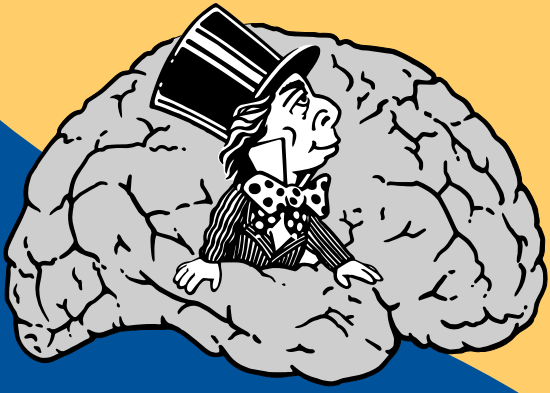
КОГНИТИВНАЯ НАУКА

В МОСКВЕ



НОВЫЕ ИССЛЕДОВАНИЯ

МАТЕРИАЛЫ КОНФЕРЕНЦИИ 2019

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

УДК 159.9
ББК 88.25
К57

Когнитивная наука в Москве: новые исследования. Материалы конференции 19 июня 2019 г. Под ред. Е. В. Печенковой, М. В. Фаликман. – М.: ООО «Буки Веди», ИППиП. 2019 г. — 656 стр.

ISBN 978-5-4465-2346-7

УДК 159.9
ББК 88.25

ISBN 978-5-4465-2346-7

THE STRUCTURE OF FACE COGNITION IN CHILDHOOD AND ADOLESCENCE: IN SEARCH OF SOCIAL INTELLIGENCE

A. V. Petrakova
petrakoa@hu-berlin.de
Humboldt-Universität zu Berlin, Berlin, Germany

Abstract. Because of their relevance in everyday life there is an increasing amount of research about social abilities. However, the structure of individual differences in so-called "social intelligence" has not yet been studied. Here we take a differential-psychological approach to investigate the important social ability of face cognition - the ability to perceive, memorize and correctly recognize human faces. We provide findings from a study about age differences in the means and covariance structure of face cognition abilities from ages 6 to 21 years. Using multiple measurements, based on a large sample of participants (N = 338) and analyzing the internal structure of face cognition with Local Structural Equation Modelling (LSEM), we were able to arrive at the following conclusions. Face cognition in childhood and adolescence can be represented as a two-factorial model including face perception and memory. LSEM revealed a slight increase of factor loadings on face perception and memory across age, occurring between 8 and 12 years and after 16 years. The relationship between face perception and memory was, however, invariant from childhood to young adulthood (r = .78). Factor means showed a slight significant improvement of face perception and memory across participant age. Thus, we suggest for discussion that this approach could extend the understanding of "social intelligence".

Keywords: social abilities, face cognition, face perception, face memory, individual differences, age differences, covariance structure, age invariance, factor means, childhood, adolescence

Background

Requests from practitioners more and more motivate researchers to investigate the adaptation and socialization of the child in an increasingly complex and constantly changing environment. However, for a long time the research was centered around the *g* factor (Spearman's general intelligence (Spearman, 1904)), for which various models were proposed, for example, Horn's and Cattell's crystallized and fluid intelligence (Horn & Cattell, 1966), three-stratum theory of Carroll (Carroll, 1993), etc. Grounded in models of general intelligence, methods for assessment were proposed, and further also methods for correction. The so-called "social intelligence" (for example, Thorndike, 1920), has remained a long time elusive. Thorndike, who first mentioned this term, defined it as specific behavioral

acts necessary for complex social interactions. This was a quite complex, streamlined definition, not emphasizing the boundaries of the construct. Analyzing also other research approaches for these specific human abilities (attempts to describe e.g. "emotional intelligence", "non-cognitive skills" etc.), it was recently concluded that the complexity of the definition leads to difficulties in operationalization and measurement (Orel & Kulikova, 2018).

Difficulties, however, dictate attempts to overcome them. One of the attempts to search for "social intelligence" is the differential psychological study of face cognition as a specific and multidimensional set of interpersonal abilities (Wilhelm et al., 2010).Thus, operationalizing face cognition as a multidimensional process, using a multiple measurements approach (BEFAT; Herzmann et al., 2008), based on large samples of participants, the authors arrived at the following conclusions. Face cognition can be represented as a two-factor structure, including face perception and face memory. Within this model, face perception, as a first factor, depicts the ability to discern the face as a whole, and to distinguish facial features and their configuration; face memory, as a second factor, is the ability underlying the encoding, storing, and retrieval of faces from long-term memory. Individual differences in these two factors are only partially (ca. 50 %) explained by the variance in general intelligence, the perception of and memory for non-social objects; thus, the face cognition factors are specific and of a special social nature. This structure is invariant and does not change due to aging (Hildebrandt et al., 2010). Within the present study we focus on individual differences in face cognition abilities across childhood and adolescence at the psychometric level and the average performance captured by latent variables.

