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NEURAL CODING

Face values

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Neurons in the so-called face patches in the inferotemporal cortex have been observed to respond selectively to faces; however, the way in which different faces are represented has not been clear. In a recent study, Chang and Tsao decipher the neural code for different faces in the brains of macaques.

The authors chose 200 forward-facing human face images from an online database. They marked a set of ‘landmark’ points on these faces to establish the shape and spatial arrangement of the face and its features (‘shape’ information). Second, by morphing all 200 faces onto the average face shape template, the authors were also able to determine shape-free, ‘appearance’ information for each face. The authors used principal components analysis of this information to identify the 25 shape dimensions and 25 appearance dimensions that best accounted for variation among the 200 faces, and used different, random combinations of these 50 dimensions to generate 2,000 faces distributed within this ‘face space’.

Chang and Tsao recorded from 205 face-selective neurons in the middle lateral and middle fundus face patches (ML–MF) and the anterior medial face patch (AM) of two macaques. By analysing the responses of each of the neurons to each of the 2,000 generated faces, the authors worked out the features of the average face that evoked a response in that cell. They found that most neurons showed ramp-like tuning to one or more of the 50 shape or appearance dimensions. Interestingly, most ML and MF neurons showed stronger tuning to shape dimensions, whereas AM neurons were more strongly tuned to appearance dimensions.

Next, the authors used the responses of neurons in the ML–MF or AM to 1,999 of the generated faces to train a computational model that could predict the shape and appearance of the 2,000th observed face on the basis of neuronal responses to the face. Consistent with the preference of neurons in different regions for different types of dimensions, ML–MF population responses were more accurate in predicting shape features than appearance features, whereas the reverse was true of AM responses. By decoding the ML–MF and AM neuronal responses together, the authors could reconstruct the faces that the monkeys had seen with considerable accuracy.

According to this ‘axis’ model of face coding, neurons in face patches are tuned to various linear shape and appearance axes. To test a key prediction of this model, Chang and Tsao identified axes along which AM or ML–MF neurons showed preferential tuning (spike-triggered average (STA) axes) and monitored the responses of these neurons to faces that differed along axes that were orthogonal to STA axes. Strikingly, AM and ML–MF neurons responded equally to each of the faces that differed on orthogonal axes, consistent with the axis model.

This study shows that neurons in the face patch system code realistic facial identity using a surprisingly simple code; rather than coding for and identifying individual faces, these neurons project faces along various continuous axes.

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ORIGINAL ARTICLE Chang, L. & Tsao, D. Y. The code for facial identity in the primate brain. *Cell* **169**, 1013–1028 (2017)