Processing of facial emotions: Neurophysiological evidence of recognition of emotions and its development

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Understanding of emotions has been shown to develop between 4 and 10 years, and children who are more lateralised for emotion processing in the right hemisphere demonstrate greater recognition of emotion. Thus far, the development of facial emotion recognition and lateralization has been mainly investigated by behavioural measures. This research aimed to investigate children's electrophysiological responses when viewing facial expressions (happy, sad, neutral). ERPs were recorded for 33 5- to 12-year-olds and 9 adults. Findings indicated developmental trends in emotional face processing. An effect of age was seen on the first negative wave (N1). The amplitude decreased with increasing age. The later positive wave was more positive for neutral than happy faces across age groups.

Introduction

- Understanding of emotions from Facial expressions is a salient component of emotional behaviour.
- Children's ability to recognise emotions from facial expressions:
  - improves with age, where full proficiency appears to be present at 10 years (Durand et al., 2007)
  - varies with emotion, with recognition of happy, followed by sad.
  - children become increasingly right hemisphere (RH) lateralised for emotion processing (Workman et al., 2006)
  - children with greater RH lateralisation were better in emotion recognition test (Workman et al., 2006)
- This research aims to investigate the neural markers of emotion recognition and their developmental trends.

Methods

Participants: 17 5- to 8-year-olds (6 girls), 17 9- to 12-year-olds (6 girls), and 9 19- to 42-year-old adults (5 females),right handed, were included in the final analysis.

Materials & Methods: ERPs were recorded at fronto-central sites (F3, Fz, F4, C3, Cz, and C4). Stimuli were black and white photographs of NIMH pictures of individuals (see examples in figure 1) displaying emotional facial expressions (happy, sad, neutral).

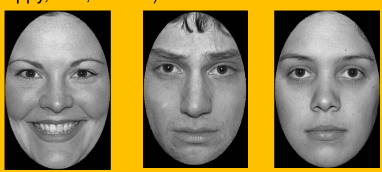

Figure 1 : Examples of happy, sad and neutral NIMH stimuli

Procedure: Participants viewed the stimuli on a 17" computer screen. The stimuli were presented for 500ms in a random order with equal probability and without immediate stimulus repetition. Each stimulus was preceded by a circle-fixation point. Participants were instructed to press the spacebar on the keyboard when the fixation point was a square rather than a circle.

***Recordings and Analysis*:** ERPs were recorded with Ag-AgCl electrodes and linked-earlobe reference from F3, F4, C3, C4 (according to the 10-20 system). Average amplitudes and the latency of the first negative peak (N1) were obtained between 100-250 ms for all conditions, happy, sad, and neutral at each electrode site. Further, to assess the slow positive wave 29 mean amplitudes were also measured in 25 ms time windows between 200 and 900 ms.

Results

N1 amplitude (C3 vs C4)

Laterality trends: amplitude was higher on the C3 left hemisphere (LH) electrode (M = -8.8 µVs) than for the C4 right hemisphere (RH) electrode (M= -8.0 µVs).

Age trends: amplitude was found to decrease with increasing age (see Figure 2), where the children had larger N1 amplitudes than the adult group.

Age X Laterality: only the C3 LH amplitude was only higher for the children in comparison to the adults for the sad faces, but not the happy faces.

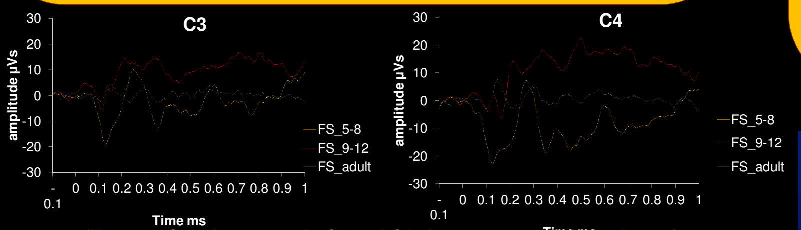

Figure 2: Grand averages in C3 and C4 sites across ages for sad emotion

Results (continued)

N1 latency (C3 vs C4)

Age trends: there is a decrease of latency with age, where the younger children had longer latencies (M=.121) than older children (M=.113) and than the adults (M=.109).

Age X Laterality: there was no difference for LH and RH latencies for the younger children (Ms=.121,.121); however, for the older children the latency in the LH was longer than in the RH (Ms=.114, .112), which was the same for the adults where the latency in the LH was longer than in the RH (Ms=.110, 109).

Emotion trends: latency was found to be longer for the sad (M=.117) faces than for the neutral faces (M= .112).

Enhanced positivity (Cz 200-900 ms)

Emotion trends: there was a greater positivity (M=1.7 µVs) when processing neutral than happy (M=.9 µVs), while there was no difference with sad (M=1.1 µVs).

Emotion X Age: only the youngest children's frontal-central activity varied depending on the emotional face viewed. When viewing neutral faces there was greater positivity for the neutral faces than for the sad and the happy faces (see Figure 3), while there was no difference depending on emotion for the older children and the adults.

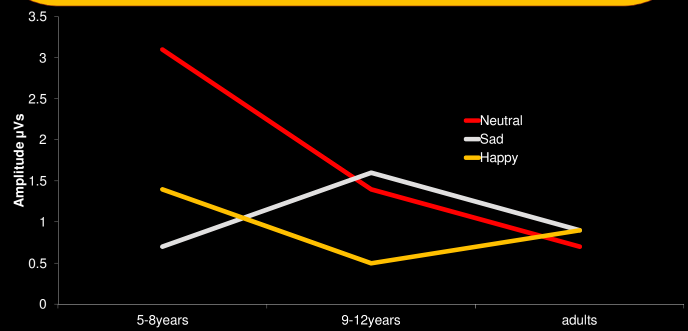

Figure 3: Mean amplitudes of enhanced positivity across age groups and emotions.

Discussion

- The data revealed developmental changes of emotional face processing, which may suggest a progressive decrease in cortical activation, perhaps indicating increased automatization in emotional processing with age. Further that facial expressions are processed faster with age possibly due to the continuing maturation and increased myelination of the neural pathways.
- It is also possible that the N1 component reflects the first stage of emotional processing suggested by Eimer et al. (2007), where emotions from faces are detected initially and rapidly.
- Consistent with Workman et al. (2006), the latencies indicate a progressive lateralization of the emotional processing to the RH.
- The second stage of emotional processing suggested by Eimer et al. (2007) is a higher level stage where the conscious evaluation of facial expression takes place, and is reflected by the sustained positivity. The age differences, especially between the younger group and adults, in amplitude between 200-900 ms perhaps show the sustained attention of the younger group especially to the neutral emotion which is a difficult emotion to recognise (Durand et al., 2007) .
- This work has important implications for exploring development of emotion recognition and identification throughout childhood; in particular, it would be important for future work to explore how these maturational changes influence speed and accuracy of emotion recognition in behavioural tasks?

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