Special issue

ijbd

International Journal of
Behavioral Development
37(2) 166–171

DOI: 10.1177/0165025412467727
ijbd.sagepub.com
SAGE

Sensitivity to spacing information increases more for the eye region than for the mouth region during childhood

Adélaïde de Heering[1] and Christine Schiltz[2]

Abstract

Sensitivity to spacing information within faces improves with age and reaches maturity only at adolescence. In this study, we tested 6–16-year-old children's sensitivity to vertical spacing when the eyes or the mouth is the facial feature selectively manipulated. Despite the similar discriminability of these manipulations when they are embedded in inverted faces (Experiment 1), children's sensitivity to spacing information manipulated in upright faces improved with age only when the eye region was concerned (Experiment 2). Moreover, children's ability to process the eye region did not correlate with their selective visual attention, marking the automation of the mechanism (Experiment 2). In line with recent findings, we suggest here that children rely on a holistic/configural face processing mechanism to process the eye region, composed of multiple features to integrate, which steadily improves with age.

Keywords

attention, development, eyes, faces, mouth, spacing

Adults are typically considered experts in face processing, but this expertise takes years to develop (Bruce et al., 2000; Carey, 1992). To date, there is no consensus about whether children's lower accuracy at face processing is driven by an immaturity of one or multiple face-specific components, such as holistic/configural face processing, or by the immaturity of general visual/cognitive mechanisms such as vernier acuity, short term memory or visual attention (e.g., Crookes & McKone, 2009; Mondloch, Le Grand, & Maurer, 2002).

De Heering, Rossion, and Maurer (2012) recently tested 6–12-year-old children and adults on the digitized version of the Benton Face Recognition Test (BFRT; Benton, Sivan, Hamsher, Vareny, & Spreen, 1983). In line with other reports supporting the view that face processing develops under the influence of visual experience selectively impacting the upright face category (see, e.g., Baudouin, Gallay, Durand, & Robichon, 2010; Carey, Diamond, & Woods, 1980; Mondloch et al., 2002; Mondloch, Geldart, Maurer, & Le Grand, 2003), de Heering et al. (2012) reported that children's accuracy for upright faces improved more with age than their accuracy for inverted faces. However, some authors such as McKone, Crookes, Jeffery, and Dilks (2012; see also Crookes & McKone, 2009) criticized the methodology used in some of the studies that favored the implication of a face-specific component during development, and rather argued in favor of the exclusive influence of general perceptual and cognitive mechanisms after age 4. They cited, as examples of generic mechanisms, the ability to concentrate on a task and avoid distractions, the ability to narrow the focus of visual attention to small stimuli and the ability to use deliberate task strategies, meta-cognition and general perceptual development such as vernier acuity, which are all known to improve with age (Betts, Mckay, Maruff, & Anderson, 2006; Bjorklund & Douglas, 1997; Davidson, Amso, Anderson, & Diamond, 2006; Flavell, 1985; Flavell & Wellman, 1977; Pasto & Burack, 1997; Skoczenski & Norcia, 2002).

In this article, we address this controversy by tracking the developmental trajectories of children's sensitivity to vertical spacing when the manipulation affects the eye region or the mouth region. Since the eyes are a critical feature to newborns (Farroni et al., 2005), infants (Reid, Striano, Kaufman, & Johnson, 2004), normally-developing children (Kelly et al., 2011), autistic children (Bar-Haim, Shulman, Lamy, & Reuveni, 2006) and adults (e.g., Haig, 1985; Sadr, Jarudi, & Sinha, 2003), we reasoned that visual experience might differentially affect their processing compared to the processing of other facial features such as the mouth. In a complementary way, information conveyed by the eye region and the mouth region could also be refined at different rates in the face-space (that is, a multidimensional space in which each critical aspect of a face is characterized by a dimension; Valentine, 1991), if considering the observation that holistic/configural face processing, although present early in infancy (Turati, di Giorgio, Bardi, & Simion, 2010), is also developing steadily during childhood (de Heering et al., 2012; Mondloch et al., 2002). Indeed, holistic/configural processing is typically defined as "the simultaneous integration of the multiple parts of a face into a single perceptual representation" (see Rossion, 2008, 2009), and the eye region contains multiple features to integrate (e.g., eyes and eyebrows). On the other side of the same coin, patients with acquired prosopagnosia, such as PS, show reduced fixation to the eye region (Orban de

---

[1] Université Catholique de Louvain, Louvain-la-Neuve, Belgium
[2] University of Luxembourg, Luxembourg

Corresponding author:
Adélaïde de Heering, Institute of Research in Psychology (IPSY), Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCL), Place du Cardinal Mercier, 10, 1348 Louvain-la-Neuve, Belgium.
Email: adelaide.deheering@uclouvain.be

Xivry, Ramon, Lefèvre, & Rossion, 2008) as well as impaired holistic/configural face processing (Ramon & Rossion, 2010).

