ISBN 978-5-4465-0705-4
9 785446 507054 >

КОГНИТИВНАЯ НАУКА В МОСКВЕ 2015

КОГНИТИВНАЯ НАУКА В МОСКВЕ: НОВЫЕ ИССЛЕДОВАНИЯ

МАТЕРИАЛЫ КОНФЕРЕНЦИИ

2015

Под ред. Е.В. Печенковой, М.В. Фаликман

STATIC AND DYNAMIC FACIAL EXPRESSIONS PROBED BY VISUAL ADAPTATION[59]

Korolkova O.A. *

olga.kurakova@gmail.com

Center for Experimental Psychology MSUPE;
Moscow Institute of Psychoanalysis

Abstract. We studied visual adaptation to static and dynamic happy and sad facial emotional expressions, and to dynamic transitions between emotions. Dynamic unfolded expressions, and dynamic transitions between expressions were presented both reversed and non-reversed in time. The adaptation aftereffect — perceiving ambiguous expression (presented for 50 ms) as more happy after prolonged (5 s) observing of a sad face and vice versa — was revealed in static and dynamic expressions, but not in dynamic transitions between happy and sad faces. Therefore, dynamic cues and timeline reversal do not alter the emotion adaptation aftereffect.

Keywords: visual adaptation, facial expression, emotion, dynamic face

Introduction

One of the experimental paradigms widely used to explore the perception of faces and facial emotional expressions is perceptual adaptation. After prolonged observing of a particular face, the perception is biased away from the adaptor, so that its briefly presented “anti-face” is recognized more easily. This paradigm is based on the idea of a multidimensional face space with opponent coding of facial features that are most distinctive from the average (“norm”) face (Valentine, 1991). This average representation may be tuned to particular context, based on the range of currently perceived faces. Recently face adaptation aftereffect has been shown for a variety of facial characteristics including identity, gender and facial emotional expressions (Butler et al., 2008; Cook et al., 2011; Fox, Barton, 2007; Hsu, Young, 2004).

Facial adaptation studies mostly use static face images to adapt and test the aftereffect. As natural facial expression is inherently dynamic, it seems important to explore the influence of the face motion on its perception and recognition. To date, only a limited number of studies addressed adaptation phenomenon in dynamic faces. In particular, de la Rosa et al. (2013) and Curio et al. (2010) adapted participants to dynamic computer-animated morphed facial expressions and revealed that combination of emotion-specific rigid head motion and intrinsic facial muscles movements can induce

[59]The study was supported by Russian Foundation for the Humanities, project 15-36-01281.

aftereffects, but none of these motion types causes adaptation separately. Morphing and 3D-modelling techniques, although very prominent, do not always adequately represent the dynamics of a naturalistic human face. Therefore, to increase the ecological validity, the use of natural dynamic facial expressions as stimuli to study adaptation may be more relevant.

Research on motion and biological motion adaptation suggest the motion direction to be among the factors causing the aftereffect (Barraclough et al., 2012). Moreover, natural timeline of increasing or decreasing intensity of facial expression can also have specific neural activation different from its time-reversed equivalents (Reinl, Bartels, 2014). Hence, time-reversion of natural dynamic expression, unlike any morphing or computer animation, may modulate the adaptation aftereffects. In our study, we tested the adaptation aftereffect to static images and dynamic video records of emotions expressed on a human face, expecting the contextual effect of adaptation as well as its modulation by timeline inversion.

Hypothesis. Adaptation to static and dynamic naturalistic emotional facial expressions, as well as to dynamic transitions between emotions, influences emotional categorization.

Method

Stimuli. Full-face video records of a female model depicting transitions from happy to sad and from sad to happy facial expressions were obtained with 120 Hz video camera.

Participants. Psychology students (9 males, 17 females, median age: 26.5 years, age range: 19–49 years) volunteered to take part in the experiment. They had normal or corrected-to-normal vision and gave their oral consent before the study. Each participant was randomly assigned to one of the three experimental groups.

Apparatus. Stimuli were presented using PXLab software (Irtel, 2007) on 100 Hz 19” CRT ViewSonic G90fB monitor connected to Intel Core2 desktop computer.

Procedure. Participants were sitting in front of the monitor at the distance of approximately 60 cm. Experiment started with the instruction to observe the sequentially presented pairs of faces and to decide which emotion, happiness or sadness, was expressed on the second face. In each trial a black central fixation cross was shown for 1 s on a neutral gray background, followed by adaptor stimulus (5 s), inter-stimuli interval (100 ms) and test image (50 ms). Both adaptor and test faces were 17.5 cm high and 12 cm wide. After the test image was removed from the screen, the question “happiness or sadness?” appeared, inviting participant to response. A short training of 8 trials was provided, with the same adaptors as in the main experiment, and with test images extracted from the same video transitions but not showed during the main session. In total, each participant performed 10 test images × 2 adaptors × 2 transitions × 4 repetitions = 160 trials in the main experiment. Trials were presented in pseudorandom order.

