Prof. Beatrice de Gelder's *Brain and Emotion* Lab

Synopsis of Main Lab Papers

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2011

- de Gelder, B., & Van den Stock, J. (2011). The bodily expressive action stimulus test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions. *Frontiers in psychology, 2*, 181.

2014

- Hortensius, R., & de Gelder, B. (2014). The neural basis of the bystander effect—The influence of group size on neural activity when witnessing an emergency. *Neuroimage, 93*, 53-58.
- Huis in 't Veld, E. M., Van Boxtel, G. J., & de Gelder, B. (2014). The Body Action Coding System I: Muscle activations during the perception and expression of emotion. *Social neuroscience, 9*(3), 249-264.
- Ross, P. D., de Gelder, B., Crabbe, F., & Grosbras, M. H. (2014). Body-selective areas in the visual cortex are less active in children than in adults. *Frontiers in Human Neuroscience, 8*, 941.

2015

- de Gelder, B., Huis in 't Veld, E. M., & Van den Stock, J. (2015). The facial expressive action stimulus test. A test battery for the assessment of face memory, face and object perception, configuration processing, and facial expression recognition. *Frontiers in Psychology, 6,* 1609.
- de Gelder, B., Tamietto, M., Pegna, A. J., & Van den Stock, J. (2015). Visual imagery influences brain responses to visual stimulation in bilateral cortical blindness. *Cortex, 72*, 15-26.
- Huis in 't Veld, E. M., & de Gelder, B. (2015). From personal fear to mass panic: The neurological basis of crowd perception. *Human brain mapping, 36*(6), 2338-2351.
- van den Stock, J., Tamietto, M., Hervais-Adelman, A., Pegna, A. J., & de Gelder, B. (2015). Body recognition in a patient with bilateral primary visual cortex lesions. *Biological psychiatry, 77*(7), e31-e33.

2018

- Poyo Solanas, M., Zhan, M., Vaessen, M., Hortensius, R., Engelen, T., & de Gelder, B. (2018). Looking at the face and seeing the whole body. Neural basis of combined face and body expressions. *Social cognitive and affective neuroscience, 13*(1), 135-144.
- Terburg, D., Scheggia, D., Del Rio, R. T., Klumpers, F., Ciobanu, A. C., Morgan, B., ... & van Honk, J. (2018). The basolateral amygdala is essential for rapid escape: a human and rodent study. *Cell, 175*(3), 723-735.

2019

- de Borst, A. W., & De Gelder, B. (2019). Mental imagery follows similar cortical reorganization as perception: intra-modal and cross-modal plasticity in congenitally blind. *Cerebral Cortex, 29*(7), 2859-2875.

2020

- de Borst, A. W., Sanchez-Vives, M. V., Slater, M., & de Gelder, B. (2020). First-person virtual embodiment modulates the cortical network that encodes the bodily self and its surrounding space during the experience of domestic violence. *Eneuro, 7*(3).
- Poyo Solanas, M., Vaessen, M. J., & de Gelder, B. (2020). The role of computational and subjective features in emotional body expressions. *Scientific reports, 10*(1), 6202.
- Poyo Solanas, M., Vaessen, M., & de Gelder, B. (2020). Computation-based feature representation of body expressions in the human brain. *Cerebral Cortex, 30*(12), 6376-6390.

2023

- Li, B., Solanas, M. P., Marrazzo, G., Raman, R., Taubert, N., Giese, M., ... & de Gelder, B. (2023). A large-scale brain network of species-specific dynamic human body perception. *Progress in Neurobiology*, 221, 102398.
- Marrazzo, G., De Martino, F., Lage-Castellanos, A., Vaessen, M. J., & de Gelder, B. (2023). Voxelwise encoding models of body stimuli reveal a representational gradient from low-level visual features to postural features in occipitotemporal cortex. *NeuroImage*, 120240.
- Poyo Solanas, M., Zhan, M., & de Gelder, B. (2023). Gradual relation between perceptual awareness, recognition, and pupillary responses to social threat. *Current Research in Behavioral Sciences, 5.* 100134.

2024

- Poyo Solanas, M., Zhan, M., & de Gelder, B. (2024). Ultrahigh Field fMRI Reveals Different Roles of the Temporal and Frontoparietal Cortices in Subjective Awareness. *Journal of Neuroscience, 44*(20), e0425232023.
- Chesley, J., Riecke, L., Lu, J., Vogels, R., & de Gelder, B. (2024). Theta activity discriminates high-level, species-specific body processes. *Imaging Neuroscience, 2,* 1-12.

2025

- Lu, J., Riecke, L., Ryan, B. E., & de Gelder, B. (2025). The contribution of body perception to self-identity: an event-related potential study. *Social Cognitive and Affective Neuroscience, 20*(1), nsaf020.
- Marrazzo, G., De Martino, F., Mukovskiy, A., Giese, M. A., & de Gelder, B. (2025) Neural encoding of biomechanically (im)possible human movements in occipitotemporal cortex. *bioRxiv.*
- Smekal, V., Poyo Solanas, M., & de Gelder, B. (2025). Disentangling dynamic information and temporal order processing of human action perception. *PNAS Nexus, 4,* pgaf067.

