

Forced facial expression – the effect of different emotions and temporal patterns

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Abstract—In recent years, the importance of facial expression patterns has been recognized, e.g. in information society, neuroscience. In the present paper, forced facial expression patterns were studied by the means of the FaceReader 8.1 system. Human subjects were asked to mimic FEEST-related static facial expressions over 4 seconds each, and their expression was registered and analyzed. The temporal dynamics of a positive and negative valence expression, happiness and anger was analyzed, altogether with arousal data. General linear model was used to establish statistical differences. A significant interaction occurred between the content of input emotion (happiness/anger) and the temporal patterns (expressed anger, happiness, valence). The interaction was not significant in the case of the measured arousal. Our data indicate the importance of studying forced facial expression patterns in the interpretation of complex emotional stimuli.

Keywords — *emotions, facial expressions, recognition system, stimulus intensity.*

1. INTRODUCTION

There is a growing interest for facial affect recognition systems in the field of computer sciences, market research, education and basic psychology/psychiatry research [1-6]. Advances in the facial affect recognition in recent years led to the development of facial affect recognition systems, among them the Noldus FaceReader [7]. Several types of affect recognition systems were introduced, and the long-term-goal of these systems is to help individuals with problems in social recognition [3,6]. Recognizing facial affect is a major component of social interactions, and mirrors several elements of the social recognition procedure. It is clear that facial affect recognition is accompanied by studying expression patterns. Thus, not only the expression to be recognized is getting

important, but studying natural or posing expression or social re-expression patterns are also getting more prominent [4, 5]. Originally, six basic universal emotions (anger, disgust, fear, happiness, sadness, surprise) were described as pan-cultural elements of facial affect [8]. In principle, the perception and interpretation of facial affect in humans is a time-dependent multilayer mechanism for each emotion [9].

Additional to its importance in the interpretation of human communicative signals, facial affect recognition systems might be considered as “social prosthetics” in vulnerable individuals [3]. Major psychiatric conditions affecting emotion recognition is autism spectrum disorder and antisocial personality disorder [10-15]. In these cases, long-term misinterpretation of social signals might result a more pronounced social dysfunction, but other psychiatric disorders, e.g. attention deficit hyperactivity disorder (ADHD), major depression are accompanied by social dysfunction [16]. Unfortunately, these studies did not target forced facial expression patterns, but studying these patterns might help to understand discrepancies in the circle of social functioning and therapeutic interventions [17-18].

Albeit FaceReader is validated for the recognition of the basic Ekman-like expressions, to our best knowledge, forced facial expression patterns were out of the scope of these studies [19-20].

The aim of the present study was to describe the detailed response profile of individuals by the means of the FaceReader system during forced facial expression patterns mimicking validated inputs of anger and happiness in a well-known stimulus database, the Facial Expression of Emotion: Stimuli and Test (FEEST). These data were used as technical preparations for studying preschoolers and their parents with certain psychopathologies both in terms of recognizing and expressing emotions.

II. METHODS

The FEEST Emotion subtest is based on the six universal emotions described by Ekman and colleagues [8,21]. From the Ekman database, only faces expressing happiness and anger were used, altogether 11 faces (5 males, 6 females) with both emotions (22 stimuli). These faces were randomized, and a video input was created with 4 seconds of a particular stimulus face visible following 4 seconds of a blank screen. Three adults were asked to mimic the visual inputs as long as they see that on the screen. The study creates preliminary data for testing the usage of the forced expression test and to optimize data collection for applying to children and their parents in social context. The Noldus FaceReader system was originally developed for marketing applications [7], at present version 8.1 was used. Representative stimuli (anger and happiness) along with the surface of the FaceReader were presented in Figure 1 and 2. The FaceReader was used to analyze the videorecordings of the faces of the individuals during the forced expression test. General model was used with smoothening classification. 30 frames per seconds were analyzed, and data collection was performed ten times per seconds. Only four emotion related data types were collected (angry, happy, valence, arousal), 5280 data points for each emotions were used for the statistical analysis.