Aims and Hypotheses of the Study

Within the present study we aimed to extend available psychometric studies of individual differences in face cognition abilities in young and old adults to childhood and adolescence (Hildebrandt et al., 2010; Wilhelm et al., 2010). Following the neuroanatomical, clinical, psychometrical evidence about distinction between face perception and face memory within accuracy tasks (De Renzi et al., 1991; Haxby et al., 2010; Wilhelm et al., 2010) and their status as specific social abilities (Wilhelm et al., 2010), we expected to establish a similar two-factor model of individual differences in face cognition in childhood and adolescence. Further, we aimed to investigate age differences in this structure. Specifically we had two hypotheses. Within the investigation of structure invariance across childhood and adolescence we followed the differentiation – dedifferentiation hypothesis, the most popular theoretical concept about life span changes of individual differences in human cognition (Balinsky, 1941). Generally, according to this hypothesis, in early periods of life, cognitive abilities gradually differentiate from an amorphous general ability, up to a certain age, after which these distinct abilities are reintegrated or dedifferentiated. To our knowledge, this hypothesis has not been tested previously for social skills. Following the research done on general skills (Tucker-Drob, 2009), we were interested, whether this concept holds for face cognition and whether more specific functions like face perception and face

memory differentiate from general face cognition abilities with increasing age. Second, we investigated age differences in face cognition performance at the level of abilities (latent factors). Assuming that face cognition abilities have a specific, social nature, we followed the theory of face-specific perceptual development (Crookes & McKone, 2009). In line with this theory, we expected that performance in face cognition abilities becomes adult-like only late (near adolescence) due to the increasing experiences in communication during this age.

Methods

Subjects were 338 children, adolescents, and young adults continuously between 6 and 21 years (50 % females), recruited in primary schools, high schools, and vocational schools in Berlin. The youngest group and the group of young adults were mixed (the youngest group included 6 and 7 years old children and the group of young adults included 18 – 21 years old participants), other age cohorts included from 20 to 40 participants.

The experiment was implemented with PsychoPy v1.82.01. Tasks were conducted on notebooks: Lenovo Thinkpad, Modell E330, with a 13.3 monitor inch and a display resolution of 1366 × 768.

Face stimuli were photographs taken by the authors under standardized conditions regarding luminance, distance, camera settings, and instructions for the photographed person. A total of 460 frontal view colour portraits (213 females), with neutral expression, without glasses, salient make-up, moles, or other facial marks were obtained from girls and boys aged between 4 and 18 years. In all photographs, face-unspecific cues (hair, ears, and clothing) were excluded by fitting the face into a vertical ellipse of 300 by 200 pixels (7.6 × 5.1 cm); thus all photographs were in the same format.

The procedure started with collecting general demographic data; furthermore, we assessed the face perception ability using "Simultaneous matching of spatially manipulated faces with upright and inverted conditions" (e.g. Herzmann et al., 2008) and a slightly modified version of the full design composite paradigm (Meinhardt-Injac et al., 2014), and the face memory ability using "Aquisition curve" and "Decay rate" (e.g. Herzmann et al., 2008). The total duration of the procedure was about 1.5 hours, including breaks. From each task we derived performance indicators for further modelling (number of the correct responses were used for these aims). Four indicators from each experimental condition, two in each task, were derived for face perception, and five indicators from four blocks of "Aquisition curve" and from the complete task "Decay rate" were derived for face memory.

Statistical analysis. In order to reveal the structure of individual differences in face cognition including face perception and face memory during childhood and adolescence we used Structural Equation Modeling estimated by *lavaan* package in the R environment. Further, for the investigation of structural age invariance, we used Local Structural Equation Modeling (LSEM (Hildebrandt et al., 2016)) implemented in the *sirt* package of the R environment. LSEM applies a kernel function for weighting observations around continuously defined focal values

of a context variable, like age, and repeatedly fits SEMs along this moving weighting window. Observations on each focal age — defined for the present study in steps of one year from 8 to 20 — received a maximum weight. Sample weights fell off symmetrically with increasing distance of an observation from the focal value. Thus, we fitted the measurement model of face cognition with changing sample weights 13 times (from age 8 in steps of one year until age 20). Based on recommendations of Hildebrandt et al. (2016) we didn't include in the computations extreme groups (of the 6 – 7 years old children and of the 21 years old young adults). Hildebrandt et al. (2016) note that the models estimated for focal points at the boundaries of the range of the moderator incorporate observations only with focal values that are either larger or smaller than the focal value of interest, and if observations are scarce, the interpretation of such results may be problematic. SEM parameter functions across age are presented as results. To test parameter changes across age inferentially, we used a permutation test (Hildebrandt et al., 2016). Using the test statistic based on permutations of age, the null hypothesis can be tested assuming that a given SEM parameter is constant across the values of age (Hildebrandt et al., 2016). Finally, to achieve our third aim and to freely estimate latent means and variances, we scaled latent factors by the marker variable method (Little et al., 2007). Thus the loading and the intercept of a selected reference indicator for each construct was fixed to be one and zero, respectively.

