VISUAL PERCEPTION OF FACIAL EXPRESSIONS

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Abstract

Psychophysical method for quantitative specification of facial expressions is presented. The method is based on subjective estimations of similarity between pair of stimuli – face expression and emotional name. Each pair of stimuli was randomly chosen from banks of 25 face pictures and 25 Russian names of emotion, and simultaneously presented on the monitor's screen. Duration of presentation was equal 1 c., and during the 2 following seconds subject should estimate similarity between the face expression and the name of emotion using integer numbers from 9 (maximal similarity) till 1 (minimal similarity). The estimates were averaged across ten presentations of each pair. In general the results for each subject was presented in the form of a matrix whose rows (faces) and columns (names) represent the two sets of stimuli while the entries contain all pairwise similarities among them. Each row of the matrix can be considered as semantic emotional function of face stimulus as well as spectral distribution of light intensity is considered

The visual perception of the emotional characteristic of stimuli is one of main information channels during human interpersonal relationship. It stipulates importance of measurement technique in this area. It is obvious that perception of facial expression are determined by personal experience as well as by detection of face configuration (Ekman & Friesan, 1978, Paramey, 1996; Bimler & Kirkland, 2001). Therefore, research into the role of the subjective estimates of facial expression and its recognition is of prime interest. The principal characteristics of facial configuration are the outline of the mouth, and eye and brow form. Psychophysical investigations using photographs and schematically presented faces as stimuli have shown that facial expression can be defined as a multidimensional function of the curvature of the lips, angle of eyebrows, and other configuration characteristics (Ekman & Friesan, 1978; Izmailov, Korshunova, & Sokolov, 1999; Paramey, Izmailov, & Babina, 1992). The contour of the mouth, eyes, and brows may in turn possibly be considered as a combination of lines of varying orientation, the detection of which forms the basis for the recognition of facial emotion expression (Abelson & Sermat, 1962; Bimler & Kirkland, 2001; Izmailov et al., 1999; Izmailov, Korshunova, Sokolov, & Chudina Yu, 2004;). In our work the results of scaling of emotional expression of the human face as the semantic emotional function are presented. These results are compared to analysis of the facial emotions using computer-based taxonomic approach (Pilowsky, Katsikitis, 1994) and graphics transformation (Bimler, Kirkland, 2001) so-called, morphing technique.

Method

Method of construction of semantic emotional functions is based on the ideas formulated in works (Osgood et al., 1975, Boynton, Gordon, 1965), and also in vector model of proximities (Shepard, Carroll, 1966). The detailed description of the experimental procedure and computing algorithm used for construction of emotional functions is reported in the article (Izmailov, 1995). The female faces expressing five basic emotions in accordance with FACS system (Ekman, Friesan, 1978) were used as stimuli. They are uniformly arranged on a scales

pleasure - surprise (top of fig. 1), surprise - fear (top of fig. 2), fear - sadness (top of fig. 3), sadness – disgust (top of fig. 4), and disgust - anger (top of fig. 5) using computer-based morphing technique (Bimler et al., 2001). Following 25 Russian names of emotions are used in the experiments: delight, admiration, enthusiasm, joy, *pleasure*, interest, attention, curiosity, *surprise*, alarm, *fear*, disappointment, affliction, *sadness*, grief, melancholy, *disgust*, irritation, anger, indignation, *hatred*, calm, shame, insult, doubt. The names are composed from the six basic emotions as it can be refereed to Schlosberg (1941) and Osgood et al. (1975). It is supplemented by an emotion "calm", and other names describing a different degree of intensity of basic emotions.

Results and Discussion

The main results are presented as faces-stimuli on figs. 1-5, which are accompanied by graphics of semantic emotional functions obtained in our work. Twenty five names of emotions are ordered on abscissa axis of the graphs in accordance with emotional circle. The ordinate displays measure of similarity between emotional expression of the face and each of emotional names distributed on abscissa axis. The data are averaged across seven subjects.
Let's consider as an example fig. 1.