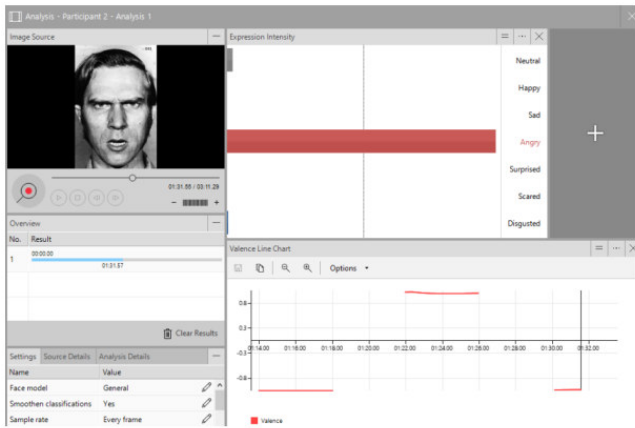


Figure 1. Representative stimulus face with the expression of anger. Participants were asked to mimic the expression as long as it was visible on the screen. Stimulus faces were on for 4 seconds, and a 4 second blank screen interval was present. FaceReader 8.1 screenshot.

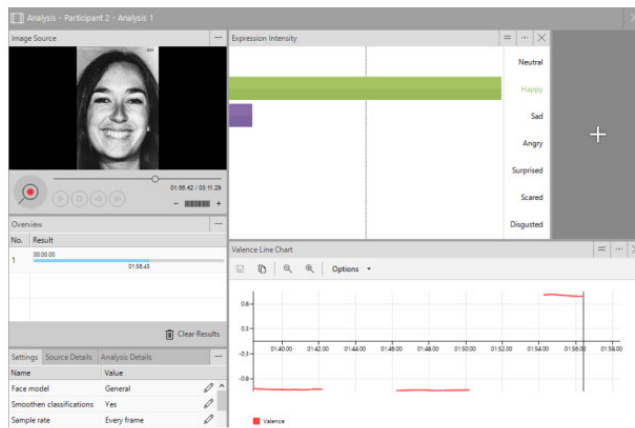


Figure 2. Representative stimulus face with the expression of happiness. Participants were asked to mimic the expression as long as it was visible on the screen. Stimulus faces were on for 4 seconds, and a 4 second blank screen interval was present. FaceReader 8.1 screenshot.

SPSS 20.0 was used to test the overall effect of the gender of the stimulus faces (male vs. female), stimulus type (anger vs. happiness) and the timing of the stimulus (during vs. over) (General Linear Model, GLM). Statistica 7.0 program was used to evaluate the timeline (per second, 4 seconds with stimulus on, 4 seconds with stimulus off) according to the stimulus type (GLM). Newman-Keuls post hoc comparisons were also run where appropriate. $p < 0.05$ was considered as significant difference.

III. RESULTS

In the detailed analysis, data loss was 2.8%. Gender and emotion interaction was present in the case of happy ($F_{(2,5130)}=68.857$, $p < 0.001$), angry ($F_{(2,5130)}=18.541$, $p < 0.001$), valence ($F_{(2,5130)}=49.843$, $p < 0.001$) and arousal ($F_{(2,5130)}=38.526$, $p < 0.001$) (Fig. 3).

