The Influence of Facial Width-to-Height Ratio on Micro-expression Recognition

Siwei Zhang, Jinyuan Xie, Qi Wu

The Influence of Facial Width-to-Height Ratio on Micro-expression Recognition

Siwei Zhang*, Jinyuan Xie*, Qi Wu[1]*

*Cognition and Human Behavior Key Laboratory of Hunan Province, Department of Psychology, Hunan Normal University
Changsha, China
sandwich624@yeah.net

ABSTRACT. The aim of the present study was to uncover the potential impact of facial width-to-height ratio (fWHR) on micro-expression and macro-expression recognition. The JACBART paradigm was used for the presentation of facial expressions. Participants were asked to recognize six kinds of basic expressions (sadness, surprise, anger, disgust, fear, happiness) on high fWHR faces or on low fWHR faces under 67ms, 333ms and 600ms duration conditions respectively. The results indicated that, the fWHR did not affect the recognition of macro-expressions which were presented for 600ms in the present study, but the fWHR could influence the recognition accuracy of micro-expressions of surprise and happiness. Specifically, participants could identify the facial expression of surprise more effectively on high fWHR faces than on low fWHR faces under the condition of 67ms. And participants also could recognize the facial expression of happiness more accurately on high fWHR faces in the conditions of 67ms and 333m. These results revealed the facial expressions of happiness and surprise on high fWHR faces may have an early processing advantage in micro-expression recognition. And the result also demonstrated that individuals spontaneously use fWHR as a clue to recognize micro-expressions.

KEYWORDS: emotion and affection, mechanism of cognition, essence of perception, facial width-to-height ratio, micro-expression, micro-expression recognition

1 Introduction

We often say a person should never judge a book by its cover. But in real life, we usually make a judgment about his/her age or personal character, according to individuals' appearance, especially the facial features, when we see unfamiliar faces on the moment. Humans are very good at using other people's facial structures to interpret their nonverbal signals, like facial expressions, helping themselves to achieve a better social interaction.

Indeed, numerous studies in the past have shown that the facial features of the expressers, such as eyes, mouths, and other facial structures (Blais *et al.,* 2012; Deska *et al.,* 2017; Sacco *et al.,* 2009), can influence facial expression recognition. The present

study focused on whether individuals can identify fleeting micro-expressions effectively through other people's facial structures.

Facial width-to-height ratio (fWHR) is a stable facial structure. A number of previous studies investigated the predictive effects of fWHR on individual traits and behaviors (Geniole *et al.,* 2015; Haselhuhn *et al.,* 2015). For instance, fWHR can influence individual's facial expression recognition (Deska *et al.,* 2017). But no studies have examined the impact of fWHR on micro-expression recognition. Therefore, we used the six basic facial expressions (happiness, sadness, anger, fear, disgust, surprise) on high fWHR faces or on low fWHR faces made by Facegen Modeller (www.facegen.com), to investigate the effect of fWHR on facial expression recognition under different duration conditions (67ms, 333ms, 600ms).

1.1 Micro-expressions of emotion

Individual's emotion is impacted by the unconscious impulses which stems from the brain's mood centers (Frank *et al.,* 2015), so that the control of body by emotion is stronger than that by logical thinking in some cases. The expression of emotions can be indicated by changes in facial expression, body posture, and other manners (Ekman *et al.,* 1983).

Micro-expressions and macro-expressions are both the manifestation of one's internal emotion. Macro-expression is a direct expression of an 'emotion', which is the most common expression in our daily life and it usually lasts for 1/2s to 4s at least (Yan et al., 2013).It is also easy to be controlled and falsified. But the micro-expression is the barometer of authentic human emotional activities and can help people to spot the lies (Frank *et al.,* 2015; Vrij *et al.,* 2014). Micro-expressions are actually very short and uncontrollable facial expressions that show up when human beings are trying to suppress or hide real emotions (Ekman 2009; Yan *et al.,* 2013) More specifically, micro-expressions usually last no longer than 1/2s (Matsumoto *et al.,* 2011; Yan *et al.,* 2013), and can often be neglected during the daily conversations (Frank *et al.,* 2015). In general, they occur under stressful situations where people want to control the feeling of fear and guilty, such as lying (Porter *et al.,* 2008). In such pressure circumstances, the ability to better recognize micro-expression may be indispensable. In order to read micro-expressions correctly, a Micro-Expression Training Tool (METT) has been developed (Ekman 2002; Hurley *et al.,* 2014).