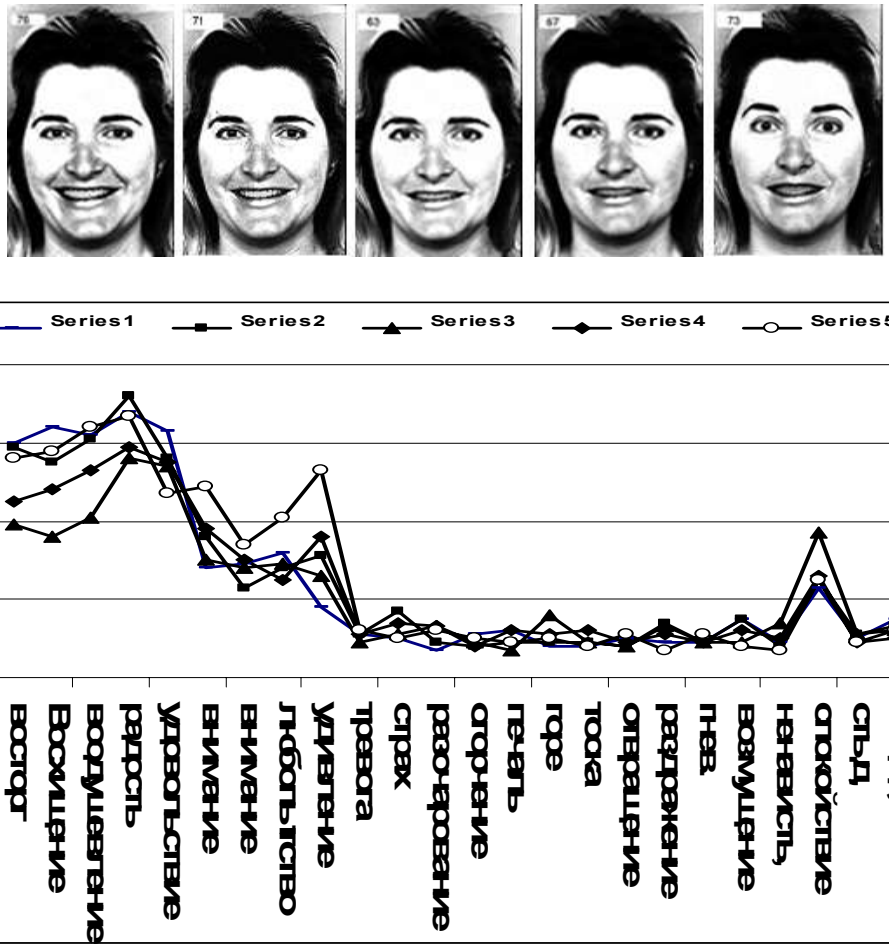

Fig. 1. Five graphics of semantic emotional functions characterizing similarity between face emotional expressions (top panel represents intermediate emotions between "pleasure" and "surprise") and names of emotions (bottom panel).

Five stimuli in this figure have been constructed as a uniform scale of emotional expressions between two basic emotions: pleasure and surprise. It is shown that maximal values of similarity functions really sequentially shifts so, that to expressed emotion "pleasure" mixed with emotion "surprise". However, under the form of functions it is visible, that the addition descends non-uniformly, functions for the first two stimuli (are designated by horizontal dashes and small squares) more similar, than for a remaining pairs. Appearance of one more peak on a graphics of the function of the third stimulus (is designated by bold triangles) in range of an emotion "calm" bears to necessity of one more dimension in addition to a scale "pleasure - surprise".

The same way in a fig. 2 it is visible, that the function of emotional similarity varies so, that to as the much as possible expressed emotion "surprise", sequentially is added an emotion "fear", however here again appearance of additional peaks in range of names "attention" and "grief", mountain the necessity of additional dimension.