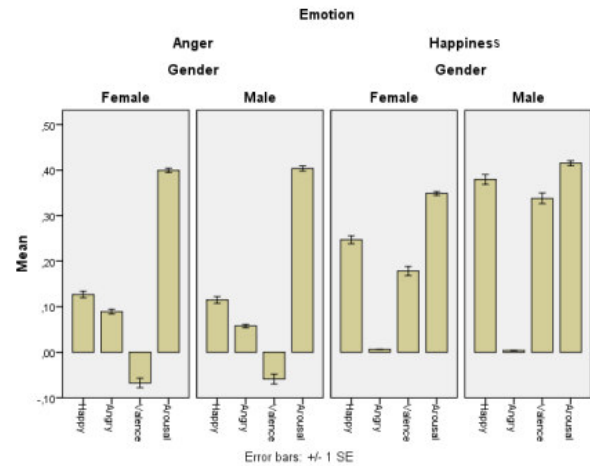


Figure 3. The overall effect of the gender and the emotion content of the stimulus faces during the study. X axis represent emotion content of the individuals with forced expressions. Y axis, arbitrary unit of the emotion content. Means and SE (standard error of the mean) are presented.

State (during input stimulus vs. over input stimulus) and emotion interaction was present in the case of happy ($F_{(2,5130)}=773.366$, $p < 0.001$), angry ($F_{(2,5130)}=320.795$, $p < 0.001$), valence ($F_{(2,5130)}=1161.416$, $p < 0.001$), but not in the case of arousal ($F_{(2,5130)}=2.271$, $p = 0.12$) (Fig. 4).

The 3-way interaction (gender, state and emotion) was also significant in the case of happy ($F_{(1,5126)}=3.866$, $p < 0.05$), angry ($F_{(1,5126)}=8.856$, $p < 0.003$), valence ($F_{(1,5126)}=4.227$, $p < 0.04$), but not in the case of arousal ($F_{(1,5126)}=3.202$, $p = 0.74$) (Fig. 5). Time and emotion interaction (but not gender interaction) was present in the case of happy ($F_{(7,126)}=14.294$, $p < 0.001$), angry ($F_{(7,126)}=6.103$, $p < 0.001$), valence ($F_{(7,126)}=24.752$, $p < 0.001$), but not in the case of arousal ($F_{(7,126)}=0.560$, $p = 0.44$) (Fig. 6-9).

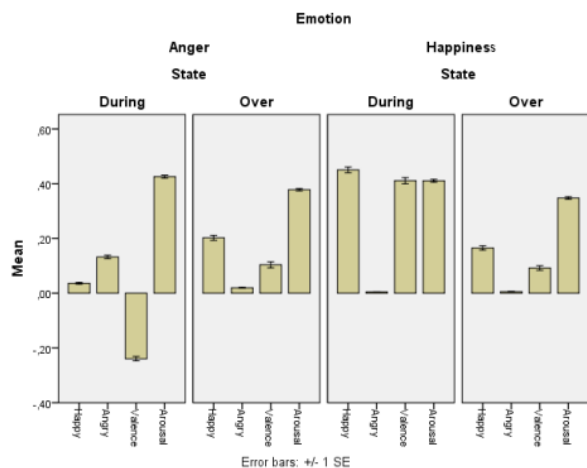


Figure 4. Summarized effect of the forced expression patterns by the two applied stimulus types (anger and happiness). During, average of the 4 seconds when the stimulus emotion was on; over, average of the 4 seconds when the stimulus emotion was off. Detailed statistics is described in the text.

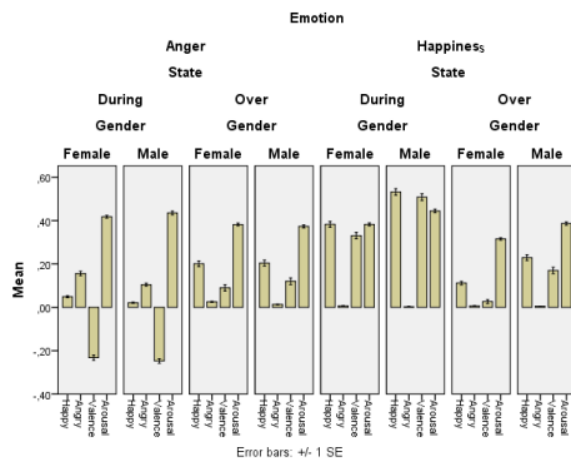


Figure 5. Summarized effect of the forced expression patterns by gender, the two applied stimulus types (anger and happiness) and state. During, average of the 4 seconds when the stimulus emotion was on; over, average of the 4 seconds when the stimulus emotion was off. Detailed statistics is described in the text.