Design. The study varied one between-subject factor with three levels (adaptor type) and one within-subject factor with two levels (transition type). (1) In *the static adaptor* condition, participants ($N = 9$) adapted to the first and last static frames derived from the emotional transitions (two images from happy-to-sad movie, and two images from sad-to-happy movie). These images represented recognizable expressions of happiness and sadness. (2) In *the full movie* adaptor condition ($N = 9$), two adaptors were original movies (transitions from one expression into another), and two were the same movies reversed in time. The speed of all the movies was slowed down from 120 to 24 frames per second to ensure the same adaptor duration as in the static condition. (3) In the *half movie* condition ($N = 8$), each original movie was divided into two parts. The cut point was the frame closest to the mean point of subjective equivalence (PSE) estimated from a pilot static adaptation experiment. For each transition, one adaptor comprised images from the cut point to the end of the original movie, and the second adaptor included images from the cut point to the start of the movie, so that its frame order was time-reversed. As the cut points did not necessarily correspond to the middle frames of the transitions, the number of frames and the duration of each frame in the two sequences varied, but the total duration of each adaptor was maintained equal.

Test stimuli were the same for the three experimental groups. They comprised 20 ambiguous images derived from the center of each transition: ten frames from happy-to-sad movie, and ten frames – from sad-to happy one. In each trial, adaptor and test belonged to the same movie. Theoretical distances between the adjacent images were computed as dot products of vectors composed of the two images' pixels brightness levels.

Results

For each participant, adaptor and transition, a psychometric function was fitted with the cumulative Gaussian distribution, connecting the theoretical distance between images to the proportion of the responses of the second emotion category in transition (responses "sad" for happy-to-sad transition and "happy" for sad-to-happy transition). Individual psychometric functions were analyzed using mixed-effect ANOVA with *adaptor type* (static, half-dynamic, or full-dynamic) as between-subject factor, and *transition* (happy-to-sad or sad-to-happy) and *adapted expression* (first or second in each transition) as within-subject factors. The adaptation aftereffect would be shown as main effect of expression factor, and the differences between static and dynamic conditions – as adaptor type effect.

The analysis revealed significant influence of *expression* ($F(1,23) = 22.105$, $p < .001$, $\eta^2_p = .490$) and *transition* ($F(1,23) = 11.198$, $p = .003$, $\eta^2_p = .327$). Main effect of *adaptor type* was non-significant ($F(2,23) = 1.378$, $p = .272$, $\eta^2_p = .107$), but *adaptor type* × *expression* interaction reached significance ($F(2,23) = 10.403$, $p = .001$, $\eta^2_p = .475$). Interactions *adaptor type* × *transition* ($F(2,23) = 1.128$, $p = .341$, $\eta^2_p = .089$), *expression* × *transition* ($F(1,23) = 0.104$, $p = .750$, $\eta^2_p = .005$), and three-way interaction of *adaptor type* × *transition* × *expression* ($F(2,23) = 1.026$, $p = .374$, $\eta^2_p = .082$) were non-significant.

To evaluate the adaptation aftereffect, we used Benjamini–Hochberg corrected paired t-test for post-hoc comparisons of PSEs estimated for different adapted expressions in each series and for each transition separately. For both emotional transitions, adaptation to static images showed significant shift of the PSE measured in theoretical distance units (happy-to-sad: $t(8) = -2.626$, $p = .045$, $M = -.00813$, $CI = [-.01528, -.00099]$; sad-to-happy: $t(8) = -5.144$, $p = .005$, $M = -.00556$, $CI = [-.00806, -.00307]$), as well as the adaptation to dynamic expressions starting from an intermediate ambiguous face (happy-to-sad: $t(7) = -3.043$, $p = .045$, $M = -.00307$, $CI = [-.00546, -.00068]$; sad-to-happy: $t(7) = -2.903$, $p = .045$, $M = -.00255$, $CI = [-.00463, -.00047]$). No aftereffect was shown for dynamic change between expressions (happy-to-sad: $t(8) = 1.139$, $p = .345$, $M = .00128$, $CI = [-.00131, .00387]$; sad-to-happy: $t(8) = 0.718$, $p = .493$, $M = -.00057$, $CI = [-.00239, .00126]$).

