CORTEX 52 (2014) 28–34

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Note

The role of human basolateral amygdala in ambiguous social threat perception

Beatrice de Gelder[a,b,c,*], *David Terburg*[d,e,1], *Barak Morgan*[f,1], *Ruud Hortensius*[b], *Dan J. Stein*[e] and *Jack van Honk*[d,e]

[a] *Department of Psychology and Neuroscience, Maastricht University, The Netherlands*
[b] *Cognitive and Affective Neuroscience Laboratory, Tilburg University, The Netherlands*
[c] *Brain and Emotion Laboratory Leuven, Department of Neurosciences, Leuven University, Belgium*
[d] *Experimental Psychology, Utrecht University, The Netherlands*
[e] *Department of Psychiatry and Mental Health, University of Cape Town, South Africa*
[f] *MRC Medical Imaging Research Unit, Department of Human Biology, University of Cape Town, South Africa*

ARTICLE INFO

Article history:
Received 22 April 2013
Reviewed 13 September 2013
Revised 14 October 2013
Accepted 19 December 2013
Action editor Alan Sanfey
Published online 31 December 2013

Keywords:
Amygdala
Body emotion expressions
Urbach–Wiethe disease
Emotion
Basolateral amygdala

ABSTRACT

Previous studies have shown that the amygdala (AMG) plays a role in how affective signals are processed. Animal research has allowed this role to be better understood and has assigned to the basolateral amygdala (BLA) an important role in threat perception. Here we show that, when passively exposed to bodily threat signals during a facial expressions recognition task, humans with bilateral BLA damage but with a functional central-medial amygdala (CMA) have a profound deficit in ignoring task-irrelevant bodily threat signals.

1. Introduction

It is a common experience that an angry face feels more menacing when accompanied by a pair of fists, but it is rather unsettling when the fists come with a smile. In that case we experience the overall signal as profoundly ambiguous. When instructed to attend to only the facial expression, the brain notices the conflict between the facial expression and the accompanying bodily expression in a matter of milliseconds (Meeren, van Heijnsbergen, & de Gelder, 2005).

A variety of functions related to affective processes have been attributed to the amygdala (AMG) including immediate perception of affective stimuli, learning and conditioning, as

* *Corresponding author*. Department of Psychology and Neuroscience, Maastricht University, The Netherlands.
E-mail address: b.degelder@maastrichtuniversity.nl (B. de Gelder).

[1] These authors contributed equally to this work.

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http://dx.doi.org/10.1016/j.cortex.2013.12.010

well as emotional memory (Phelps & LeDoux, 2005). The AMG is also involved in modulating behavioral responses and has multiple connections to brain areas directly involved in behavioral output (Mosher, Zimmerman, & Gothard, 2010). There is also overwhelming evidence that the AMG plays an important role in regulating emotion perception and preparing adapted motor behavior (Phelps & LeDoux, 2005).

Previous research has shown that the AMG plays an important role in face (Costafreda, Brammer, David, & Fu, 2008) and body (de Gelder, Snyder, Greve, Gerard, & Hadjikhani, 2004) expression recognition and is also highly sensitive to ambiguous signals (Kim et al., 2004; Whalen, 1998). But further progress in understanding the AMG will require understanding the specific contribution of the multiple nuclei of the AMG. Functions or loss of functions ascribed to the AMG as a whole may in fact result from activation of AMG nuclei or inter- and intra-amygdala connectivity. For example, facial expression recognition has been attributed to the AMG as a whole (Rutishauser et al., 2011) and consequently it was assumed that AMG damage abolishes this (Adolphs, Tranel, Damasio, & Damasio, 1994, but see Tsuchiya, Moradi, Felsen, Yamazaki, & Adolphs, 2009). But more recently it was shown that an impairment of one of the AMG nuclei, the basolateral amygdala (BLA), leads to hypersensitivity for facial fear expressions (Terburg et al., 2012).