IV. DISCUSSION

The main results of the present study were the following. First, unlike naturally expressed emotions or microemotions, long-lasting forced expressions have rebound effects, e.g. expressing anger accompanied by increased happy feelings afterwards. Second, a major gender, state and input stimulus interaction was observed in the case of happy, angry, and valence data. Third, arousal data were continuously high during the experimental setting, irrespective of the nature or the presence of the stimuli.

Emotion recognition systems are regularly more sensitive to happiness than to other emotions, like anger [22-24]. Busso et al reported higher sensitivity to happiness compared to anger recognition [23], irrespective of the methodology used. In a study where FaceReader was tested in relation with EMG activity, the highest correlation was achieved between the

activity of musculus zygomaticus activity and happiness labeling ($r=0.72$), while smaller but still significant effect was achieved in the case of musculus corrugator activity and anger expression ($r=0.55$) [25]. Overall, there are general differences in the sensitivity of recognizing distinct emotions in humans.

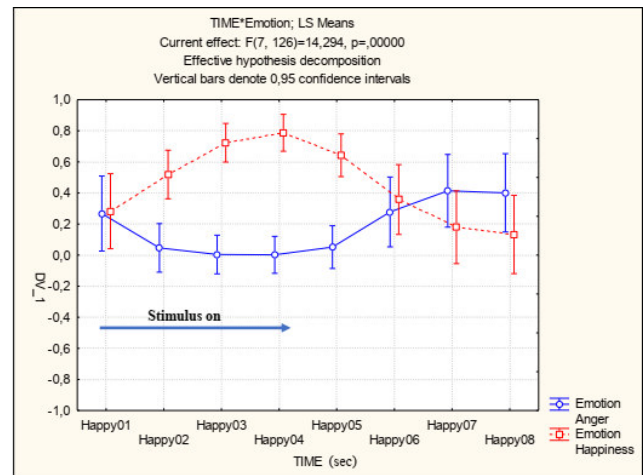


Figure 6. X axis represents emotion content (happy) of the individuals with forced expressions, timeline is presented, the 01-04 values (4 seconds) represent the stimulus (anger or happiness) on, while the 05-08 values represent the stimulus off (4 seconds). Y axis, arbitrary unit of the emotion content (happy). Means and 95% confidence intervals are presented.

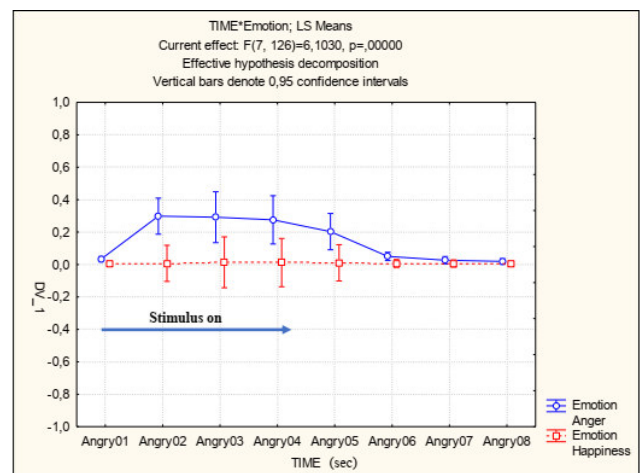


Figure 7. X axis represents emotion content (angry) of the individuals with forced expressions, timeline is presented, the 01-04 values (4 seconds) represent the stimulus (anger or happiness) on, while the 05-08 values represent the stimulus off (4 seconds). Y axis, arbitrary unit of the emotion content (angry). Means and 95% confidence intervals are presented.