The main objective of this article was to test 6–16-year old children, with an original child-friendly drag-and-drop face-matching task, on their ability to match face stimuli manipulated with respect to spacing information in the eye region or in the mouth region (Experiment 2). To do so, we first tested one group of children to verify that spacing variations introduced at the level of the mouth and at the level of the eyes were of similar detectability (Experiment 1). We also correlated children's results to their selective visual attention abilities, as measured by the Wechsler Intelligence Scale for Children (WISC IV) (Experiment 2).

We used children's faces to prevent the emergence of an other-age effect in children (that is, better recognition of faces of participant's age; Anastasi & Rhodes, 2005; Hills, 2012) as well as three distinct types of spacing manipulations ranging from small to extreme, because at the time of testing there was no consensus about the minimal amount of variation needed for young children to detect this kind of manipulation (abnormal: Mondloch & Thomson, 2008, vs. normal: Macchi Cassia, Turati, & Schwarzer, 2011). Finally, and critically because previous studies manipulated these features simultaneously (e.g., Macchi Cassia et al., 2001; Mondloch et al., 2002; Pellicano, Rhodes, & Peters, 2006), we manipulated the eyes and the mouth separately to disentangle their respective roles in the development of face processing abilities.

In line with previous results showing a steady increase of the ability to match upright faces with age (e.g., Carey et al., 1980; de Heering et al., 2012), we hypothesized that children's ability to match faces whose spacing was manipulated would increase, regardless of whether this manipulation involved the upper part (eye condition) or the lower part (mouth condition) of the face. Moreover, we expected this increase to be steeper when the spacing changes were made to the eye region rather than to the mouth region because the former region requires the simultaneous integration of more facial features than the latter region (e.g., eyes and eyebrows). We finally predicted that children's scores in the visual selective attention task would be less correlated to their results in the eye condition than to their results in the mouth condition as a consequence of the use of a simultaneous and automated mechanism (that is, holistic/configural face processing).

Experiment 1

In this experiment, we focused on children's results when the manipulations were embedded in inverted faces, because, by doing so, the manipulations are not (or less) influenced by other facial features (Rossion, 2008, 2009). Other authors (e.g., Macchi Cassia et al., 2011; Robbins, Shergill, Maurer, & Lewis, 2011) used non-face objects as control stimuli in their studies because they were sharing critical properties such as symmetry with faces. In line with de Heering et al. (2012), we used inverted faces because they contain the exact same visual information as upright faces except that this information is rotated by 180° in the picture plane.

Method

Participants

A group of 24 participants, 9 to 12 years old, was recruited from a school in Belgium. All had normal or corrected-to-normal visual acuity. As according to the recent review by McKone et al. (2012) studies performed on developmental populations are often contaminated by floor or ceiling effect, we retained only those children who performed within the 55% and 95% range of correct responses in the conditions of the test (that is, upright mouth condition; inverted mouth condition; upright eye condition; inverted eye condition). The final sample consisted of 11 participants (six males, mean age = 127 months, *SD* = 20; outperformers (>95%): *N* = 1; poor-performers (<55%): *N* = 12).

Stimuli. Twelve full-front color pictures of Caucasian children posing with a neutral expression (6 males, mean age = 58 months, *SD* = 11 months) were part of the original set of face stimuli. Their global luminance was equalized and they were placed on a uniform white background. They were 195 pixels in width and 250 pixels in height (9.9° x 12.4° of visual angle at a viewing distance of 30 cm). We manipulated spacing by moving the eyes closer to the nose vertically by 4.9 mm, 2.9 mm and 1.8 mm (0.9°, 0.6°, and 0.3° of visual angle at a viewing distance of 30 cm), or the mouth closer to the nose vertically by 2.9 mm, 1.8 mm and 1.1 mm (0.6°, 0.3°, and 0.2° of visual angle at a viewing distance of 30 cm). Based on the anthropomorphic norms (Farkas, 1994), these spacing variations correspond to 1.5 *SD* (small variations), 2.4 *SD* (intermediate variations), and 4.02 *SD* (extreme variations), (Figure 1A). We also rotated all the images by 180° to create the inverted version of each face stimulus.