Inversion superiority in visual agnosia may be common to a variety of orientation polarised objects besides faces

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BACKGROUND

There are two opposing views within the face processing literature. One argues that prosopagnosia, i.e., the inability to recognise faces, provides evidence for an independent face processing module. Contrary propositions define prosopagnosia merely as a specific manifestation of visual object agnosia, thereby refuting a face dedicated module. The *inversion inferiority effect* demonstrates impaired face recognition with stimulus inversion in healthy controls, while this is not the case for other mono-oriented stimuli, e.g. houses or landscapes. Moreover, a contrasting *inversion superiority effect* in favour of face modularity has been reported in prosopagnosiacs, where inverted faces are better recognised than upright ones. Yet, the latter effect has been likewise reported for gun dogs and handwriting, which stresses the importance of studying recognition performance in prosopagnosia for both faces and objects. Thus, we further investigated the *inversion superiority effect* using face and object stimuli in a prosopagnosia and visual agnosia patient.

RESEARCH QUESTION

Will a 74-year-old prosopagnosia / visual agnosia patient AD exhibit the *inversion superiority effect* for both faces and objects?

STIMULI

RESULTS

Table 1
The results of studies 1–4 results of control subjects (study 1) and patient AD for shoes (upright/inverted) and face (upright/inverted) tasks.

Study	Task	Participants	Stimulus mode	Response	Shoes UP	Shoes DOWN	t/X2	Faces UP	Faces DOWN	t/X2
1	ABX	12 continued	PC	Key	58/80	53/80	$t_{11} = 1.0$ 2 NC	62/80	55/80	$t_{11} = 2.76$ $P < 0.02$
2	AX	AD	PC	Key	32/80	48/80	X2 = 3.2 NS	36/60	48/80	X2 = 1.8 NS
3	AX	AD	Manual	Vocal	44/80	75/80	X2 = 15. 5 $P < 0.001$	46/80	64/80	X2 = 4.7 $P < 0.05$
4	ABX	AD	Manual	Vocal	31/60	60/60	X2 = 24.1 $P < 0.001$	44/80	67/80	X2 = 26.7 $P < 0.001$

Healthy controls demonstrated the *inversion inferiority effect* (impaired recognition of inverted stimuli) for inverted faces.
Patient AD demonstrated the *inversion superiority effect* (improved recognition of inverted stimuli) for both inverted faces and shoes.

CONCLUSIONS

Research question: Unlike previous studies, we demonstrated for the first time that a prosopagnosia/visual agnosia patient can exhibit the *inversion superiority effect* for both faces and non-facial stimuli, i.e., shoes. Theoretical: Considering that the *inversion superiority effect* is not constrained to faces, these findings challenge the notion of face modularity.

NOVELTY

This is the first study investigating the *inversion superiority effect* in prosopagnosia/visual agnosia by comparing recognition of faces and shoes.

De Gelder, B., Bachoud-Lévi, A. C., & Degos, J. D. (1998). Inversion superiority in visual agnosia may be common to a variety of orientation polarised objects besides faces. *Vision research*, *38*(18), 2855-2861.

Non-conscious recognition of affect in the absence of striate cortex

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BACKGROUND

Previous literature has shown evidence of emotional processing without visual awareness. Emotional stimuli are known to elicit amygdala activation and induce subcortical reactions. Moreover, blindsight patients, i.e., individuals with striate cortex lesions, are able to unconsciously process basic visual stimuli, like spatial frequency gratings or simple shapes. However, non-conscious visual processing of naturalistic stimuli, e.g., emotional human faces, is yet to be investigated in this population. Therefore, we administered behavioural and electroencephalography (EEG) methods in a blindsight patient GY, blind to his right visual field, to investigate emotional face recognition in absence of conscious perception.

RESEARCH QUESIONS

1. Can a blindsight patient GY unconsciously perceive emotional facial expressions?

2. Are visually evoked ERPs presented to the affected visual hemifield comparable to those elicited by emotional facial expressions presented in the intact visual hemifield?

STIMULI

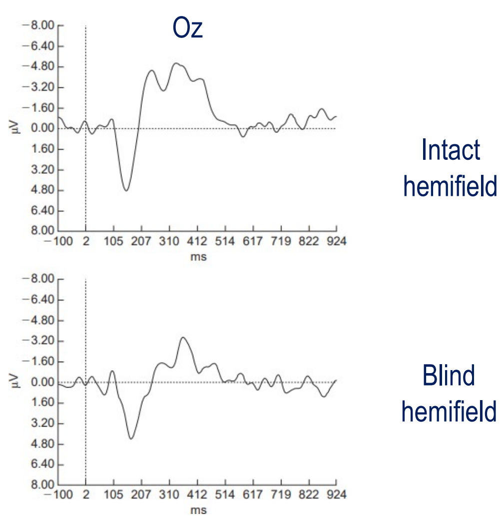
Dynamic: Videos of a female face pronouncing the same sentence using 4 facial expressions (happy / sad / angry / fearful)

Static: Images of faces from the Ekman series (neutral / happy / fearful)

RESULTS

Table 1. Covert recognition of facial expressions

Stimulating pair	Image size	L/R presentation	Correct	*p*
Happy/fearful	Small	Randomized	22/27	< 0.001
Happy/fearful	Large	Randomized	18/28	NS
Happy/fearful	Small	Blocked	37/58	<0.05
Happy/fearful	Large	Blocked	37/58	< 0.05
Angry/sad	Small	Randomized	15/27	NS
Angry/sad	Small	Blocked	39/54	< 0.01
Angry/fearful	Small	Randomized	15/27	NS
Angry/fearful	Small	Blocked	37/56	< 0.05



CONCLUSIONS

Research question: Behavioural and neuronal data show that a blindsight patient can successfully discriminate emotional facial expressions without visual awareness. **Theoretical:** Complex visual stimuli, such as emotional face expressions, can elicit activation in the ventral visual processing stream by bypassing primary visual areas. Instead, direct anatomical routes from the retina reaching extrastriate areas are recruited, most likely through the pulvinar/collicular-pulvinar pathway.