Currently, micro-expression recognition has been widely applied in the field of medicine, political psychology, national security and justice (ten Brinke *et al.,* 2012; Shen *et al.,* 2012; Weinberger 2010). Even in the field of education, some researchers found that the changes of micro-expression can be used as effective indicators to measure the intellectual level and the knowledge conceptual paradox of students. It can also be used to monitor the teaching efficiency (Chiu *et al.,* 2014). However, due to its characteristics, micro-expression recognition is challenging for humans and the recognition

accuracy is about 45~59% (Matsumoto *et al.,* 2011). Therefore, it is advisable for researchers to develop automatic micro-expression recognition tools (e.g., Guo *et al.,* 2017; Wu *et al.,* 2011) and investigating the potential factors that affect the recognition of micro-expressions in humans would help us to better achieve that purpose.

1.2 Facial Width-to-Height Ratio (fWHR)

As an anthropometric measure of facial shape, fWHR is calculated by measuring the ratio between bizygomatic width and the distance from the upper lip to the midbrow (Hehman *et al.,* 2015; Weston *et al.,* 2007). The higher the fWHR, the wider the face. The smaller the fWHR, the longer the face (Haselhuhn *et al.,* 2012). Abundant studies found that high fWHR is associated with aggression and dominance (Geniole *et al*., 2015). Meta-analytic evidence also strongly indicate that there is a positive relationship between high fWHR and aggression traits (Haselhuhn *et al.,* 2015).

Furthermore, there were findings suggested that the anger — the state most closely related to aggression — increased fWHR (Marsh *et al,* 2014). And some researchers also found that high fWHR may share phenotypic overlap with angry expressions (Deska *et al.,* 2017). The recent evidence also showed that fWHR significantly influences the recognition of macro-expressions of anger, fear and happiness (Deska *et al.,* 2017). For example, researchers demonstrated that when neutral expressions were presented, high fWHR and low fWHR neutral expression were respectively perceived as signaling anger and fear. When individuals' faces display emotional expressions, such as happiness, fear and anger, fWHR can bias ascriptions of emotion by facilitating the recognition of fear and happiness on low fWHR faces and increasing the recognition of anger on faces with high fWHR (Deska *et al.,* 2017).

2 The current study: effects of Facial Width-to-Height Ratio on the recognition micro-expressions

Macro-expression is an important source of social interactions that appear over a single or various regions of the face. It is easily recognized by human. Like macro-expression, micro-expression has three rendering stages: onset, peak and offset (Yan *et al.,* 2013). But unlike macro facial expressions, micro-expression displays more rapidly and transiently (less than 1/2s) which makes it hard to be identified. And few can fake a micro-expression (Frank *et al.,* 2015).

Macro-expression recognition has already been studied a lot by researchers. We found that macro facial expression recognition is easily to be influenced by our facial structure, such as larger eyes facilitated the recognition of fearful facial expressions (Sacco *et al.,* 2009). The latest study also found that the fWHR can influence the recognition of macro facial expression of anger, fear and happiness (Deska *et al.,* 2017). Previous study has also illustrated that the recognition of micro-expression is affected by facial features, such as the mouth movements of a face inhibited conscious detection of all types of micro-expressions in that face (Iwasaki *et al.,* 2016). But it is unclear

whether the fWHR can also influence the recognition of micro-expressions. Therefore, the present study investigated the relationship between fWHR and the recognition of micro-expressions and explored the differential influence of fWHR on macro-expression and micro-expression recognition.