Procedure. We used a PC tablet equipped with an EMR pen (Acer Travel Mate C300) to display the stimuli. Participants were seated 30 cm away from it and were asked to perform a drag-and-drop task. Specifically, they had to match each of two horizontally-aligned faces displayed on the right of the screen (an original face and its manipulated version) to the exact same pictures aligned vertically on the left of the screen (Figure 1B). The location of the manipulated stimulus (left/right and up/down) was randomized across trials, as was the degree of difficulty of the trial (1.5 *SD*, 2.4 *SD*, and 4.02 *SD*) and the facial feature involved in the manipulation (eyes or mouth). The experiment started with cartoon faces to familiarize participants with the task, followed by six practice trials involving real face images randomly picked from amongst those of the test. Then, children were administered 36 upright trials (12 trials per level of difficulty, half involving the eye region) and 36 inverted trials (12 trials per level of difficulty, half involving the eye region), on two separate days. The orientation of the faces was blocked and the order of the blocks was counterbalanced across participants. A trial started with the presentation of four face stimuli and ended when the participant pressed on the image of the door to validate his/her response, which launched the feedback for 2000 ms (that is, a rewarding or unrewarding sound) (Figure 1B). Trials were separated from each other by attractive images and sounds. Accuracy (% correct) was recorded using E-Prime 1.1.

Results

We performed a repeated measure ANOVA on children's accuracy with the condition (eyes/mouth) and the orientation (upright/inverted) as within subject factors. We did not include the level of difficulty of the manipulation in the analyses given (1) the limited number of trials per condition and (2) the main objective

