Furthermore, understanding specifically which characteristics of the eyes make them unique to a person and salient in recognition may provide breakthroughs in the advances of artificial intelligence technology. For example, this could lead to advancements in facial recognition security systems.

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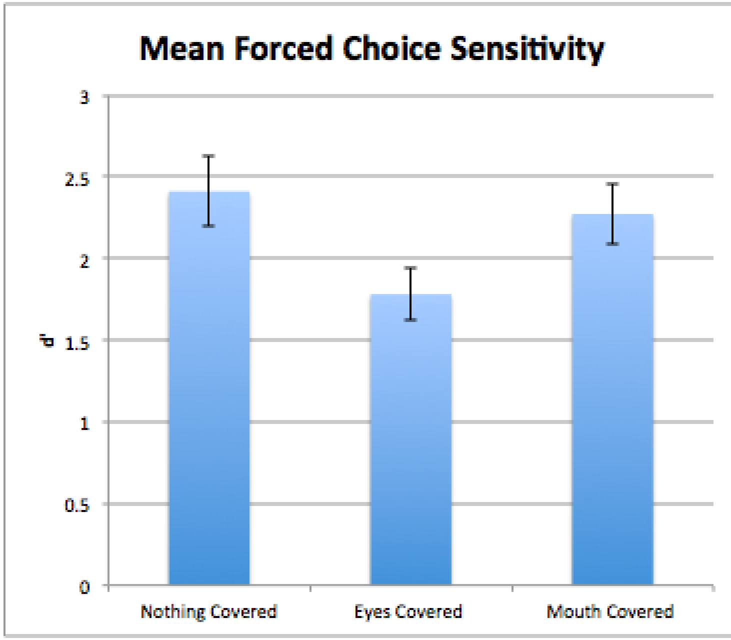

Figure 1. Mean Forced Choice Sensitivity across conditions. Standard error bars shown.

Participant Number	d' (Covered - None)	d' (Covered - Eyes)	d' (Covered - Mouth)
1	**2.32**	**1.81**	**2.32**
2	3.29	2.07	3.29
3	0.65	0.40	0.91
4	3.29	1.88	2.93
5	3.31	2.07	2.32
6	**3.34**	**2.32**	**2.70**
7	2.68	1.68	2.49
8	1.88	1.88	2.93
9	1.06	1.20	0.91
10	**2.34**	**2.49**	**3.31**
11	**1.29**	**0.51**	**1.04**
12	2.32	2.32	2.56
13	2.93	2.07	2.93
14	3.29	2.56	2.12
15	3.31	2.12	2.95
16	3.29	2.68	2.32
17	1.29	0.78	1.53
18	1.52	1.23	1.35

Figure 2. Individual Forced Choice Sensitivity across conditions. Participants with position bias indicated by bold font and darkened rows.