Facial affect recognition might have major importance in the pathogenesis in certain psychiatric disorders [10-16]. Alterations described in the working of the amygdalo-prefrontal systems were described both in animal models [26-27] and in human studies [28-30]. Direct therapeutic processes targeting facial affect recognition are widely and beneficially used [11,12,15], albeit it is still questionable whether these processes might be able to modify core symptoms of the pathological conditions.

Philip et al reported subtle differences in response to facial expressions of real vs. virtual faces [31]. Facial electromyography revealed that rapid facial reactions were significantly stronger in the case of joy and anger when participants were presented with real faces compared with virtual ones. Interestingly, this effect was not present in the

case of sadness. As happiness and anger might have a major role in evolutionary processes (the 'angry male' and 'happy female' hypothesis), it is always important to study the effect of individual expressed emotion instead using emotion recognition or expression in general [32].

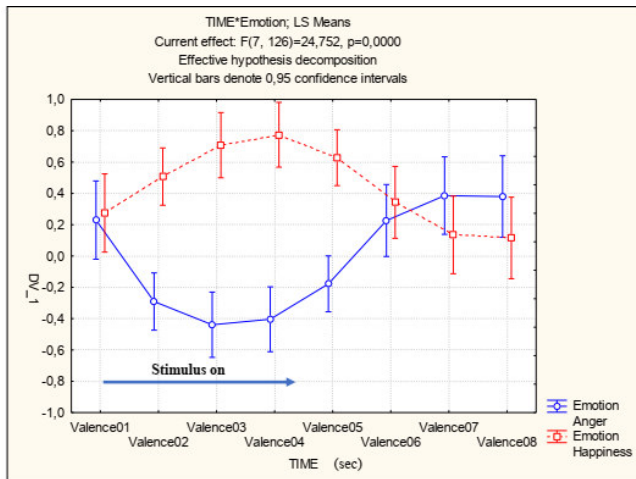


Figure 8. X axis represents emotion content (valence) of the individuals with forced expressions, timeline is presented, the 01-04 values (4 seconds) represent the stimulus (anger or happiness) on, while the 05-08 values represent the stimulus off (4 seconds). Y axis, arbitrary unit of the emotion content (valence). Means and 95% confidence intervals are presented.

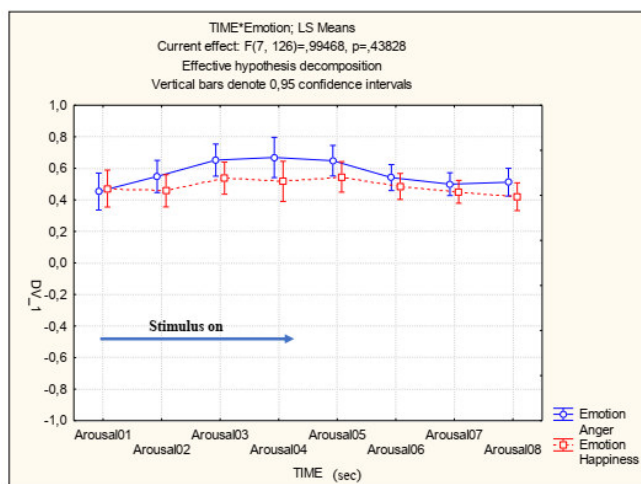


Figure 9. X axis represents emotion content (arousal) of the individuals with forced expressions, timeline is presented, the 01-04 values (4 seconds) represent the stimulus (anger or happiness) on, while the 05-08 values represent the stimulus off (4 seconds). Y axis, arbitrary unit of the emotion content (arousal). Means and SE (standard error of the mean) are presented.