NOVELTY

This is the first study showing non-conscious perception of emotional stimuli.

De Gelder, B., Vroomen, J., Pourtois, G., & Weiskrantz, L. (1999). Non-conscious recognition of affect in the absence of striate cortex. *Neuroreport*, *10*(18), 3759-3763.

Paradoxical configuration effects for faces and objects in prosopagnosia

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BACKGROUND

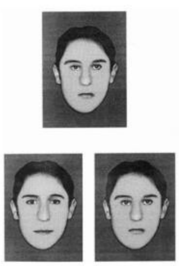
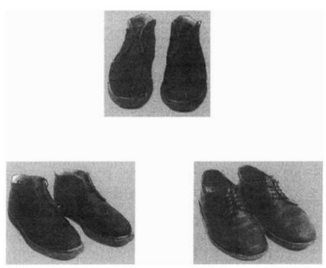
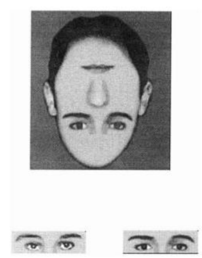
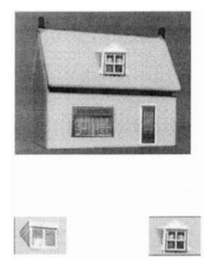
There are two contrasting views on the neural substrate of prosopagnosia – a deficit in the object recognition pathway versus damage to a module dedicated to face processing. A common argument in favour of face modularity is *the inversion inferiority effect*, i.e., a decrease in recognition performance for inverted compared to upright faces. Interestingly, in prosopagnosic patients, the inversion effect is either absent or exhibits an opposite outcome with increased recognition performance for inverted faces. Nonetheless, the lack of appropriate control conditions, including objects with canonical orientations, limits possible conclusions from previous studies regarding the two contrasting theories. Therefore, this study aims to tackle this debate in a patient LH with prosopagnosia.

RESEARCH QUESTIONS

Will a prosopagnosiac patient LH exhibit superior recognition performance for inverted compared to upright faces, but not objects?

Will the prosopagnosic patient LH display impaired performance in a part-to-whole matching task with both faces and objects or faces only?

STIMULI

RESULTS

Table 1
Number (percentage) correct responses on faces and shoes in simultaneous presentation

	Upright	Inverted
Faces	36/80 (45%)	65/80 (81%)
Shoes	31/64 (48%)	51/64 (80%)

Table 3
Number (percentage) correct responses on houses in simultaneous and delayed presentation

	Upright	Inverted
Simultaneous	44/64 (69%)	62/64 (97%)
Delayed	30/64 (47%)	59/64 (92%)

LH's identification performance was significantly better with inverted stimuli than with upright ones for faces as well as for shoes in both the wholes (left table) and part-to-whole (right table) matching tasks.

CONCLUSIONS

Research questions: LH exhibited an *inversion superiority* and *context inferiority effect* for both faces and shoes. Theoretical: These findings question the existence of a face module, since the inversion superiority effect is found for both faces and objects. Moreover, the context inferiority effect, i.e., superior performance for matching stimulus parts of inverted compared to upright objects, emphasizes the sensitivity towards context in prosopagnosia.

NOVELTY

The first study to show that the inversion superiority effect for faces extends to objects. Moreover, whole stimulus context seems to impair object recognition in a prosopagnosiac patient.

de Gelder, B., & Rouw, R. (2000). Paradoxical configuration effects for faces and objects in prosopagnosia. *Neuropsychologia*, *38*(9), 1271-1279.

Hemispheric Asymmetries for Whole-Based and Part-Based Face Processing in the Human Fusiform Gyrus

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[1] Université Catholique de Louvain, [2] Tilburg University

BACKGROUND

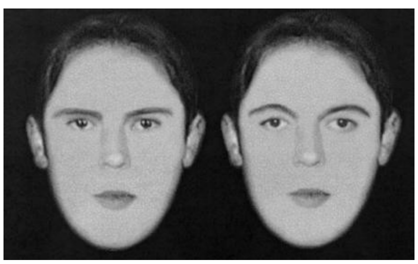
Insights from neuroimaging studies provide evidence for regions specialized in face processing. Nonetheless, studies have yielded inconclusive results about possible hemisphere specificity for whole-face processing versus facial-feature processing. One possibility is that this debate has not been settled because facial processing has been prevalently studied using passive paradigms and facial recognition tasks. To test this hypothesis, this study combined an active task requiring individual facial features analysis with a task warranting whole- face processing.