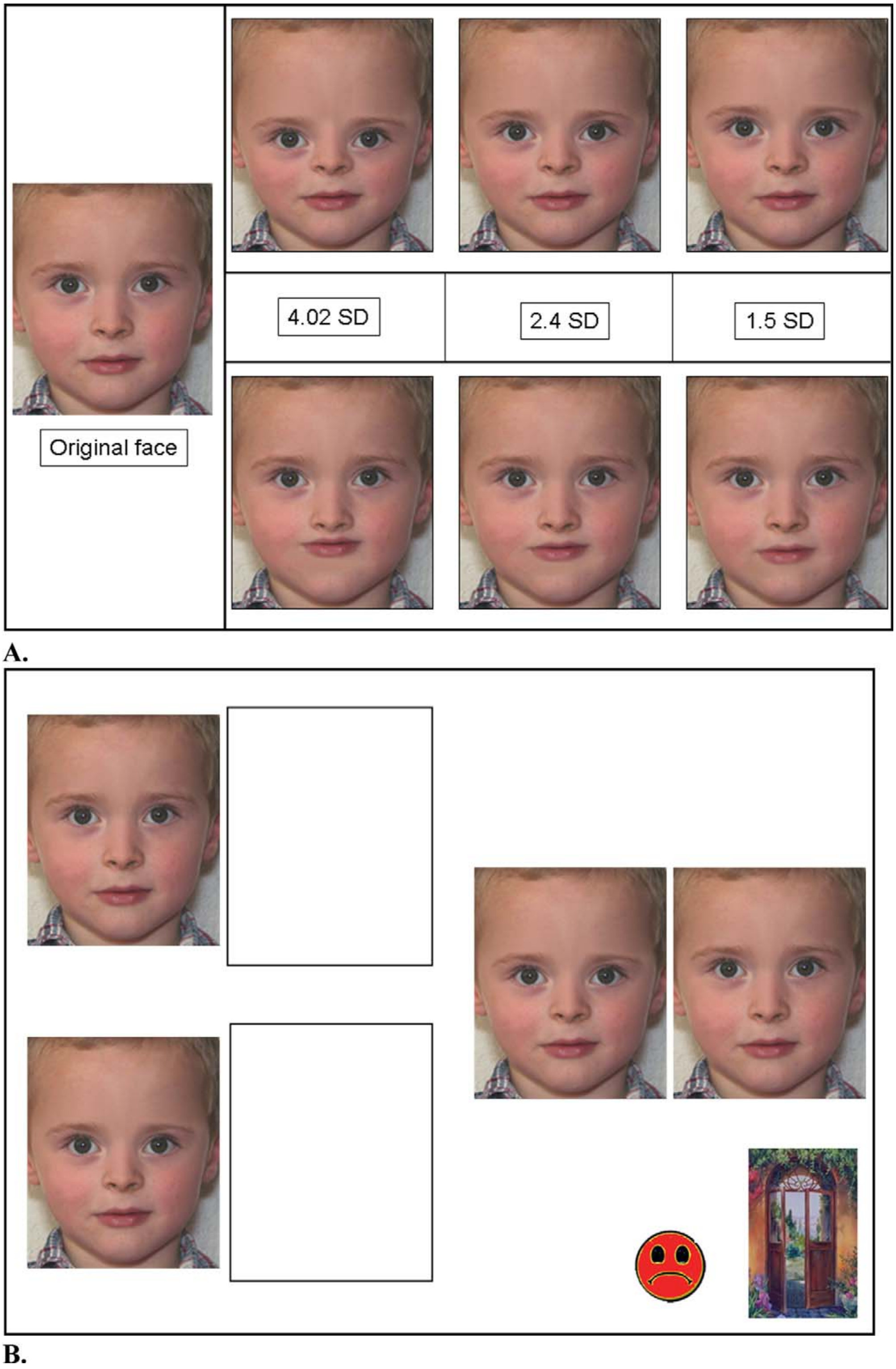

Figure 1. (A) Example of an original face stimulus with extreme (4.02 *SD*), large (2.4 *SD*). and small (1.5 *SD*) spacing variations introduced at the level of the eyes (top row) or the mouth (bottom row). (B) Example of a drag-and-drop 1.5 *SD* trial: Participants had to match each of the two horizontally aligned pictures presented on the right of the panel to the vertically aligned pictures presented on the left of the panel.

of the experiment that was exploring whether the manipulations introduced in the eye region and the mouth region were of similar detectability for children.

There was a main effect of condition (better for the eyes: $F(1, 10) = 9.826, p = .011$), a main effect of orientation (better for upright: $F(1, 10) = 15.098, p = .003$) but, within this small sample, no significant interaction between condition and orientation, $F(1, 10) = 3.112$, $p = .108$. Nonetheless, when each orientation (upright/inverted) was considered separately, there was a significant difference between the eye condition and the mouth condition for upright trials—eyes: 91% ($SD = 3$) vs. mouth: 75% ($SD = 4$): $t(10) = -3.447$, $p = .006$, but not for inverted trials—eyes: 71% ($SD = 4$) vs. mouth: 67% ($SD = 4$); $t(10) = -.848$, $p = .416$.[1]

Experiment 2

The two objectives of Experiment 2 were to track the developmental trajectories of children's sensitivity to vertical manipulations between 6 and 16 years of age, and to determine whether a cognitive variable, such as selective visual attention, can influence children's ability to detect these manipulations.

Method

Participants

A group of 72 children, 6 to 16 years old (36 males, mean age = 134 months; $SD = 40$), was recruited from schools in Belgium and Luxembourg. None of the children tested in Experiment 2 overlapped those tested in Experiment 1. All had normal or corrected-to-normal visual acuity. As for Experiment 1, we only included in the analyses children who performed within 55% (floor effect) and 95% (ceiling effect) of correct responses in the eye condition *and* in the mouth condition. With this criterion, the final sample consisted of 50 children, aged 6 to 16 years (23 males, mean age = 133 months, $SD = 42$; outperformers (>95%): $N = 10$, poorperformers (<55%): $N = 12$).

Stimuli. We used the 36 upright stimuli of Experiment 1 that we presented twice in order to equate the duration of Experiment 2 to the one of Experiment 1. We also used the selective visual attention (SVA) subtest of the WISC IV (Wechsler, 2003).