Our results indicate that not only the type of the emotion, but the gender of the expresser and the timing of the stimuli might be crucial in the interpretation and in the re-expression. As we noted earlier, responding appropriately to the facial expression of others is a major factor in proper social functioning. It is widely acknowledged that understanding facial emotion expressions is critical, but unintentional and intentional self-re-expressions might cause troubles in social communication [33]. First, certain individuals need social prosthetics to help their interpretations, and the future of emotion recognition systems is to help these individuals [3,4,6]. Second, the recognition of emotions is not enough, but a proper re-expression is inevitable. Moreover, mimicking the expression during the recognition process might help the individuals in gaining better results in recognition [34,35].

Thus, these two sides can not be easily distinguished, what is clear, that people with autism spectrum disorder have multiple difficulties in this respect [11,36]. Posed vs. genuine expression can be used to help individuals with social difficulties [review: 37], but it is also unclear whether neurotypical subjects are able to distinguish properly the expression of individuals with autism spectrum disorder [38]. Thus, planning experiments all these things have to be taken into account. Our data on arousal indicate that between stimulus intervals were emotionally intensive for the subjects, and probably the effect has major importance when subject with behavioural problems would be tested. Our results also indicate to take the interstimulus intervals seriously, robust, overall analysis patterns for the whole timing of the studies would be inappropriate, but detailed framing is recommended.

The limitations of our study that only anger and happiness were used as stimulus emotions, and instead of dynamic, but long lasting emotions (e.g. slow emotions with reduced speed), a long static input was delivered to the subjects. The only advantage of static inputs were the clear cut latency data throughout the procedure. Using these inputs the effect of valence and arousal data could be interpreted, as these emotions are accompanied by high (opposite) valence and high arousal levels.

In a further step, we would like to assess the facial expression profile both in preschool children and their parents, also in natural settings and also during forced expression test. Understanding and controlling expression patterns might facilitate or disrupt dual communication signals. Later, we would like to discuss with couples their facial expression patterns to the emotions expressed by their children, and also in settings when their child is getting involved in a situation what might be emotionally intense to their parents. The process might have crucial importance in parent training that is considered as number one intervention for preschool children with ADHD or conduct disorder, but literature data is also indicating the usage of the procedure in children with autism spectrum disorder or attachment problems. An independent effect of perioral or eye region is also suggested, and an intervention study using action units (identical actions of independent facial muscles) is planned.

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The authors declare no conflict of interest.

REFERENCES

- [1] B. Fasel, and J. Luetttin, "Automatic facial expression analysis: a survey", *Pattern Recogn.*, vol. 36, pp. 259–275, 2003.
- [2] I. Cohen, N. Sebe, A. Garg, L.S. Chen, and T.S. Huang, "Facial expression recognition from video sequences: temporal and static modeling", *Comp. Vis. Image Understanding*, vol. 91, pp. 160–187, 2003.
- [3] N. Samadiani *et al.*, "A Review on Automatic Facial Expression Recognition Systems Assisted by Multimodal Sensor Data", *Sensors*, vol. 19, art. E1863, 2019.