RESEARCH QUESTIONS

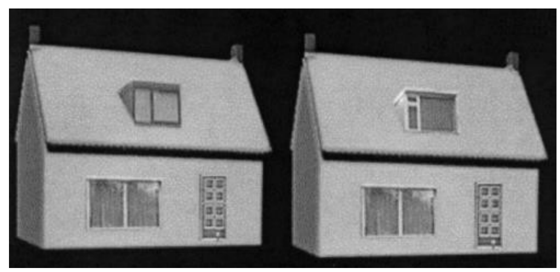
1. What role does the middle fusiform gyrus play in face-specific processing?

2. Is the right fusiform gyrus more involved in face processing when the faces as processed as a whole compared to processing face parts?

STIMULI



Images of faces, houses and objects



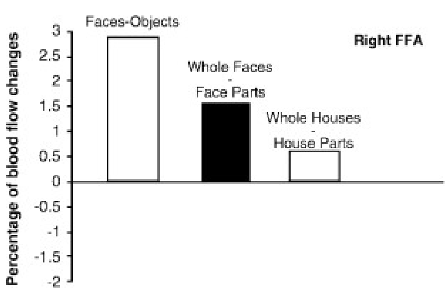
RESULTS

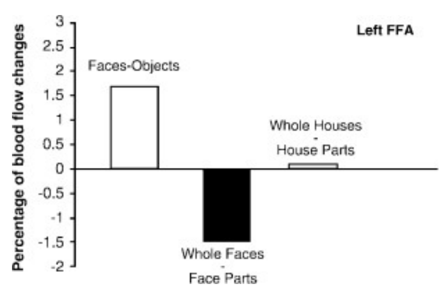
Right FFA

Whole faces

>

Face parts





Left FFA

Face parts

>

Whole face

CONCLUSIONS

Research question: Bilateral fusiform areas have shown selectivity for faces, with stronger activation in the right fusiform gyrus. Although the right fusiform gyrus displayed higher activation for whole-face processing, the left homologous area exhibited an activation advantage for facial-feature processing. Theoretical: These findings have important implications for understanding face processing in humans. Specifically, this study sheds light on the frequently neglected nature of activity in the left fusiform gyrus, i.e., its involvement in face-feature processing.

NOVELTY

This is the first study to show functional specificity of the left (face-part processing) and right hemisphere

Rossion, B., Dricot, L., Devolder, A., Bodart, J. M., Crommelinck, M., De Gelder, B., & Zoontjes, R. (2000). Hemispheric asymmetries for whole-based and part-based face processing in the human fusiform gyrus. Journal of cognitive neuroscience, 12(5), 793-802.

A modulatory role for facial expressions in prosopagnosia

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BACKGROUND

Prosopagnosia is a condition in which damage to the temporo-occipital, i.e., fusiform, cortex, leads to impairments in facial recognition. The underlying principle of this condition has been related to impairment of the configural processing abilities, i.e., the inability to perceive faces as a whole, but merely as individual parts. Yet, this viewpoint has been recently challenged by findings reporting improvement in recognizing identities from faces in the presence of emotional expressions, suggesting a possible modulatory role for the latter. Therefore, the aim of this study was to find evidence for a modulatory role of facial expressions in facial processing of prosopagnosic patients.

RESEARCH QUESTIONS

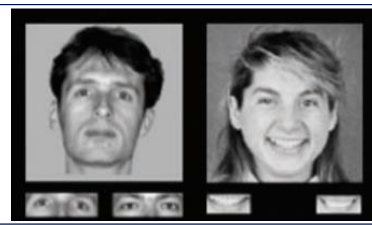
Does the presence of emotional expressions improve facial recognition in prosopagnosia?

Will remaining brain areas of the face-processing network, aside of the damaged fusiform cortex, be activated by the facial-expression condition and thus, provide an explanation for the behaviourally observed performance facilitation?

STIMULI

Grayscale images

Neutral, happy, angry facial expressions

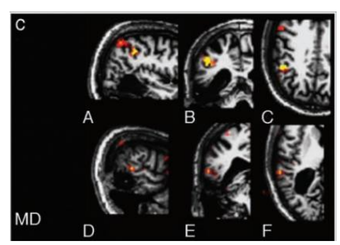


RESULTS

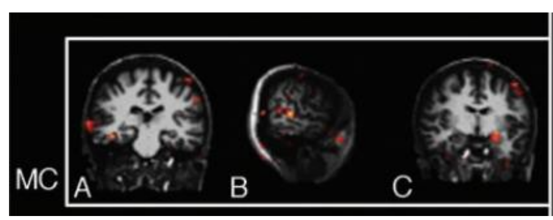
Table 3. Experiment 3: Accuracy and reaction times on the Part to Whole matching task

	Accuracy, % correct				Reaction times, ms							
	Neutral		Expression		Neutral				Expression			
Patients	Upright	Inverted	Upright	Inverted	Upright	Inverted	Inv–up	P	Upright	Inverted	Inv–up	P
Control	96 ± 3.6	94 ± 4.7	93 ± 3.8	94 ± 5.7	1,583	1,704	+	0.00	1,772	1,999	+	0.00
FJ	100	100	97	97	3,603	2,822	−	0.02	2,998	4,105	+	0.02
GA	91	84	94	94	5,510	5,706	0	0.41	4,388	6,085	+	0.04
KC	83	91	97	88	3,246	3,989	+	0.00	3,829	4,611	+	0.02
MD	86	83	94	84	7,516	6,722	−	0.04	6,812	6,365	0	0.22
MK	88	97	91	88	2,819	2,775	0	0.39	1,847	2,498	+	0.00
RB	89	92	97	97	6,821	8,460	+	0.00	5,973	7,254	+	0.01
RG	75	69	84	78	9,626	7,212	−	0.00	6,841	8,650	+	0.03

A "+" in the "Inv–up" (inverted–upright) column indicates normal inversion/context effect, "−" indicates a paradoxical effect, and "0" indicates no difference (P values are for one-tailed t tests).