Results

1. Establishment of the structure of individual differences in face cognition across childhood and adolescence. First, we estimated Model (M1) which assumed a single general face cognition factor to explain the shared variance of all nine performance indicators originating from face perception and face memory tasks. The fit of M1 was poor: χ^2 (25) = 140.885, p = .000, CFI = .917, RMSEA = .124, SRMR = .073. Factor loadings ranged between .55 and .77. Next, we estimated Model (M2), which assumed face cognition performance to be explained by two factors, face perception and face memory. The fit of M2 improved: χ^2 (24) = 97.541, p = .000, CFI = .947, RMSEA = .101, SRMR = .060. Factor loadings ranged between .61 and .79. The correlation between latent factors was reasonably different from 1 (FP/FM = .75). The Models M1 and M2 were compared with the Likelihood ratio difference test, showing that the less parsimonious Model M2 is necessary for an adequate structural representation of individual differences in face cognition in childhood and adolescence. Further, investigating the internal structure of face cognition and attempting to explain challenges in establishment of an adequate structural representation we have found that these challenges are related to quality of measurement of the full design composite paradigm. Within our earlier work (Petrakova et al., 2018) we have found that this task has perfect correlation with the same task with non-face (house) stimuli (r = 1). This finding indicates that the full design of the composite task does not specifically measure face perception. After excluding this task from the model, our actual model tends to the perfect: χ^2 (21) = 1078.874, p = .000, CFI = 1.000, RMSEA = .000, SRMR = .010. Factor loadings ranged between .51 and .91. The correlation between latent factors was reasonably different from 1 (FP/FM = .78).

2. Age invariance of the measurement structure. LSEM revealed measurement a slight increase of factor loadings on face perception and on face memory across age, occurring between 8 and 12 and after 16 years. The relationship between face perception and memory was however invariant from childhood to young adulthood.

3. Age differences on latent factor means across childhood and adolescence Factor means showed a slight significant improvement of face perception and memory across participant age. Especially noticeable increase is between 8 and 12 and after 14 years for both abilities.

Conclusion

1. We could confirm the two-factorial model of face cognition for representing individual differences of this process in childhood and adolescence providing evidence about adult-like structure of face cognition in these periods of life. Interestingly, from early school age even the relationship between face perception and face memory was of nearly the same magnitude as reported for individual and age differences in face cognition abilities across adulthood ($r = .75$; Hildebrandt et al., 2010; Wilhelm et al., 2010).
2. Moreover, we rejected differentiation hypothesis for the structure of face cognition; the structure of face cognition is invariant across childhood and adolescence proving again adult-like level of this process already from early school age.
3. We could confirm our expectations that the increase in performance in face perception and memory continues until late adolescence.
4. Our findings contribute to an unresolved discussion about the most appropriate design to be applied in the composite task (Rossion, 2013) and support the position that the modified design of the composite task may not measure a specific holistic face processing ability. Finally, with the present study we suggest a measurement approach for such important social ability as face cognition, which in future can be used for scientific and practical aims.

References

Balinsky B. An analysis of the mental factors of various age groups from nine to sixty // Genetic psychology monographs. 1941. Vol. 23. P. 191 – 234.

Carroll J. B. Human cognitive abilities: A survey of factor-analytic studies. United Kingdom, Cambridge: Cambridge University Press, 1993.

Crookes K., McKone E. Early maturity of face recognition: No childhood development of holistic processing, novel face encoding, or face-space // Cognition. 2009. Vol. 111. No. 2. P. 219 – 247. doi:10.1016/j.cognition.2009.02.004

De Renzi E., Faglioni P., Grossi D., Nichelli P. Apperceptive and associative forms of prosopagnosia // Cortex. 1991. Vol. 27. No. 2. P. 213 – 221. doi:10.1016/s0010-9452(13)80125-6

Haxby J. V., Hoffman E. A., Gobbini M. I. The distributed human neural system for face perception // Trends in Cognitive Sciences. 2000. Vol. 4. No. 6. P. 223 – 233. doi:10.1016/s1364-6613(00)01482-0

Herzmann G., Danthiir V., Schacht A., Sommer W., Wilhelm O. Toward a comprehensive test battery for face cognition: Assessment of the tasks // Behavior Research Methods. 2008. Vol. 40. No. 3. P. 840 – 857. doi:10.3758/brm.40.3.840

