The Quantification of Facial Expression Using a Mathematical Model of the Face: Validation and Extension of a Microcomputer-Based Technique.

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Abstract

This thesis describes the use of a new measurement technique for the study of the facial expression of emotion. Based on a mathematical model of the face, a microcomputer-based approach is utilised to quantify facial movement. Sixty-two points are digitised from a still image of a face and twelve facial measures are generated which represent distance scores between facial landmarks. Furthermore, the digitised points can be connected to form a smooth curved line drawing representation of the facial expression.

This thesis has three parts. An extensive literature review focusing on the theories of emotion and the methodological and measurement techniques used to describe and capture facial expressions is presented in Part 1.

Part 2 of this thesis concerns the validation of the computer model as a measurement tool. Two experiments were conducted to examine the relationship between the ratings made by a set of smiling and neutral expressions and the facial features which influence these ratings. In the first study, judges were shown forty real face photographs of smile and neutral expressions and forty line drawings derived from the photographs. In Study Two, subjects were shown eighty line drawing representations only of smile and neutral expressions. They were asked to rate the degree of smiling behaviour of each expression. Significant differences were found between the ratings of smile and neutral expressions. Furthermore, there were several facial measures which were found to discriminate significantly between the ratings made on smile and neutral expressions. The second study was further designed to assess differences in expression development. The findings revealed that there was a greater variation in ratings for the development of the smile than there was for the neutral expression. Encoder differences emerged and gender differences in the decoding abilities of the raters were also found.

In Part 3 of the thesis, the utility of the model is extended to firstly incorporate the quantification of other expressions and secondly to extend its utility into
the clinical arena. To address the first issue, twenty-three actors posed the six fundamental emotions of happiness, surprise, fear, disgust, anger, sadness and a neutral expression. These expressions were digitised and the resulting facial measures were subjected to a numerical taxonomy analysis, which yielded five main classes. The most prominent of these were three classes comprising of a majority of the happiness expressions, surprise expressions and a total absence of happiness expressions respectively. Two further experiments were conducted to assess the ability of human subjects to classify these emotions. A Multidimensional Scaling Procedure was applied to the judgements of two separate groups of volunteers. The results from both experiments revealed a two-dimensional structure consisting of a Pleasant-Unpleasant and Facial Activity dimension.

Secondly, this method was used to measure the smiling behaviour of a group of Parkinson’s disease (PD) sufferers, a group of patients with Major Depression and a Control group, of comparable age. Subjects were asked to view a series of amusing slides and the most animated smile for each subject was chosen for analysis. The Depressed group differed significantly from the other groups on several of the facial measures. Both the Depressed group and the PD group were found to smile significantly less often during the slide session when compared to the Control group.

Conclusions focus on the primacy of happiness and the utility of the model as a measurement tool.