3 Method

3.1 Participants and design

We used the Gpower software (V3.1; Faul *et al.*, 2007) to estimate our sample size. This analysis suggested we collect at least 168 participants to obtain 0.8 power. Consequently, one hundred sixty-eight undergraduate students as participants were recruited from Hunan Normal University. All the participants were Chinese, M_{age} = 21.75, *SD* = 1.75, 47.6 % female. Participants had normal or corrected-to-normal vision and never had experience with such an experiment. After the experiment, the participants were given partial course credit or monetary reward.

A 2 (fWHR: high fWHR, low fWHR) × 3 (duration: 67ms, 333ms, 600ms) ×6 (facial expression: sadness, surprise, anger, disgust, fear, happiness) mixed-model experimental design was used, with fWHR being the between-subjects factor while facial expression and duration being the within-subjects factors.

3.2 Stimuli

Emotion images used in the practice trials were from Nimstim database (Tottenham *et al.*, 2009), which could help participants to get familiar with the experimental procedure. In the formal test, we used the FaceGen Modeller software to generate 24 models (12 females, 12 males; age 21-30) and transformed them into images of seven facial expressions (neutral, sadness, surprise, anger, disgust, fear, happiness) with high fWHR faces (fWHR > 1.9) and low fWHR faces (fWHR < 1.7) (Chae *et al.*, 2014; Haselhuhn *et al.*, 2012). The height of faces from one person were consistent. And the intensity of basic expressions was set to maximum (1). The number of images was 336 in total, the size of each image was 400 × 400 pixels.

4 Apparatus and procedure

Each participant was randomly assigned to the high fWHR face group (n = 84) or the low fWHR face group (n = 84). Before the formal test, participants were familiarized with the procedure and finished six practice trials. The stimulus was presented centrally with a 60-Hz refresh rate on a laptop. The E-Prime software controlled stimulus presentation and data collection. In the practice trials, six images of basic expressions would be presented. In the formal test, the duration of expression was divided into three conditions (67ms, 333ms and 600ms) which consisted of 144 trials, with 48 trials per condition. The 24 models were randomly assigned to three duration conditions, with 8 models per condition. The order of the combination of the models and the duration

conditions was counterbalanced across participants by balanced Latin square. In each condition, the six micro-expressions of each model were randomly displayed.

This study adopted the JACBART paradigm (Ekman 2002; Svetieva *et al*., 2016) to present the facial expressions. Firstly, a fixation cross (500ms) was presented in the center of the screen, then the facial expression image was sandwiched in between two 1000ms presentations of the same model's neutral expression. Facial expression images randomly presented for 67ms, 333ms or 600ms. When the facial expression disappeared, participants were asked to choose one of six emotion expression labels (i.e., sadness, surprise, anger, disgust, fear, happiness) and "none of the above" from a list to describe the expression on the screen (pressing one of seven buttons 1-7 on a response keyboard). The next trial was presented after the participants made the judgment (unlimited reaction time).

5 Results

We conducted a 2 (fWHR: high fWHR, low fWHR) × 3 (duration: 67ms, 333ms, 600ms) × 6 (facial expression: sadness, surprise, anger, disgust, fear, happiness) analysis of variance (ANOVA) on recognition accuracy. The analysis yielded a significant main effect on facial expression [F (5, 830) = 356.93, $p < 0.01$, $\eta_p^2 = 0.68$], and the duration [F (2, 332) = 125.39, $p < 0.01$, $\eta_p^2 = 0.43$]. Generally, the recognition accuracy of happy, surprise and sad expressions was higher than other expressions in three duration conditions, and the recognition accuracy of all facial expressions in the condition of 600ms duration was much higher than the other two duration conditions. Descriptive statistical results were shown in Table 1. The main effect of fWHR was not significant [F (1, 166) = 2.33, $p > 0.05$, $\eta_p^2 = 0.01$]. The interaction between facial expression and duration was significant [F (10, 1660) = 15.15, $p < 0$ .01, $\eta_p^2 = 0.08$]. However, there were no significant interactions of fWHR × facial expression and fWHR × duration [F (5, 830) = 0.86, $p > 0$ .05, $\eta_p^2 = 0.01$; F (2, 332) = 1.26, $p > 0.05$, $\eta_p^2 = 0.01$]. The three-way interaction among the three factors was significant [F (10, 1660) = 2.15, $p < 0.05$, $\eta_p^2 = 0.01$].