Prosopagnosic patients, e.g., MD, with damage to the fusiform cortex still show activation in the wider face processing network, i.e., the right fusiform gyrus, right superior temporal sulcus, the amygdala, orbitofrontal gyrus, when exposed to emotionally expressive faces. MC – healthy control



CONCLUSIONS

Research question: The presence of emotional expressions in a face recognition task leads to a normalisation of the inversion effect in prosopagnosics. A wider face recognition compensatory brain network is activated in this population when exposed to emotionally expressive compared to neutral faces. Theoretical: Thee presence of facial expressions can enhance face identification in prosopagnosia, which presents important implications for diagnostic test batteries which generally use neutral faces.

NOVELTY

Performance on face recognition tasks can be improved in prosopagnosia by introducing a stimulus dimension, i.e., facial expression, that is not necessarily relevant for task performance.

de Gelder, B., Frissen, I., Barton, J., & Hadjikhani, N. (2003). A modulatory role for facial expressions in prosopagnosia. *Proceedings of the National Academy of Sciences*, *100*(22), 13105-13110.

Seeing fearful body expressions activates the fusiform cortex and amygdala

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BACKGROUND

For a long time, the fusiform cortex and amygdala have been implicated in emotional processing of faces only. Yet, studies investigating biological motion, such as dance-like movements, have reported amygdala and fusiform cortex activations, thereby arguing in favour of the aforementioned areas not being restricted to processing emotional faces. Therefore, this study employed Functional magnetic resonance imaging (fMRI) to explore the brain's response to whole-body expressions of emotions, specifically fear.

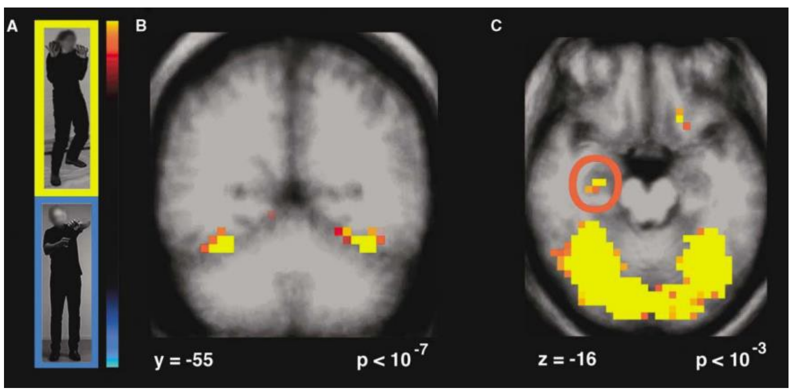
RESEARCH QUESTION

Do the fusiform cortex and amygdala respond to whole-body emotional expressions?

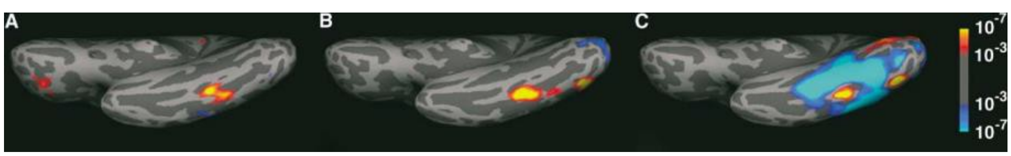
STIMULI

Grayscale images of whole-body **fear** expressions vs meaningful **non-emotional** body expressions

RESULTS



A) Example stimuli, yellow = fearful body expression, blue = neutral, i.e., pouring liquid into container. Frame color corresponds to coding on the brain activation map. **B, C)** Activation associated with fearful compared with neutral bodies. Activation (yellow) can be seen for the fearful bodies in the fusiform face area (FFA) **B)** and in the right amygdala (circled in red, **C)**.



Panels show FFA activation in three different conditions. **A)** Activation to body expression of fear, **B)** FFA face localizer activation, **C)** Comparison between faces (yellow) and objects (blue). Threshold used ($p < 0.001$, uncorrected).

CONCLUSIONS

Research question: Whole-body emotional expressions activated within the right amygdala and FFA. Theoretical: Results show that the amygdala and FFA play a larger role in emotion recognition than it has been argued before. Moreover, it opens a new revenue of research in clinical populations with affected facial expression processing, that could be targeted at emotion recognition from whole-body expressions.

NOVELTY

This is the first study to show that the amygdala and FFA are activated by whole-body emotional expressions.

Hadjikhani, N., & de Gelder, B. (2003). Seeing fearful body expressions activates the fusiform cortex and amygdala. *Current biology*, *13*(24), 2201-2205.