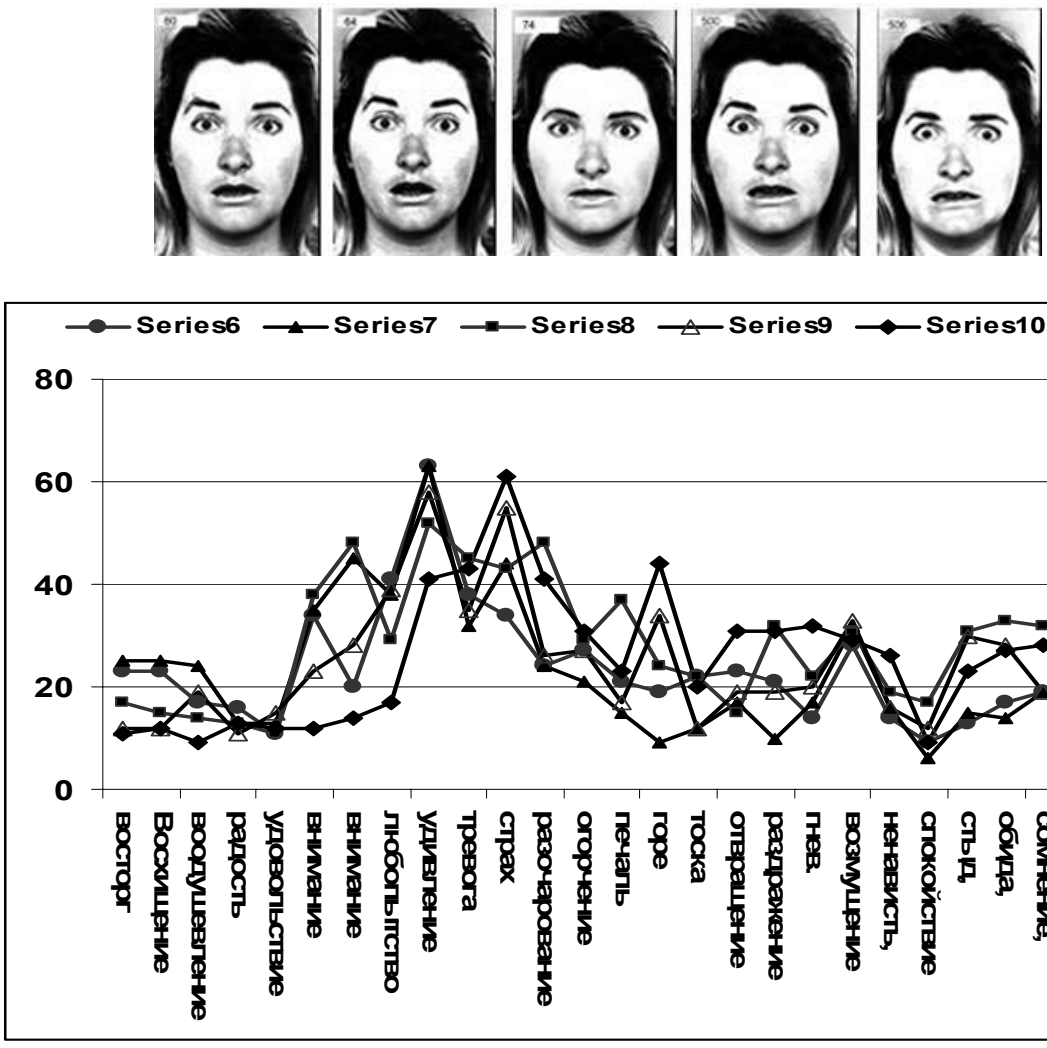

Fig. 2. Five graphics of semantic emotional functions characterizing similarity between face emotional expressions (top panel represents intermediate emotions between “surprise” and “fear”) and names of emotions (bottom panel).

The next figures also demonstrate a possibility to find quantitative characteristics of facial expressions in terms of traditional semantic description of emotions.
The obtained data are coincided with a results discussed in Bimler&Kirkland (2001), where facial emotions are represented as a "mountain" points of a polyhedron in three-dimensional space, instead of points of a circle. At the same time obtained data it is possible also to consider from the point of view of the spherical model of emotions offered in Izmailov et al. (1999).