Procedure. Participants were first asked to perform the face task involving the same procedure as in Experiment 1, except that they saw only upright faces. They also performed the SVA subtest of the WISC IV. This subtest evaluates participants' selective visual attention, their speed of processing, vigilance and visual neglect. Specifically, participants were instructed to find a maximum of animal targets randomly located with respect to other pictures (trial 1) and then aligned to these pictures (trial 2), within 45 seconds. Accuracy (% correct) was calculated for this subtest by subtracting the number of targets crossed by the participant in the two trials (maximum 132) to the number of false alarms.

Results

Overall, children performed better in the eye condition ($X = 80\%$, $SD = 13$) than in the mouth condition ($X = 72\%$, $SE = 14$, $t(71) = -4.188$, $p < .0001$).

We performed two separated one-tailed Spearman correlations between children's age (months) and their accuracy in the eye condition and their accuracy in the mouth condition because these variables were abnormally distributed according the Shapiro–Wilk test of normality. We found that children's age was significantly correlated to their accuracy in the eye condition ($r_s = .449$, $p = .001$) but not to their accuracy in the mouth condition ($r_s = .059$, $p = .341$).[2] The same pattern was present for the three levels of difficulty when each level of difficulty was analyzed separately. Further investigation indicated that the linear model was a good fit for the eye data ($R^2 = .196$; $F(1, 49) = 11.737$, $p = .001$) but not as good for the mouth data ($R^2 = .016$; $F(1, 49) = .785$, $p = .380$). None of the more complex models (that is, cubic, quadratic, logarithmic) increased the goodness of fit of the mouth condition, probably because of the high variability characterizing the data of this condition. Finally, bootstrap analyses performed on the linear regressions for the mouth condition and the eye condition indicated that the slope for the mouth condition ($y = .0003x + .6866$) fell outside the 95% confidence interval [.0004–.0019] defined for the eye condition ($y = .0011x + .6320$), showing that the slope of the function relating accuracy to age was significantly more pronounced for the eye condition than for the mouth condition (Figure 2).

Another one-tailed Spearman correlation between children's age (months) and their SVA scores indicated that, as expected, children's attention scores significantly increased with age ($r_s = .737$, $p < .0001$).[3] After neutralizing the influence of children's age on the SVA scores by computing 2-tailed partial correlations between their scores in the attention task and their scores in the face task, it also appeared that their attention scores correlated significantly with their accuracy in the mouth condition (partial $r = .284$, $p = .048$) but not with their accuracy in the eye condition (partial $r = -.011$, $p = .939$). The same pattern was present for the three levels of difficulty when each level was analyzed separately.

General discussion

The current study investigated, through an original and child-friendly task, 6–16-year-old children's sensitivity to spacing information when the vertical manipulation implied the upper part (eye region) or the lower part (mouth region) of different facial identities. To explicitly investigate the co-variation of children's accuracy in a perceptual task tracking the holistic/configural component and their accuracy in a general cognitive test, we also administered, to the same children, the visual selective attention subtest of the WISC IV (Wechsler, 2003). Our findings were as follows.

Consistently with previous studies implying faces whose spacing information was simultaneously manipulated at the level of the eyes and the mouth (Pellicano et al., 2006), we first found that it was easier for children to detect spacing manipulations within the eye region than within the mouth region of upright faces.

Second, we observed that 6–16-year-old children's ability to perceive spacing variations in the eye region significantly increased with age. This developmental pattern was present although the children's faces used as stimuli were not of exactly the same age as the participants' age (Hills, 2012). Contrary to previous studies performed on infants (Bhatt, Bertin, Hayden, & Reed, 2005; Hayden, Bhatt, Reed, Corbly, & Joseph, 2007) and preschoolers (Macchi Cassia et al., 2011; Mondloch & Thomson, 2008), the developmental pattern was also consistent across the three levels of spacing manipulations ranging from normal (1.5 *SD*) to abnormal (4.02 *SD*) (Farkas, 1994) and independent of children's selective visual attention aptitudes, when age was factored out as a confounding variable. Regarding this latter result, we would suggest that the automation permitted by the reliance on holistic/configural processing probably reduced children's need of selective visual attention to process spacing manipulations performed

