A small-world network model of facial emotion recognition

Takuma Takehara, Fumio Ochiai, Naoto Suzuki

Doshisha University

Facial emotion recognition has generally been discussed in terms of two models. In the categorical model, many facial emotions, including computer-generated morphs, could be effectively categorized into six basic emotion categories. In the dimensional model, valence and intensity are defined as the two fundamental dimensions that locate facially expressed emotions in emotion space. However, both models have not explored collective behaviors relating to each facial emotion as part of the comprehensive cognitive system. If it is possible to apply a small-world network model, such as is famous for the “six degrees of separation” (Watts & Strogatz, 1998), that has both close connectivity and extremely short distance between any two nodes, one may capture the collective behaviors of facial emotion recognition, as well as the efficient processing of facial emotions. This study shows that facial emotion recognition can be characterized in terms of a small-world network. We specified fifteen possible continua between pairs of the six basic facial emotions, and generated five morphs for each continuum under an equal transformation ratio. In total, 81 images were prepared. We asked participants to use a 4-point Likert-type scale with anchors of 0 (not similar at all) to 3 (very similar) to rate degrees of similarity of all 3,240 pairs of faces at their own pace. We averaged rating scores for each face pair across participants. If means were less than the median value of 1.5, face pairs were disconnected due to dissimilarity, whereas if means were greater than the median, face pairs were linked due to similarity. We made these judgments for all face pairs and then constructed the network. Consequently, the average distance and clustering coefficient of the network were 1.78 and 0.78, indicating that the distance between any two facial emotions was extremely short and the network was hyper-clustered. Additionally, nodes that were crucial to the maintenance of the network were morphs, not prototypes. Results indicate that facial emotion network clearly forms a small-world network, suggesting the existence of collective behaviors in facial emotion recognition. This describes why we can efficiently recognize facial emotions, in terms of enhancement of signal-propagation and spreading activation speed, and indicates the importance of morphs. Moreover, these results are new to the literature of cognition and emotion, showing that the framework of the small-world network is effective in this application.