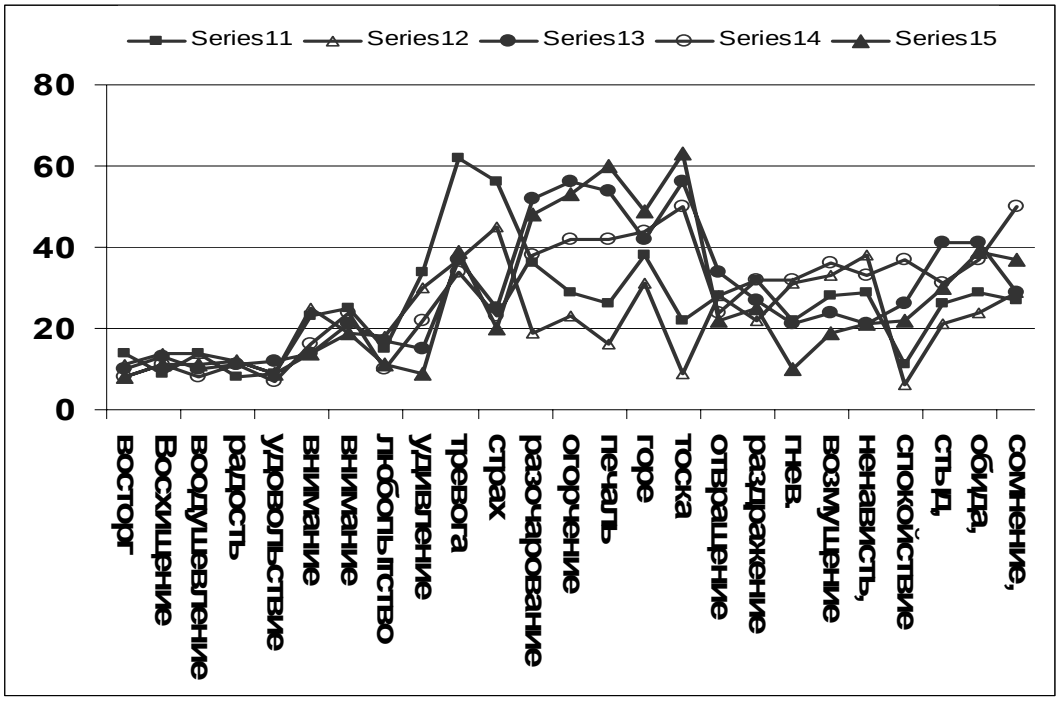

Fig. 3. Five graphics of semantic emotional functions characterizing similarity between face emotional expressions (top panel represents intermediate emotions between “fear” and “sadness”) and names of emotions (bottom panel).

For final conclusion about spatial structure of emotions it is possible to use the analysis of proximity (Shepard&Carroll, 1966). In this case each semantic emotional function of stimuli-faces can be considered as 25-dimensional vector, and matrix of paired differences between vectors can be calculate. The next step is using a multidimensional scaling procedure to reconstruct general semantic emotional space for facial expressions.

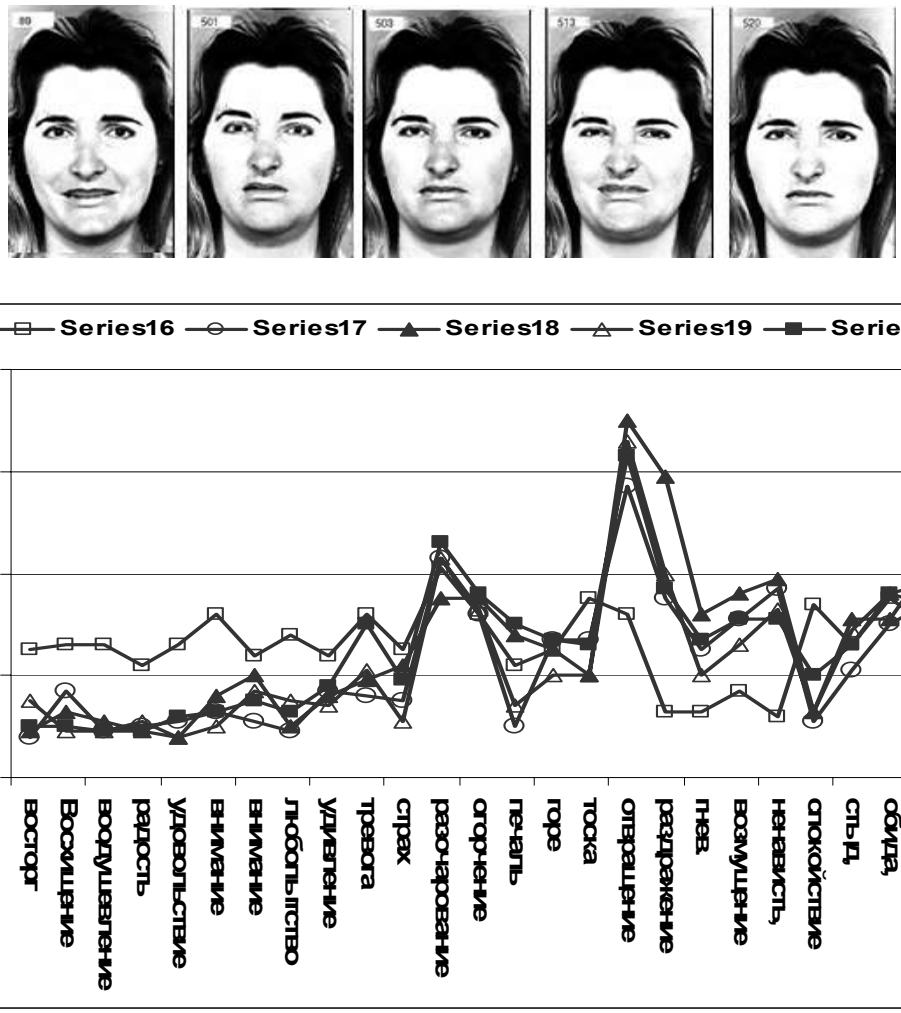

Fig. 4. Five graphics of semantic emotional functions characterizing similarity between face emotional expressions (top panel represents intermediate emotions between "sadness" and "disgust") and names of emotions (bottom panel).