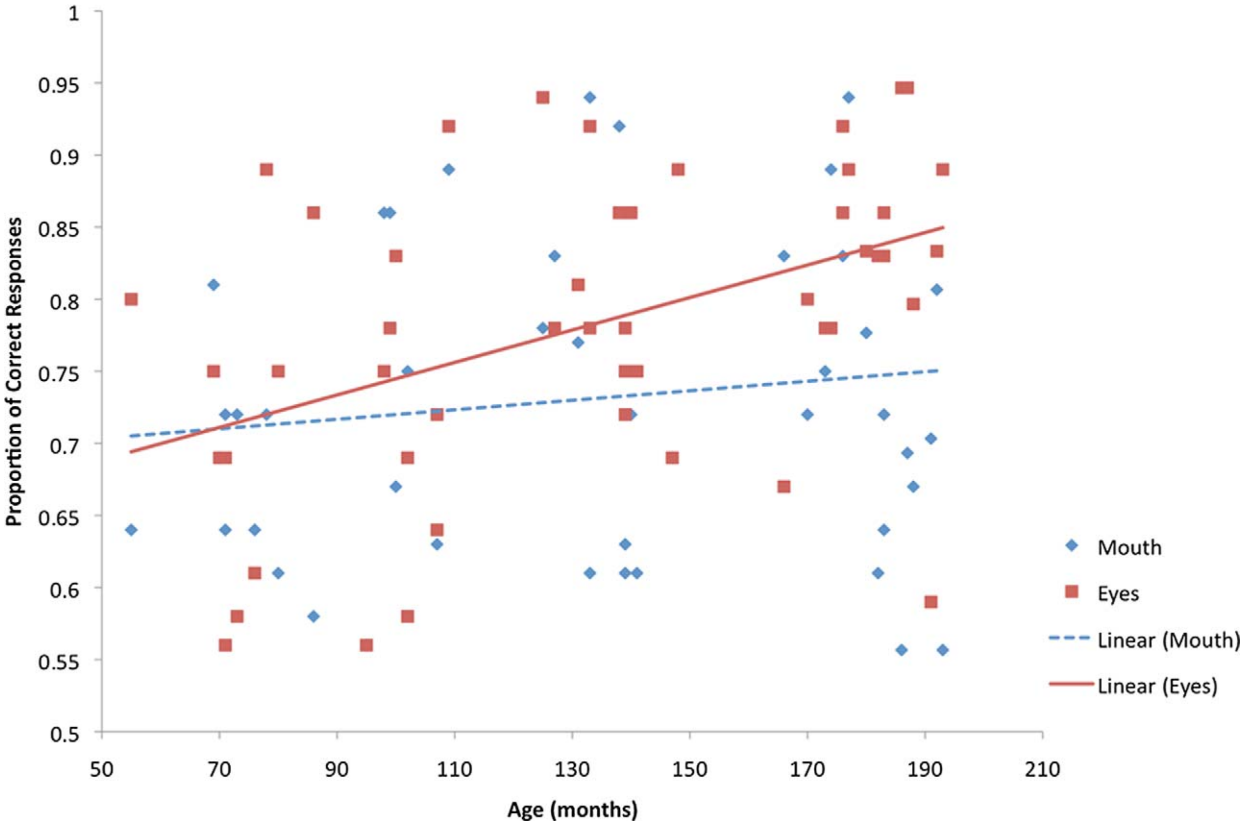

Figure 2. Participants' mean proportion of correct responses when the face stimuli were manipulated at the level of the mouth (◊) or at the level of the eyes (□) as a function of their age (months). The lines represent the linear regressions for the mouth condition (blue) and the eye condition (red).

within the eye region. Conversely, 6–16-year-old children's ability to process spacing changes involving the mouth remained stable with age and did significantly co-vary with their selective visual attention scores, even after controlling for the effect of age. Even if no firm conclusion can be made because of children's highly variable results in this condition, we would attribute this stability to the insufficient amount of holistic/configural processing children could allocate to the mouth region (see also Kelly et al., 2011).

More generally, it might be proposed that visual experience continuously refines individuals' face-space and its dimensions, which in turn positively affects their face-processing abilities. In a recent study, 8-year-old children were shown to be particularly sensitive during similarity judgments to the eye color dimension (Nishimura, Maurer, & Gao, 2009). One reason why these children did not count on other dimensions relating to coding feature spacing could be that adult faces rather than children's faces were used in this study, which might have undermined participants' sensitivity to holistic/configural cues.