	67ms High fWHR		67ms Low fWHR		333ms High fWHR		333ms Low fWHR		600ms High fWHR		600ms Low fWHR	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
sad-	0.69	0.33	0.71	0.35	0.75	0.34	0.74	0.34	0.79	0.31	0.75	0.33
sur-	0.72	0.26	0.64	0.25	0.78	0.21	0.73	0.24	0.76	0.23	0.77	0.23
an-	0.12	0.17	0.14	0.19	0.16	0.21	0.13	0.20	0.12	0.19	0.12	0.19
dis-	0.07	0.13	0.08	0.14	0.09	0.20	0.09	0.19	0.08	0.17	0.11	0.19
fear	0.40	0.27	0.40	0.29	0.59	0.33	0.54	0.34	0.60	0.30	0.57	0.33
hap-	0.78	0.22	0.67	0.27	0.90	0.18	0.83	0.20	0.90	0.17	0.85	0.22
piness												

Table 1. *Descriptive statistical results from this study*

Further simple effects analysis revealed that, participants were more sensitive to the facial expressions of happiness and surprise on high fWHR faces than on low fWHR faces under the condition of 67ms [F (1, 166) = 8.31, $p < 0.01$, $\eta_p^2 = 0.05$; F (1, 166) = 4.14, $p < 0.05$, $\eta_p^2 = 0.02$]. But under the condition of 67ms, the fWHR did not influence the recognition of other micro-expressions (i.e., sadness, anger, disgust, fear) [$Fs < 1$, $ps > 0.43$]. In addition, under the condition of 333ms, the recognition accuracy of the expression of happiness was higher on high fWHR faces than on low fWHR faces [F (1, 166) = 5.11, $p < 0.05$, $\eta_p^2 = 0.03$]. But the fWHR also did not influence the recognition of other micro-expressions (i.e., sadness, surprise, anger, disgust, fear) [$Fs < 1.8$, $ps > 0.19$]. The fWHR also did not influence the recognition of macro-expression in the condition of 600ms (i.e., sadness, surprise, anger, disgust, fear, happiness) [$Fs < 3.4$, $ps > 0.07$].

6 Discussion

This study compared the recognition of facial expression with 6 basic expressions on high fWHR faces or on low fWHR faces under different duration conditions (67ms, 333ms, 600ms), and investigated the differential influence of facial width-to-height ratio on macro and micro expressions. To be specific, the duration of expression did influence the recognition of facial expression, which was consistent with previous studies (Shen *et al.*, 2012). And the results also showed that, the fWHR did not affect the recognition of macro expression which was presented for 600ms in the present study. In contrast, the fWHR influenced the micro-expressions of happiness and surprise. More specifically, participants identified the facial expression of surprise more effectively on high fWHR faces than on low fWHR faces under the condition of 67ms. And participants also recognized the facial expression of happiness more accurately on high fWHR faces in the condition of 67ms and 333ms duration. It suggests that the expression of surprise and happiness on high fWHR faces may have an early advantage in micro-expression recognition.

A recent eye-tracking study indicated that individuals pay more attention to the eyes area in large faces, while the distribution of gaze towards small faces is still in the nose center (Wang 2018). The expression of surprise is accentuated by the eyes, such as raised eyebrows and wide eyes (Ekman 1978). In a very short period, individuals are likely to notice the eyes area first. So the micro-expression of surprise on high fWHR face may be more likely to be unconsciously processed by individuals. The reason for fWHR can influence the recognition of happiness on high fWHR faces might be related to the processing characteristics of the expression of happiness. The expressed regions of happiness in face is mainly concentrated on the mouth, which is the prominent region to convey information (Blais *et al.*, 2012). Studies have indicated that the lower face plays more important role than the upper face in micro-expression recognition (Iwasaki *et al.*, 2016). So high fWHR means the lower face is large, the participants were more

likely to focus on the mouths, and thus were more accurately to recognize the expression of happiness. The present study, did not find a similar results as previous research that the fWHR affects the recognition of macro-expression (Deska *et al.*, 2017). However, in the previous studies (Deska *et al.*, 2017), researchers had only provided two labels (anger versus fear or happiness) for participants to choose. This procedure would definitely overactive the concepts of anger thereby participants could easily establish a link between fWHR and anger. But in the current experiment, participants were asked to choose correct response from more than six expression labels. Such a design would reduce the activation of emotional semantic concepts that may be related to fWHR. The interaction between language and fWHR should be investigated in future works.

