Face Aftereffects Improve Discriminability for Similar Faces

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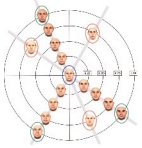
Introduction

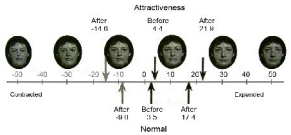
Previous studies have demonstrated a face identity aftereffect that facilitates face identification performance [2]. Adaptation should improve discrimination between faces in the region of the adapting stimulus, but this has not previously been demonstrated. We report an investigation on face discrimination, using faces distorted with the Photoshop spherize function to be either expanded or compressed. We did psychophysical experiments on 13 participants using an adaptive Bayesian method in order to present stimuli efficiently and effectively. The participants were adapted to systematically distorted faces (-60% or +60%) and then tested on discrimination sensitivity around both +60 and -60. The results show that discrimination is facilitated at -60% after repetitive adaptation to -60% faces, but not significantly facilitated at +60% following adaptation to +60. Overall, there is a significant shift in discriminability with adaptation condition. We conclude that face discrimination can be facilitated at the point of adaptation but that demonstrating such an improvement will require a more tightly controlled stimulus presentation protocol.

Norm Face Theory and Face Adaptation

Our work assumes norm face theory. We tested facilitation of face distortion aftereffects and explained it using this theory. This theory and the distortion adaptation are outlined.



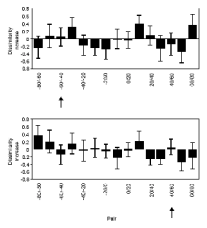
Norm Face Theory: faces can be represented as vectors of figural features, e.g. face width [1]. Then a trajectory can be formed by systematically manipulated face vectors with their norm at the centre. A multidimensional face space can be made up from many trajectories.



Distortion adaptation: In Rhodes et al's work [4], participants were adapted to systematically distorted faces (contracted and expanded), and then they rated the perceived attractiveness. They showed that the most attractive distortion shifted to match the most normal looking faces, suggesting the shifting norm corresponds to the distortion perception.

Motivation

Can enduring changes in face norms caused by repetitive exposure facilitate the discrimination of faces? In Jaquet et al's experiments [3], participants were asked to dissimilate among systematically distorted faces using 7 rates for each pair of test faces, after adapted to -50% and +50% levels. But their results provided no evidence of facilitation. We argue: 1) The rating may be subjective; 2), the face stimuli may not be effectively novel to the participant, who then used existing face patterns rather than newly shifted norm to discriminate.



Methods

We investigated whether discrimination is improved at the adapted point. The participants were adapted to -60% and +60% distortion, then tested discrimination performance at target levels -60% and +60%. If there are facilitations, the results should show symmetry of performance at two target levels between two adaptation conditions.

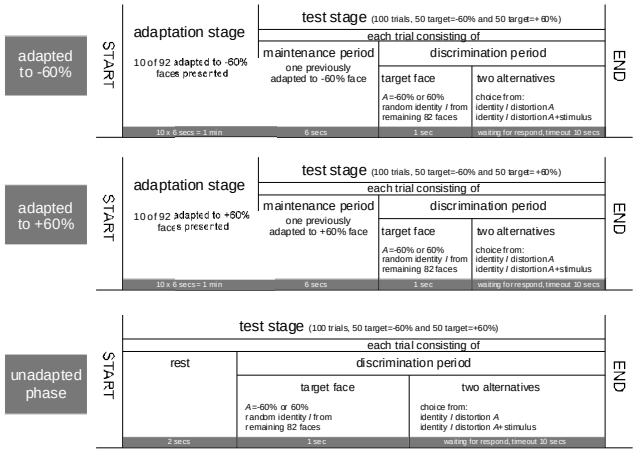
Participants: 13 participants at the age of 20-40.

Stimuli: 92 Caucasian male faces (to ensure novelty), each at 400x400 pixel, 21 distortion levels (-100% to +100% step 10%), using Photoshop spherize filter, central distortion. Stimulus is the absolute distortion distance from target level (-60% and +60%), ranging from 0% to 160%.

Adaptive Bayesian estimation of psychometric curve

We used psychometric curve to measure performance change of each participant. We used the curve's threshold to decide the participant's limit to sense the stimulus (distortion difference). The threshold straddles the range from "can't do it" (0%) to "always can" (=100%). An efficient adaptive Bayesian technique [5] was adopted to avoid problems with inaccuracy due to fatigue in an overly long experiment.

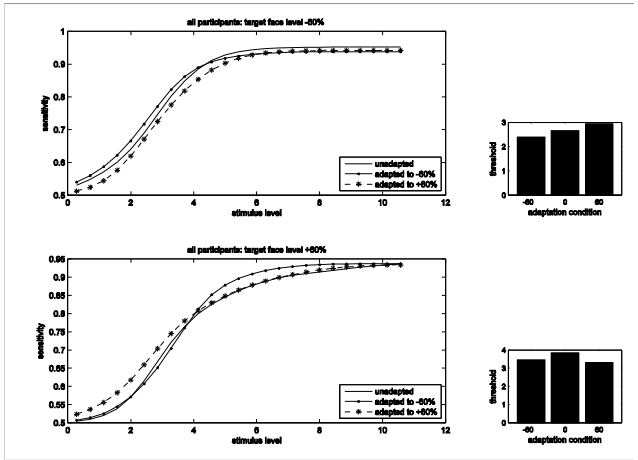
Procedure: each participant did 3 phases with random order at different days; attempts were made to reduce participants' 'learning' effect.



Discussion

The figure shows the mean sensitivity curve and threshold for 13 participants. This overall average result indicates that there is a significant shift in discriminability with two adaptation conditions - the left-shifted adapted to -60% curve at target -60% and the left-shifted case at target +60%.

However, judging from 13 individual thresholds, the paired t-test (not shown) suggests that there is facilitation at -60% after adaptation to -60% faces, but not significant at +60% following +60. We consider that a more tightly controlled stimulus presentation protocol should be adopted. But overall, there is a significant shift in discriminability.



Preliminary Modelling

Currently we are working in collaboration with James Bednar on a computational model of ventral visual pathway to account for the face adaptation aftereffects, based on the LISSOM model of face detection [6]. This model uses a hierarchy of sheets of interconnected neurons to represent cortical layers. Neurons have lateral connections and are developed through a Hebbian self-organizing process. Preliminary results suggest that the spatial representation of neurons in cortical layers may be related to the psychophysical face space. Perceived aftereffects can then be measured quantitatively on the change of such representation. In future work we plan to improve the modelling method and validate the model results by corresponding psychophysical experiments.

Conclusion

In general the results are consistent with the hypothesis that there are facilitations of discrimination at the point of adaptation. The left shift curves agree with the face norm encoding theory, although they do not rule out other possible explanations. Future work with more tightly controlled input stimuli should be able to establish these effects more clearly.

References

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