Similarly, the same complete AMG impairment does not seems to abolish body expression recognition (Atkinson, Heberlein, & Adolphs, 2007). This finding does not rule out that an impairment of a specific nucleus of the AMG does nevertheless have consequences for normal processing of body expressions. In the case of a complex structure like the AMG a functional role attributed to the AMG as a whole cannot be attributed automatically to each of its subnuclei.

We addressed the issue of the functional role of the BLA in ambiguous social threat perception using subjects with Urbach–Wiethe disease (UWD), a rare genetic disorder that in our sample has resulted in bilateral focal calcification of the BLA. We tested three subjects from the South African UWD cohort (Thornton et al., 2008) selected for this specific BLA damage (Morgan, Terburg, Thornton, Stein, & van Honk, 2012) and a group of matched controls on a series of face and body expression recognition tasks. Our goal was first, to investigate the specific role of the BLA in implicit bodily expression recognition and second, the role of the BLA in ambiguity perception. We used angry and fearful Face Body Compounds created by combining a facial expression with either a congruent or incongruent bodily expression. Using convergent evidence from behavior and eye tracking measures, we investigated how BLA damage affects the processing of affective information from body expressions of anger and fear that are, unattended, not task relevant, and presented in the periphery. We conjectured that under these conditions of implicit perception participants with BLA damage would still process the threatening body signals and these signals would be more salient than in normal controls. Therefore we expect an increased effect from threatening bodily expressions on facial expression perception in the UWD group.

2. Methods

2.1. Subjects

Three subjects from the South African UWD cohort (Morgan et al., 2012; Thornton et al., 2008) without any history of secondary psychopathology or epileptic insults and 12 matched controls participated in the experiment. The UWD and control group were all female and matched for age and IQ (see Table 1 for demographic data). All participants were from mountain-desert villages near the Namibian border. Detailed neuropsychological assessment of the UWD group is described elsewhere (Morgan et al., 2012; Terburg et al., 2012). Structural and functional MRI assessment by means of cytoarchitectonic-probability labeling showed that bilateral calcification is restricted to the BLA (see Fig. 1). This study was approved by the Health Sciences Faculty Human Research Ethics Committee of the University of Cape Town. All participants provided written informed consent. We note that all UWD subjects reported here and in previous studies (Adolphs et al., 1994; Morgan et al., 2012; Terburg et al., 2012) are female and we cannot exclude that gender colors past and present results. Resolution of this issue must await availability of male UWD subjects.

2.2. Tasks

2.2.1. Face Body Compound task (FBC)

Congruent and incongruent threatening FBCs (Meeren et al., 2005) were constructed using angry and fearful bodies (de Gelder & Van den Stock, 2011) and angry and fearful faces (MacBrain Face Stimulus Set) (see Fig. 2A). Stimuli (12 per condition, 6 female) were on screen for 350 msec for behavioral testing and 2000 msec for eye tracking. Participants had to recognize the facial expression and ignore the bodily expression while accuracy and reaction time were recorded during behavioral testing.

2.2.2. Sample-to-match task

The Bodily Expressive Action Stimulus Test (BEAST) (de Gelder & Van den Stock, 2011) was used to assess the perception of emotional whole bodily expression. Participants had to match angry, happy, fearful or sad bodily expressions with one of two simultaneously presented bodily expressions (12 per condition, 6 female). Both the target and distracter had different identities, while the distracter had a different

Table 1 – Demographic data.

	UWDs				Controls
	UWD 1	UWD 2	UWD 3	Mean	Mean
Age	24	31	35	32 ± 5.1	32 ± 8.6
VIQ	95	84	93	90.7 ± 5.9	88.1 ± 4.2
PIQ	98	86	85	89.7 ± 7.2	87.1 ± 6.9
FSIQ	97	84	87	89.3 ± 6.8	86.4 ± 4.3

VIQ: verbal IQ, PIQ: performance IQ, FSIQ: full-scale IQ. Means and standard deviations are reported.