Fear fosters flight: A mechanism for fear contagion when perceiving emotion expressed by a whole body

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*Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, First Street Building 36, Charlestown, †Cognitive and Affective Neurosciences Laboratory, Tilburg University, Tilburg, The Netherlands

BACKGROUND

The majority of our knowledge on emotion processing in the brain comes from studies using still images expressing different emotions. More importantly, studies investigating emotion processing using whole-body expressions of emotion are lacking. Likewise, the relationship between emotional body expressions and the action system is still unknown. Furthermore, although evidence in favour of cortical speacialisation for face and body processing has been found, similarity between facial and body processing systems has been reported as well. Therefore, this study employed Functional magnetic resonance imaging (fMRI) to investigate whole-body emotional expressions.

RESEARCH QUESTION

Does viewing whole-body emotional expressions activate brain areas related to emotion and action processing?

STIMULI

Still images of happy and fearful whole-body movements vs. images of neutral meaningful whole-body movements

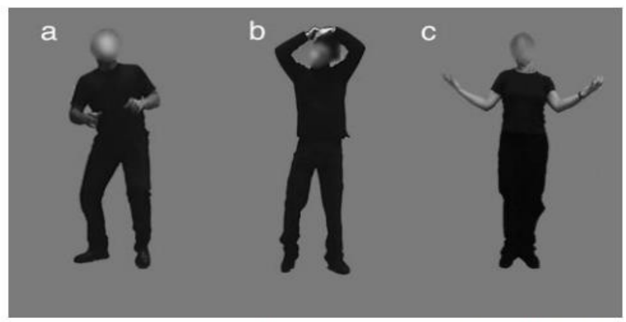

Fig. 4. Examples of stimuli used in this experiment. (*a*) Fearful. (*b*) Neutral. (*c*) Happy.

RESULTS

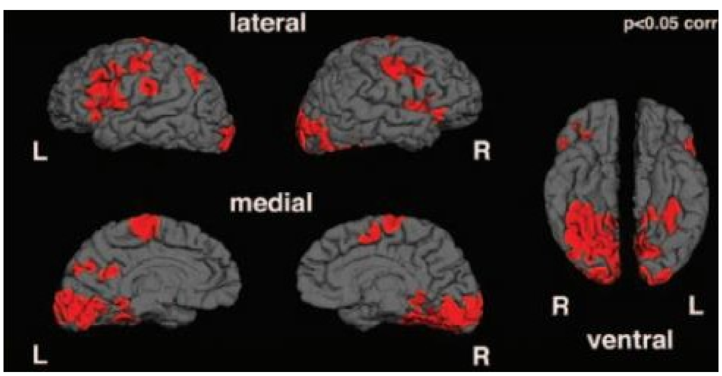

Figure. Areas of activation corresponding to viewing body expression of fear vs. neutrality are represented on the cortical surface. L, left; R, right

Viewing fearful whole-body expressions produces higher activity in areas specifically known to process emotional information (amygdala, orbitofrontal cortex, posterior cingulate, anterior insula, retrospenial cortex, and nucleus accumbens) than viewing images of meaningful but emotionally neutral body actions.

CONCLUSIONS

Research question: Images of whole-body expressions of emotions elicit activation in brain areas related to emotion and action preparation processing. Theoretical: Whole-body emotion expressions elicit activity in brain areas traditionally implicated in emotional processing od faces, such as the amygdala, and the action system, e.g. the SMA and precentral gyrus. The finding possibly reflects a fear contagion and action preparation mechanism.

NOVELTY

This is the first study to show that whole-body expressions of fear activate the amygdala and areas involved in action and motor preparation.

De Gelder, B., Snyder, J., Greve, D., Gerard, G., & Hadjikhani, N. (2004). Fear fosters flight: a mechanism for fear contagion when perceiving emotion expressed by a whole body. *Proceedings of the National Academy of Sciences*, *101*(47), 16701-16706.

The neural correlates of perceiving human bodies: an ERP study on the body-inversion effect

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BACKGROUND

Although the importance of the body expressions has been emphasized before in emotion literature, the majority of research so far has focused on investigating emotional facial expressions and identifying face-specific, e.g. configural, processing routines. These types of routines rely on processing the overall stimulus configuration consisting of individual fragments, e, g., facial, parts. Conversely, objects are believed not to be processed holistically, but recognized as isolated parts. Considering that the strongest evidence in favour of configural processing of faces stems from the inversion effect, i.e., findings of impaired facial recognition and larger N170 components for inverted stimuli, the aim of the current study was to replicate these findings using whole body emotional stimuli.

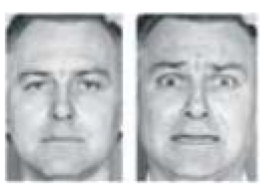
RESEARCH QUESTONS

Will inverted compared to upright whole-body stimuli result in a larger N170 component?

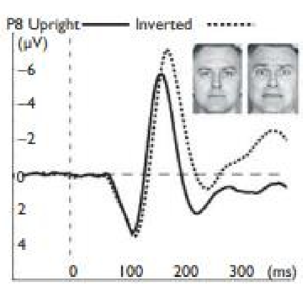
Will the N170 component reflect the difference between emotional vs. neutral whole-body expressions?