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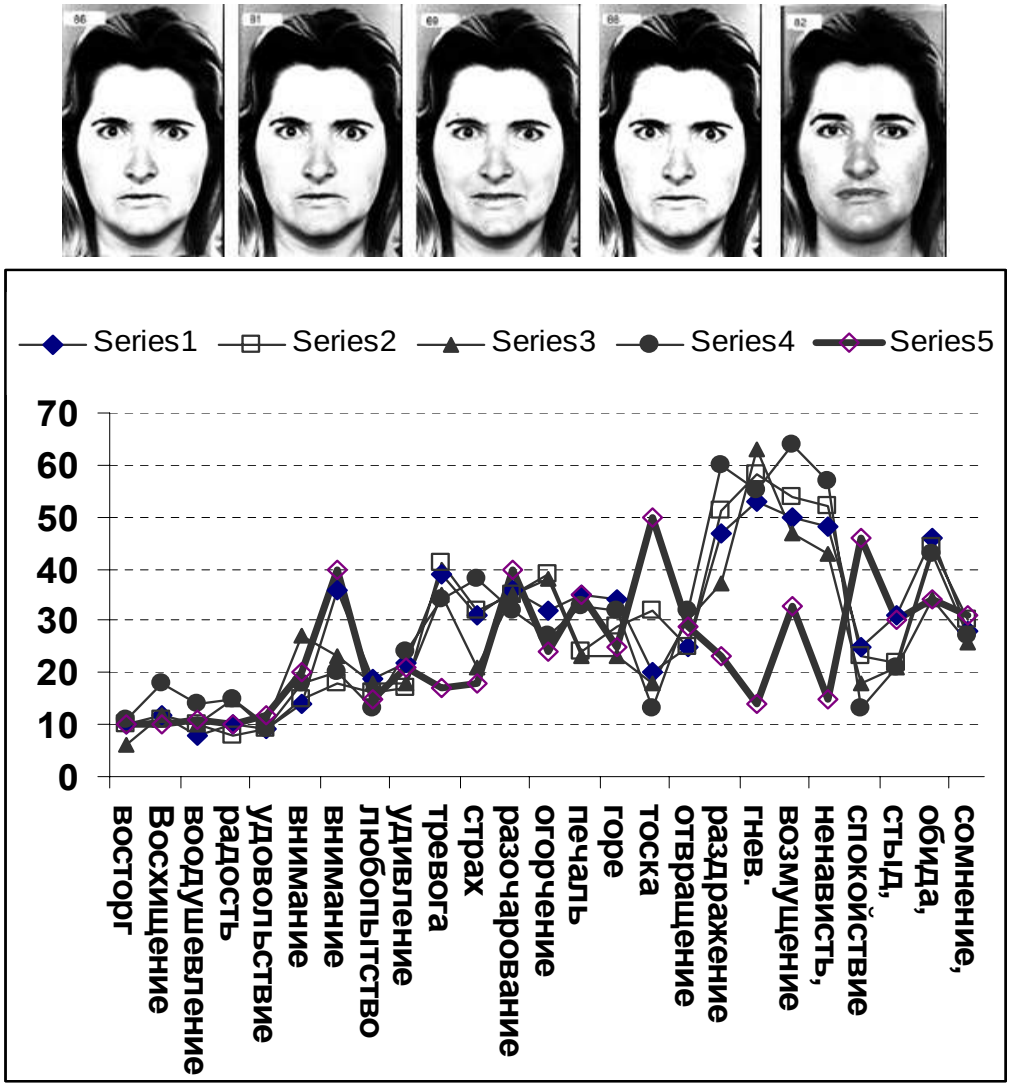

Fig. 5. Five graphics of semantic emotional functions characterizing similarity between face emotional expressions (top panel represents different aspects of emotion “hatred” comparatively with emotion “attention”) and names of emotions (bottom panel).