- [4] F. Zhang, T. Zhang, Q. Mao, and C. Xu, „Geometry Guided Pose-invariant Facial Expression Recognition”, *IEEE Trans. Image Process. Publ. IEEE Signal Process. Soc.*, 2020, doi: 10.1109/TIP.2020.2972114.
- [5] Y.-J. Hong, S. E. Choi, G. P. Nam, H. Choi, J. Cho, and I.-J. Kim, „Adaptive 3D Model-Based Facial Expression Synthesis and Pose Frontalization”, *Sensors*, vol. 20, no. 9, art. E2578, 2020, doi: 10.3390/s20092578.
- [6] B. C. Ko, „A Brief Review of Facial Emotion Recognition Based on Visual Information”, *Sensors*, vol. 18, art. E401, 2018, doi: 10.3390/s18020401.
- [7] Noldus Information Technology B.V., „FaceReader 8.0 Reference Manual”, Noldus GMB, The Netherlands, 2019.
- [8] P. Ekman, E.R. Sorenson, and W.V. Friesen, „Pan-cultural elements in facial displays of emotion”, *Science*, vol. 164, pp. 86–88, 1969.
- [9] R. Adolphs, „Recognizing emotions from facial expressions: psychological and neurological mechanisms”, *Behav. Cogn. Neurosci. Rev.*, vol. 1, pp. 21–62, 2002.
- [10] B. Chakrabarti, and S. Baron-Cohen, „Empathizing: neurocognitive developmental mechanisms and individual differences”, *Prog. Brain Res.*, vol. 156, pp. 403–417, 2006.
- [11] G. Golarai, K. Grill-Spector, and A.L. Reiss, „Autism and the development of face processing”, *Clin. Neurosci. Res.*, vol. 6, pp. 145–160, 2006.
- [12] O. Golan, and S. Baron-Cohen, „Systemizing empathy: teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia”, *Dev. Psychopathol.*, vol. 18, pp. 591–617, 2006.
- [13] S. Baron-Cohen, O. Golan, and E. Ashwin, „Can emotion recognition be taught to children with autism spectrum conditions?”, *Philos. Trans. R. Soc. Lond. B. Biol. Sci.*, vol. 364, pp. 3567–3574, 2009.
- [14] A.A. Marsh, and R.J. Blair, „Deficits in facial affect recognition among antisocial populations: a meta-analysis”, *Neurosci. Biobehav. Rev.*, vol. 32, pp. 454–465, 2008.
- [15] M.R. Dadds, Y. El Masry, S. Wimalaweera, and A.J. Guastella, „Reduced eye gaze explains "fear blindness" in childhood psychopathic traits”, *J. Am. Acad. Child Adolesc. Psychiatry*, vol. 47, pp. 455–463, 2008.
- [16] K. Borhani, and V. Nejati, „Emotional face recognition in individuals with attention-deficit/hyperactivity disorder: a review article”, *Dev. Neuropsychol.*, vol. 43, pp. 256–277, 2018.
- [17] R. Adolphs, „How should neuroscience study emotions? by distinguishing emotion states, concepts, and experiences”, *Soc. Cogn. Affect. Neurosci.*, vol. 12, pp. 24–31, 2017.
- [18] K. Dobs, I. Bülthoff, and J. Schultz, „Use and Usefulness of Dynamic Face Stimuli for Face Perception Studies—a Review of Behavioral Findings and Methodology”, *Front. Psychol.*, vol. 9, art. 1355, 2018, doi: 10.3389/fpsyg.2018.01355.
- [19] V. Terzis, C.N. Moridis, and A.A. Economides, „Measuring instant emotions during a self-assessment test: the use of FaceReader”, *Proceed. Measur. Behav.*, pp. 192–195, 2010.
- [20] V. Terzis, C.N. Moridis, and A.A. Economides, „Measuring instant emotions based on facial expressions during computer-based assessment”, *Pers. Ubiquit. Comput.*, vol. 17, pp. 43–52, 2013.
- [21] A. Young, D. Perrett, A. Calder, R. Sprengelmeyer, and P. Ekman, „Facial expressions of emotion- stimuli and tests (FEEST)”, Thames Valley Test Company, Bury St. Edmunds, UK, 2002.
- [22] S.V. Ioannou, A.T. Raouzaïou, V.A. Tzouvaras, T.P. Mailis, K.C. Karpouzis, and S.D. Kollias, „Emotion recognition through facial expression analysis based on a neurofuzzy network”, *Neural Networks*, vol. 18, pp. 423–435, 2005.