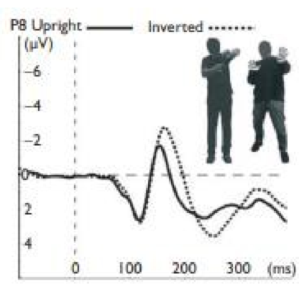
STIMULI

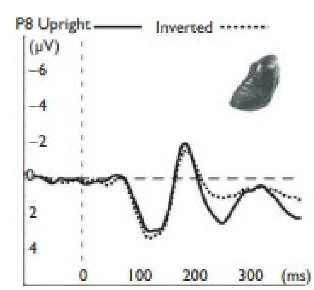
Fear vs. neutral



RESULTS







CONCLUSIONS

Research questions: The inversion effect has been found for both faces and bodies. Moreover, the N170 component was show to reflect differences between emotional vs. neutral expressions for faces only. Theoretical: Despite finding a larger N170 amplitude for faces, there is insufficient evidence for facial specificity. Namely, both bodies and faces exhibited the inversion effect and a similar N170 topography, which speaks in favour of similarity between facial and whole-body processing routines.

NOVELTY

This is the first electrophysiological study to provide evidence for processing similarity between faces and bodies.

Stekelenburg, J. J., & de Gelder, B. (2004). The neural correlates of perceiving human bodies: an ERP study on the body-inversion effect. *Neuroreport*, *15*(5), 777-780.

Unconscious fear influences emotional awareness of faces and voices

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BACKGROUND

Certain emotional facial expressions can be processed without visual awareness, with fear being the most frequently reported emotion. Moreover, differences in brain activity for consciously vs. non-consciously perceived fear have been reported in healthy controls, suggesting a differentiation of emotional processing streams for conscious and unconscious perception. Importantly, this raises a possibility that the brain simultaneously operates in two modes of affective processing, i.e., conscious and nonconscious. Therefore, the aim of this study was to investigate interactions between consciously and unconsciously perceived emotional stimuli in a hemianopic, blindsighted patient who lacks visual awareness in one visual hemifield due to a unilateral visual cortex lesion.

RESEARCH QUESTIONS

1. Do unseen emotional facial expressions influence the processing of seen facial expressions?

2. Do unseen emotional expressions influence emotion processing from voices?

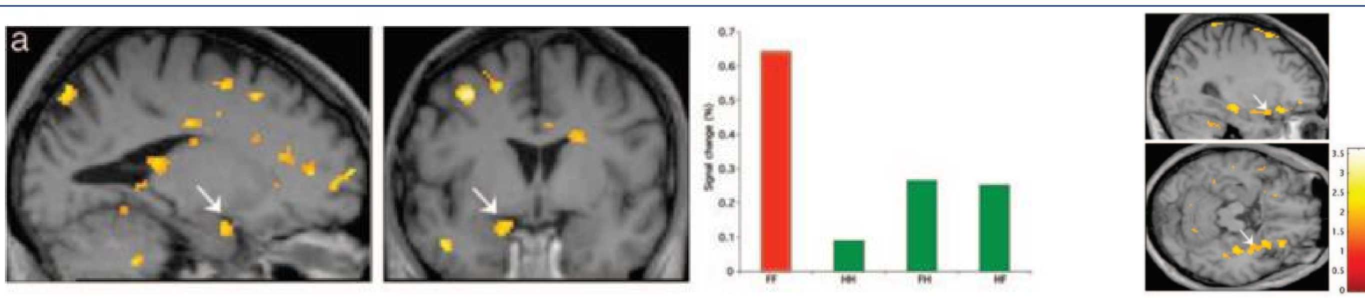
3. Is affective blindsight face specific?

STIMULI

Grayscale images of full or half faces portraying *happiness* or *fear*

Happy or *fearful* voices

RESULTS



(Left and Middle) Enhanced amygdala activation for fear congruent conditions; (Far right) Fear congruent face/voice conditions in the blind hemifield result in enhanced right amygdala activation

CONCLUSIONS

Research questions: Unseen fearful facial expressions resulted in increased activity in the amygdala during fear congruent conditions. Theoretical: Results show robust amygdala activation for unconsciously perceived fearful stimuli, which is persistent regardless of the presence of incongruent consciously perceived facial or voice stimuli of a different emotional category. Likewise, fear congruent conditions for simultaneous face/voice presentation resulted in increased right amygdala activation. Finally, there is moderate evidence in favour of face specificity for affective blindsight.

NOVELTY

The paper provides evidence for two distinct processing streams for affective processing, i.e., a conscious and non-conscious pathway.

De Gelder, B., Morris, J. S., & Dolan, R. J. (2005). Unconscious fear influences emotional awareness of faces and voices. *Proceedings of the National Academy of Sciences*, *102*(51), 18682-18687.

Context Influences Early Perceptual Analysis of Faces—An Electrophysiological Study

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BACKGROUND

Despite a large amount of literature investigating facial processing in the last decades, the majority of studies focused on facial encoding in neutral surrounding contexts. Numerous studies have reported decreased N400 components for conditions in which objects are embedded within highly expected contexts (congruent object-context compounds). Yet, the influence of the surrounding context on facial processing is yet to be studied. Therefore, the aim of this study was to explore the contribution of fearful versus neutral scene contexts towards the processing of fearful and neutral facial expressions by employing electrophysiological methods.