In summary, we asked 6–16-year-old children to process face stimuli with vertical spacing changes in the eye region and in the mouth region, that were matched for difficulty. We observed that these children's ability to perceive spacing variations in the eye region increased with age, which emphasizes the growing importance of the eyes during childhood (Kelly et al., 2011). Conversely, their sensitivity to manipulations involving the mouth was rather stable between those ages. In line with these findings, we proposed that processing the eye region implies holistic/configural face processing which improves with age, and consequently requires less selective attention.

Acknowledgments

We would like to acknowledge Malorie Deboni for collecting the data and drafting a version of the manuscript, Bruno Rossion for his comments on an earlier version of the manuscript, Xiaoqing Gao for his technical help, as well as the children who took part in the tests.

Funding

Adélaïde de Heering is supported by the Belgian National Fund for Scientific Research (FNRS). Christine Schiltz is supported by the University of Luxembourg (F3R-EMA-PUL-08FACE) and the National Research Fund (BFR07/081 grant to Malorie Deboni).

Notes

1. The same pattern was observed when the data of all the children tested ($N = 24$) were taken into account in the analyses, namely no significant difference between the eye condition and the mouth condition for inverted trials—eyes: 58% (SD = 17) vs. mouth: 65% (SD = 17); $t(23) = 1.261$, $p = .220$.
2. The same trend was observed when all the children tested were considered in the analyses ($N = 72$).
3. The same trend was observed when the data of all the children tested were considered in the analyses ($N = 72$).

References

Anastasi, J., & Rhodes, M. G. (2005). An own-age bias in face recognition for children and older adults. *Psychonomic Bulletin & Review*, *12*, 1043–1047.

Bar-Haim, Y., Shulman, C., Lamy, D., & Reuveni, A. (2006). Attention to eyes and mouth in high-functioning children with autism. *Journal of Autism and Developmental Disorders*, *36*, 131–137.

Baudouin, J. Y., Gallay, M., Durand, K., & Robichon, F. (2010). The development of perceptual sensitivity to second-order facial relations in children. *Journal of Experimental Child Psychology*, *107*, 195–206.

Benton, A. L., Sivan, A. B., Hamsher, K., Vareny, N. R., & Spreen, O. (1983). Facial recognition: Stimulus and multiple choice pictures. In A. L. Benton, A. B. Sivan, K. D. S. Hamsher, N. R. Varney, & O. Speen (Eds.), *Contributions to neuropsychological assessment* (pp. 30–40). New York, NY: Oxford University Press.

Betts, J., Mckay, J., Maruff, P., & Anderson, V. (2006). The development of sustained attention in children: The effect of age and task load. *Child Neuropsychology*, *12*, 205–221.

Bhatt, R. S., Bertin, E., Hayden, A., & Reed, A. (2005). Face processing in infancy: Developmental changes in the use of different kinds of relational information. *Child Development*, *76*, 169–181.

Bjorklund, D. F., & Douglas, R. N. (1997). The development of memory strategies. In N. Cowan (Ed.), *The development of memory in childhood* (pp. 201–246). Hove, UK: Psychology Press.

Bruce, V., Campbell, R. N., Doherty-Sneddon, G., Import, A., Langton, S., McAuley, S., & Wright, R (2000). Testing face processing skills in children. *British Journal of Developmental Psychology*, *18*, 319–333.

Carey, S. (1992). Becoming a face expert. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *335*, 95–102.

Carey, S., Diamond, R., & Woods, B. (1980). The development of face recognition—a maturational component? *Developmental Psychology*, *16*, 257–269.

Crookes, K., & McKone, E. (2009). Early maturity of face recognition. No childhood development of holistic processing, novel face encoding, or face-space. *Cognition*, *111*, 219–247.

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*, 2037–2078.

de Heering, A., Rossion, B., & Maurer, D. (2012). Developmental changes in face recognition during childhood: Evidence from upright and inverted faces. *Cognitive Development*, *27*, 17–27.

Farkas, L. G. (1994). *Anthropometry of the head and face in medicine* (2nd ed.). New York, NY: Elsevier.

Farroni, T., Johnson, M. H., Menon, E., Zulian, L., Faraguna, D., & Csibra, G. (2005). Newborn's preference for face-relevant stimuli: Effects of contrast polarity. *Proceedings of the National Academy of Sciences of the United States of America*, *102*, 17245–17250.