In summary, the results demonstrated that there are differences between the recognition of micro-expressions and macro-expressions, and that fWHR can influence the processing of micro-expression of happiness and surprise on high fWHR faces. The current study only found that fWHR can affect the micro-expression recognition, but the underlying mechanisms behind this phenomenon — such as how the fWHR changes the processing of faces — have not been clarified yet. In addition, our participants mainly were from China. More cross-cultural studies should be considered in future.

Acknowledgements

The authors wish to express sincere appreciation to Shengjie Zhao (Hunan Normal University, Changsha, China) for his assistance with data collection. This work was supported by the National Natural Science Foundation of China (grant number 31300870) and the Hunan Normal University (grant number 13XQN01 2015yx08).

References

1. Blais, C., Roy, C., Fiset, D., Arguin, M., Gosselin, F., "The eyes are not the window to basic emotions", *Neuropsychologia*, vol .50 no.12, 2012, p. 2830-2838.
2. Chae, D. H., Nuru-Jeter, A. M., Adler, N. E., Brody, G. H., Lin, J., Blackburn, E. H., et al., "Discrimination, racial bias, and telomere length in african-american men", *American Journal of Preventive Medicine*, vol. 46 no .2, 2014, p. 103-111.
3. Chiu, M. H., Chou, C. C., Wu, W. L., Liaw, H., "The role of facial microexpression state (FMES) change in the process of conceptual conflict", *British Journal of Educational Technology*, vol. 45 no .3, 2014, p. 471-486.
4. Deska, J. C., Lloyd, E. P., Hugenberg, K., "The face of fear and anger: facial width-to-height ratio biases recognition of angry and fearful expressions", *Emotion*, Vol.18 no .3, 2017, p. 453-464.
5. Ekman P., *Facial Action Coding System*. Salt Lake City, UT: Network Information Research, 1978.
6. Ekman, P., *Micro Expression Training Tool*. University of California, San Francisco, 2002.
7. Ekman, P., "Lie catching and microexpressions", *The Philosophy of Deception*, 2009, p. 118-133.