Hildebrandt A., Lüdtke O., Robitzsch A., Sommer C., Wilhelm O. Exploring factor model parameters across continuous variables with local structural equation models // Multivariate Behavioral Research. 2016. Vol. 51. No. 2 – 3. P. 257 – 258. doi:10.1080/00273171.2016.1142856

Hildebrandt A., Sommer W., Wilhelm O., Herzmann G. Structural invariance and age-related performance differences in face cognition // Psychology and Aging. 2010. Vol. 25. No. 4. P. 794 – 810. doi:10.1037/a0019774

Horn J. L., Cattell R. B. Refinement and test of the theory of fluid and crystallized general intelligence // Journal of Educational Psychology. 1966. Vol. 57. No. 5. P. 253 – 270. doi:10.1037/h0023816

Little T. D., Card N. A., Slegers D. W., Ledford E. C. Representing contextual effects in multiple-group MACS models // Modeling contextual effects in longitudinal studies / T. D. Little, J. A. Bovaird, N. A. CardMahwah (Eds.). NJ: Erlbaum, 2007. P. 121 – 147.

Meinhardt-Injac B., Persike M., Meinhardt G. Holistic face perception in young and older adults: Effects of feedback and attentional demand // Frontiers in Aging Neuroscience. 2014. Vol. 6. P. 1 – 13. doi:10.3389/fnagi.2014.00291

Orel E. A., Kulikova A. A. Analysis of psychometric properties of the diagnostic tool for socio-emotional habits assessment in elementary school // Journal of Modern Foreign Psychology. 2018. Vol. 7. No. 3. P. 8 – 17. doi:10.17759/jmfp.2018070301

Petrakova A., Sommer W., Junge M., Hildebrandt A. Configural face perception in childhood and adolescence: An individual differences approach // Acta Psychologica. 2018. Vol. 188. P. 148 – 176. doi:10.1016/j.actpsy.2018.06.005

Rossion B. The composite face illusion: A whole window into our understanding of holistic face perception // Visual Cognition. 2013. Vol. 21. No. 2. P. 139 – 253. doi:10.1080/13506285.2013.772929

Spearman C. "General intelligence" objectively determined and measured // The American Journal of Psychology. 1904. Vol. 15. No. 2. P. 201 – 293. doi:10.2307/1412107

Thorndike E. L. Intelligence and its uses // Harper's Magazine. 1920. Vol. 140. P. 227 – 235.

Tucker-Drob E. Differentiation of cognitive abilities across the life span // Developmental Psychology. 2009. Vol. 45. No. 4. P. 1097 – 1118. doi:10.1037/a0015864

Wilhelm O., Herzmann G., Kunina O., Danthiir V., Schacht A., Sommer W. Individual differences in perceiving and recognizing faces — one element of social cognition // Journal of Personality and Social Psychology. 2010. Vol. 99. No. 3. P. 530 – 548. doi:10.1037/a0019972

СТРУКТУРА УЗНАВАНИЯ ЛИЦ В ДЕТСКОМ И ПОДРОСТКОВОМ ВОЗРАСТЕ: В ПОИСКАХ СОЦИАЛЬНОГО ИНТЕЛЛЕКТА

А. В. Петракова
petrakoa@hu-berlin.de
Берлинский университет им. Гумбольдта, Берлин, Германия

Аннотация. В связи с актуальностью для повседневной жизни появляется все больше исследований, посвященных социальным способностям. Структура индивидуальных различий по так называемому «социальному интеллекту» остается, однако, так и не охваченной исследователями. В данной мини-статье мы представляем дифференциально-психологический подход для исследования такой важной социальной способности

как узнавание лиц — восприятие лиц, запоминание и их последующее успешное распознавание. Мы представляем результаты исследования различий в средних значениях и ковариационной структуре восприятия лиц и памяти на лица в возрасте от 6 до 21 года. Используя многомерный измерительный подход, базируясь на большой выборке испытуемых (N = 338) и проанализировав структуру узнавания лиц при помощи Local Structural Equation Modelling (LSEM), мы пришли к следующим выводам. Узнавание лиц в детском и подростковом возрасте может быть представлено как двухфакторная модель, включающая такие латентные переменные, как восприятие лица и память на лица. Анализ LSEM выявило незначительное увеличение факторных нагрузок в случаях измерения восприятия лиц и памяти на лица в период между 8 и 12 годами и после 16 лет. Однако корреляция между восприятием лиц и памятью на лица оставалась инвариантной во всех возрастных когортах (r = .78). Для средних значений обоих факторов наблюдается значимое возрастание; взрослый уровень достигается к 18 годам. На наш взгляд, предложенный подход может расширить понимание «социального интеллекта».

Ключевые слова: социальные способности, узнавание лиц, восприятие лиц, память на лица, индивидуальные различия, возрастные различия, ковариационная структура, инвариантность структуры для разных возрастных когорт, средние значения факторов, детство, подростковый возраст