Flavell, J. H. (1985). *Cognitive development* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Flavell, J. H., & Wellman, H. M. (1977). Metamemory. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition* (pp. 3–33). Hillsdale, NJ: Lawrence Erlbaum Associates.

Haig, N. D. (1985). How faces differ: A new comparative technique. *Perception*, *14*, 601–615.

Hayden, A., Bhatt, R. S., Reed, A., Corbly, C. R., & Joseph, J. E. (2007). The development of expert face processing: Are infants sensitive to normal differences in second-order relational information? *Journal of Experimental Child Psychology*, *97*, 85–98.

Hills, P. J. (2012). A developmental study of the own-age face recognition bias in children. *Developmental Psychology*, *48*, 499–508.

Kelly, D. J., Liu, S., Rodger, H., Miellet, S., Ge, L., & Caldara, R. (2011). Developing cultural differences in face processing. *Developmental Science*, *14*, 1176–1184.

Macchi Cassia, V., Turati, C., & Schwarzer, G. (2011). Sensitivity to spacing changes in faces and nonface objects in preschool-aged children and adults. *Journal of Experimental Child Psychology*, *109*, 454–467.

McKone, E., Crookes, K., Jeffery, L., & Dilks, D. D. (2012). A critical review of the development of face recognition: Experience is less important than previously believed. *Cognitive Neuropsychology*, *i*, 1–39.

Mondloch, C. J., Geldart, S., Maurer, D., & Le Grand, R. (2003). Developmental changes in face processing skills. *Journal of Experimental Child Psychology*, *86*, 67–84.

Mondloch, C. J., Le Grand, R., & Maurer, D. (2002). Configural face processing develops more slowly than featural face processing. *Perception*, *31*, 553–566.

Mondloch, C. J., & Thomson, K. (2008). Limitations in 4-year-old children's sensitivity to the spacing among facial features. *Child Development*, *79*, 1513.

Nishimura, M., Maurer, D., & Gao, G. (2009). Exploring children's face-space: A multidimensional scaling analysis of the mental representation of facial identity. *Journal of Experimental Child Psychology*, *103*, 355–375.

Orban de Xivry, J. J., Ramon, M., Lefèvre, P., & Rossion, B. (2008). Reduced fixation on the upper area of personally familiar faces following acquired prosopagnosia. *Journal of Neuropsychology*, *2*, 245–268.

Pasto, L., & Burack, J. A. (1997). A developmental study of visual attention: Issues of filtering efficiency and focus. *Cognitive Development*, *12*, 523–535.

Pellicano, E., Rhodes, G., & Peters, M. (2006). Are preschoolers sensitive to configural information in faces? *Developmental Science*, *9*, 270–277.

Ramon, M., & Rossion, B. (2010). Impaired processing of relative distances between features and of the eye region in acquired prosopagnosia—two sides of the same holistic coin? *Cortex*, *46*, 374–389.

Reid, V. M., Striano, T., Kaufman, J., & Johnson, M. H. (2004). Eye gaze cueing facilitates neural processing of objects in 4-month-old infants. *Neuroreport*, *15*, 2553–2555.

Robbins, R., Shergill, Y., Maurer, D., & Lewis, T. L. (2011). Development of sensitivity to spacing versus feature changes in pictures of houses: Evidence for slow development of a general spacing detection mechanism? *Journal of Experimental Child Psychology*, *109*, 371–382.

Rossion, B. (2008). Picture-plane inversion leads to qualitative changes of face perception. *Acta Psychologica*, *128*, 274–289.

Rossion, B. (2009). Distinguishing the cause and consequence of face inversion: The perceptual field hypothesis. *Acta Psychologica*, *132*, 300–312.

Sadr, J., Jarudi, I., & Sinha, P. (2003). The role of eyebrows in face recognition. *Perception*, *32*, 285–293.

Skoczenski, A. M., & Norcia, A. M. (2002). Late maturation of visual hyperacuity. *Psychological Science*, *13*, 537–541.

Turati, C., di Giorgio, E., Bardi, L., & Simion, F. (2010). Holistic face processing in newborns, 3-month-old infants, and adults: Evidence of the composite effect. *Child Development*, *81*, 1894–1905.

Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *The Quarterly Journal of Experimental Psychology*, *43*, 161–204.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV)*. San Antonio, TX: Harcourt Assessment.