8. Ekman, P., O'Sullivan, M., “From flawed self-assessment to blatant whoppers: the utility of voluntary and involuntary behavior in detecting deception”, *Behavioral Sciences the Law*, vol. 24 no. 5, 2010, p. 673-686.
9. Ekman, P., Levenson, R. W., Friesen, W. V., “Autonomic nervous system activity distinguishes among emotions”, *Science*, vol. 221 no. 4616, 1983, p. 1208-1210.
10. Endres, J., Laidlaw, A., “Micro-expression recognition training in medical students: A pilot study”, *BMC Medical Education*, vol 9 no. 1, 2009, p. 47-53.
11. Faul, F., Erdfelder, E., Buchner, A., Lang, A. G., “Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses”, *Behavior Research Methods*, vol. 41 no. 4, 2009, p. 1149-1160.
12. Frank, M. G., Svetieva, E., “Microexpressions and Deception”, *Understanding Facial Expressions in Communication*, 2015, p. 227-242.
13. Geniole, S. N., Mccormick, C. M., “Facing our ancestors: judgements of aggression are consistent and related to the facial width-to-height ratio in men irrespective of beards”, *Evolution Human Behavior*, vol. 36 no. 4, 2015, p. 279-285.
14. Haselhuhn, M. P., Ormiston, M. E., Wong, E. M., “Men’s facial width-to-height ratio predicts aggression: a meta-analysis”, *Plos One*, vol. 10 no. 4, 2015, e0122637.
15. Haselhuhn, M. P., Wong, E. M., “Bad to the bone: facial structure predicts unethical behaviour”, *Proceedings Biological Sciences*, vol. 279 no. 1728, 2012, p. 571-576.
16. Hehman, E., Leitner, J. B., Deegan, M. P., Gaertner, S. L., “Picking teams: when dominant facial structure is preferred”, *Journal of Experimental Social Psychology*, vol. 59, 2015, p. 51-59.
17. Hurley, C. M., Anker, A. E., Frank, M. G., Matsumoto, D., Hwang, H. C., “Background factors predicting accuracy and improvement in micro expression recognition”, *Motivation Emotion*, vol. 38 no. 5, 2014, p. 700-714.
18. Iwasaki, M., Noguchi, Y., “Hiding true emotions: micro-expressions in eyes retrospectively concealed by mouth movements”, *Scientific Reports*, vol. 6, 2016, 22049.
19. Guo, J., Zhou, S., Wu, J., Wan, J., Zhu, X., Lei, Z., et al., “Multi-modality Network with Visual and Geometrical Information for Micro Emotion Recognition”, IEEE International Conference on Automatic Face and Gesture Recognition IEEE, 2017, p. 814-819.
20. Marsh, A. A., Cardinale, E. M., Chentsova-Dutton, Y. E., Grossman, M. R., Krumpos, K. A., “Power plays expressive mimicry of valid agonistic cues”, *Social Psychological Personality Science*, vol. 5 no. 6, 2014, p. 684-690.
21. Matsumoto, D., Hwang, H. S., “Evidence for training the ability to read microexpressions of emotion”, *Motivation and Emotion*, vol. 35 no. 2, 2011, p. 181-191.
22. Porter, S., ten Brinke, L. T., “Reading between the lies: identifying concealed and falsified emotions in universal facial expressions”, *Psychological Science*, vol. 19 no. 5, 2008, p. 508-514.
23. Sacco, D. F., Hugenberg, K., “The look of fear and anger: facial maturity modulates recognition of fearful and angry expressions”. *Emotion*, vol. 9 no. 1, 2009, p. 39-49.
24. Shen, X. B., Qi, W. U., Xiao-Lan, F. U., “ Effects of the duration of expressions on the recognition of microexpressions”, *Journal of Zhejiang University-Science B(Biomedicine Biotechnology)*, vol. 13 no. 3, 2012, p. 221-230.
25. Svetieva, E., Frank, M. G., “Empathy, emotion dysregulation, and enhanced microexpression recognition ability”, *Motivation Emotion*, vol. 40 no. 2, 2016, p. 309-320.
26. ten Brinke, L., MacDonald, S., Porter, S., O’Connor, B., “Crocodile tears: Facial, verbal and body language behaviours associated with genuine and fabricated remorse”, *Law and Human Behavior*, vol. 36 no. 1, 2012, p. 51-59.

27. Tottenham, N., Tanaka, J. W., Leon, A. C., Mccarry, T., Nurse, M., Hare, T. A., et al., "The nimstim set of facial expressions: judgments from untrained research participants", *Psychiatry Research,* vol. 168 no.3, 2009, p. 242-249.
28. Vrij, A., Ganis, G., "*Theories in Deception and Lie Detection",* Credibility Assessment, 2014, p. 301-374.
29. Wang, S., "Face size biases emotion judgment through eye movement", *Scientific Reports,* vol. 8 no. 1, 2018, p. 317.
30. Weinberger, S., "Airport security: intent to deceive?", *Nature,* vol. 465 no. 7297, 2010, p. 412-415.
31. Weston, E. M., Friday, A. E., Pietro, L., " Biometric evidence that sexual selection has shaped the hominin face", *Plos One,* vol. 2 no. 8, 2007, e710.
32. Wu, Q., Shen, X., Fu, X., "The machine knows what you are hiding: an automatic micro-expression recognition system", *Lecture Notes in Computer Science,* vol. 6975, 2011, p. 152-162.
33. Yan, W. J., "How fast are the leaked facial expressions: the duration of micro-expressions", *Journal of Nonverbal Behavior,* vol. 37 no. 4, 2013, p. 217-230.