- [23] C. Busso, Z. Dheng, S. Yildirim, M. Bulut, C.M. Lee, A. Kazemzadeh, S. Lee, U. Neumann, and S. Narayanan, „Analysis of emotion expression using facial expressions, speech and multimodal information”, *ICMI*, ACM-1-58113-890-3, 2004.
- [24] Z. Zhang, M. Lyons, M. Schuster, and S. Akamatsu, „Comparison between geometry-based and Gabor-wavelets-based facial expression recognition using multi-layer perceptron”, *IEEE Int. Conf on Automatic Face and Gesture Recognition*, 1998.
- [25] T.J. D’Arcey, „Assessing the validity of the FaceReader using facial EMG”, M.A. Thesis, California State University, Chico, 2013.
- [26] J. Halász, M. Tóth, I. Kalló, Z. Liposits, and J. Haller, „The activation of prefrontal cortical neurons in aggression—a double labeling study”, *Behav. Brain Res.*, vol. 175, pp. 166–175, 2006.
- [27] J. Halász *et al.*, „The effect of neurokinin1 receptor blockade on territorial aggression and in a model of violent aggression”, *Biol. Psychiatry*, vol. 63, pp. 271–278, 2008.
- [28] A.A. Marsh *et al.*, „Reduced amygdala response to fearful expressions in children and adolescents with callous-unemotional traits and disruptive behavior disorders”, *Am. J. Psychiatry*, vol. 165, pp. 712–720, 2008.
- [29] A.P. Jones, K.R. Laurens, C.M. Herba, and G.J. Barker, „Amygdala hypoactivity to fearful faces in boys with conduct problems and callous-unemotional traits”, *Am. J. Psychiatry*, vol. 166, pp. 95–102, 2009.
- [30] R.J. Davidson, K.M. Putnam, and C.L. Larson, „Dysfunction in the neural circuitry of emotion regulation—a possible prelude to violence”, *Science*, vol. 289, pp. 591–594, 2000.
- [31] L. Philip, J.-C. Martin, and C. Clavel, „Rapid Facial Reactions in Response to Facial Expressions of Emotion Displayed by Real Versus Virtual Faces”, *I-Percept.*, vol. 9, 2018, doi: 10.1177/2041669518786527.
- [32] P. K. C. Tay, „The adaptive value associated with expressing and perceiving angry-male and happy-female faces”, *Front. Psychol.*, vol. 6, art. 851, 2015, doi: 10.3389/fpsyg.2015.00851.
- [33] J. Yi, P. Pärnamets, and A. Olsson, „The face value of feedback: facial behaviour is shaped by goals and punishments during interaction with dynamic faces”, *R. Soc. Open Sci.*, vol. 8, art. 202159, 2021, doi: 10.1098/rsos.202159.
- [34] A. E. Kowalik, M. Pohl, and S. R. Schweinberger, „Facial Imitation Improves Emotion Recognition in Adults with Different Levels of Sub-Clinical Autistic Traits”, *J. Intell.*, vol. 9, art. 4, 2021, doi: 10.3390/jintelligence9010004.
- [35] A. Wood, M. Rychlowska, S. Korb, and P. Niedenthal, „Fashioning the Face: Sensorimotor Simulation Contributes to Facial Expression Recognition”, *Trends Cogn. Sci.*, vol. 20, pp. 227–240, 2016.
- [36] K. Safar, M. M. Vandewouw, and M. J. Taylor, „Atypical development of emotional face processing networks in autism spectrum disorder from childhood through to adulthood”, *Dev. Cogn. Neurosci.*, vol. 51, 2021, doi: 10.1016/j.dcn.2021.101003.
- [37] P. J. Webster, S. Wang, and X. Li, „Review: Posed vs. Genuine Facial Emotion Recognition and Expression in Autism and Implications for Intervention”, *Front. Psychol.*, vol. 12, o. 653112, 2021, doi: 10.3389/fpsyg.2021.653112.
- [38] R. Brewer *et al.*, „Can Neurotypical Individuals Read Autistic Facial Expressions? Atypical Production of Emotional Facial Expressions in Autism Spectrum Disorders”, *Autism Res. Off. J. Int. Soc. Autism Res.*, vol. 9, 262–271, 2016.