Discussion

The main aim of the present study was to explore the adaptation aftereffects on natural human-posed facial expressions, both dynamic and static. In addition, we tested whether the time-reversing of the dynamic expressions influence the subsequent expression recognition. Three main conditions of adaptation were used to evaluate the impact of context and timeline: static images used as adaptors that can only provide different contextual influence without any dynamics; dynamic transitions from one expression into another, presented both straight in time and time-reversed, with context being the same in two conditions; and dynamic unfolding of expressions starting from an ambiguous emotion, which provide different contexts in different timeline organizations.

We expected the aftereffect to occur after adaptation to static facial expression images, as well as to dynamic unfolding of expressions. This hypothesis has been supported: prolonged adaptation to dynamic expressions indeed produces aftereffect on ambiguous expressions categorization, in accordance with previous studies (de la Rosa et al., 2013; Hsu, Young, 2004). The influence of naturalistic dynamic adaptor is comparable to that of the static one, for the same presentation duration.

Extending the previously reported results to ecologically valid stimulation, in our study the adaptation effect was for the first time obtained on naturally expressed dynamic emotions.

We were also interested in whether any aftereffects occur after adaptation to dynamic shift from one expression to another. Though, no influence on emotion recognition was observed for forward versus reversed timeline of transitions. One possible explanation is our manipulation with natural speed of the expression that equalized the overall adaptor duration but changed the time of exposure to intense emotions in different series. Further research is needed to rule out this possibility.

Conclusion

In general, our results support the idea of adaptation as high-level context-based effect that tunes the recognition of ambiguous emotions to the range of facial expressions perceived in particular communication context. Additional dynamic cues and timeline organization do not appear to change the effect of adaptation.

References

Barraclough N.E., Ingham J., Page S.A. Dynamics of walking adaptation aftereffects induced in static images of walking actors // Vision Research. 2012. Vol. 59. P. 1–8. doi:10.1016/j.visres.2012.02.011

Butler A., Oruc I., Fox C.J., Barton J.J.S. Factors contributing to the adaptation aftereffects of facial expression // Brain Research. 2008. Vol. 1191. P. 116–126. doi:10.1016/j.brainres.2007.10.101

Cook R., Matei M., Johnston A. Exploring expression space: adaptation to orthogonal and anti-expressions // Journal of Vision. 2011. Vol. 11. No 4. doi:10.1167/11.4.2

Curio C., Giese M.A., Breidt M., Kleiner M., Bulthoff H.H. Recognition of dynamic facial action probed by visual adaptation // Dynamic faces: Insights from experiments and computation / C. Curio, H.H. Bulthoff, M.A. Giese (Eds.). Cambridge, MA: MIT Press, 2010. P. 47–65.

de la Rosa S., Giese M., Bulthoff H.H., Curio C. The contribution of different cues of facial movement to the emotional facial expression adaptation aftereffect // Journal of Vision. 2013. Vol. 13. No 1. doi:10.1167/13.1.23

Fox C.J., Barton J.J.S. What is adapted in face adaptation? The neural representations of expression in the human visual system // Brain Research. 2007. Vol. 1127. No 1. P. 80–89. doi:10.1016/j.brainres.2006.09.104

Hsu S., Young A. Adaptation effects in facial expression recognition // Visual Cognition. 2004. Vol. 11. No. 7. P. 871–899. doi:10.1080/13506280444000030

Irtel H. PXLab: The Psychological Experiments Laboratory [online]. Version 2.1.11. Mannheim (Germany): University of Mannheim, 2007. Available from http://www.pxlab.de

Reinl M., Bartels A. Face processing regions are sensitive to distinct aspects of temporal sequence in facial dynamics // NeuroImage. 2014. Vol. 102. Part 2. P. 407–415. doi:10.1016/j.neuroimage.2014.08.011

Valentine T. A unified account of the effects of distinctiveness, inversion, and race in face recognition // The Quarterly Journal of Experimental Psychology Section A. 1991. Vol. 43. No 2. P. 161–204, doi:10.1080/14640749108400966

Зрительная адаптация к статическим и динамическим экспрессиям лица

Королькова О.А. *

olga.kurakova@gmail.com

Центр экспериментальной психологии МГППУ,
Московский институт психоанализа

Аннотация. Эффект зрительной адаптации изучался на материале статических и динамических эмоциональных экспрессий лица и динамических переходов между экспрессиями радости и печали. Динамические последовательности предъявлялись как с прямым, так и с инвертированным во времени порядком кадров. Показано, что продолжительное (5 с) рассматривание и динамических, и статических выражений радости приводит к последующей оценке амбивалентных экспрессий (демонстрируемых 50 мс) как более печальных, и наоборот. Экспозиция динамических переходов между экспрессиями не вызывает эффекта адаптации. Таким образом, введение динамики и изменение временной организации экспрессий лица не влияет на зрительную адаптацию.

Ключевые слова: зрительная адаптация, экспрессии лица, эмоции, динамические экспрессии.