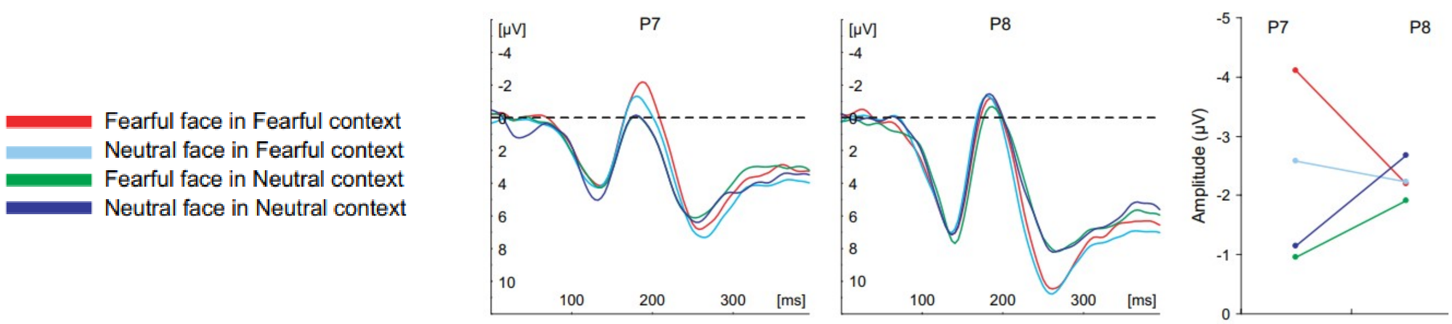
RESEARCH QUESTION

Do congruent *facial expression - context conditions* increase the amplitude of ERP components (i.e., P1 and N170) related to processing of facial expressions?

STIMULI

Fearful vs. neutral faces and contexts

RESULTS



An enhanced N170 amplitude negativity has been found for faces in fearful contexts, particularly for fearful faces on left occipito-temporal sites. P7 and P8 depict electrode sites.

CONCLUSIONS

Research question: N170 amplitudes are enhanced for faces in fearful contexts as compared with faces in neutral contexts. This effect is only significant for left hemisphere electrodes. Theoretical: The N170 component, associated with face processing, seems to be sensitive to the presence of context information, which leads to a reduced amplitude in comparison with isolated faces. Moreover, the N170 is susceptible to the emotional information the context provides, since the N170 displayed an increased negativity for fearful faces in fearful compared to neutral contexts.

NOVELTY

This is the first study to show that context surrounding facial expressions modulates face processing in the brain.

Righart, R., & De Gelder, B. (2006). Context influences early perceptual analysis of faces—an electrophysiological study. *Cerebral Cortex*, *16*(9), 1249-1257.

Intact navigation skills after bilateral loss of striate cortex

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[1]Cognitive and Affective Neuroscience Laboratory, Tilburg University, The Netherlands; [2]Martinos Center for Biomedical Imaging, Charlestown, USA; [3]Department of Psychology, University of Torino, Italy; [4]Institute for Scientific Interchange (ISI) Foundation, Torino, Italy; [5]Department of Neurocognition, Faculty of Psychology, University of Maastricht, The Netherlands; [6]Vision Research Laboratories, School of Psychology, University of Aberdeen, Scotland; [7]Department of Experimental Psychology, University of Oxford, UK; [8]Laboratory of Experimental Neuropsychology, Neuropsychology Unit and Department of Neurology, Geneva University Hospitals, Switzerland

BACKGROUND

Lesions to the striate cortex are known to cause blindness. Moreover, blindsight in the absence of early visual cortices has been reported in the literature. Traditional paradigms investigating residual visual skills focus on perceptual tasks in absence of visual awareness. However, other cognitive skills that require involvement of the visual cortex are not investigated. Therefore, this study focused on investigating complex navigational skills in patient TN with bilateral striate cortex lesions.

RESEARCH QUESTION

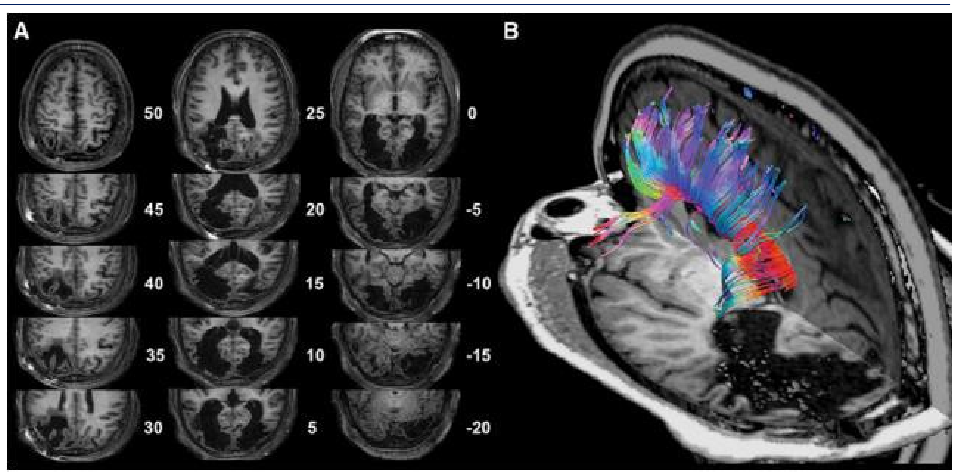
Does a clinically blind patient due to damage to the striate cortex have preserved navigation skills?

TASK

The participant was instructed to navigate without assistance down a long corridor in which physical barriers (e.g. boxes and chairs) have been placed.

RESULTS

A) T1-weighted anatomical scans of patient TN show bilateral damage to striate cortex. No active visual cortex has been identified following exposure to visual stimuli or retinotopic mapping during neuroimaging procedures. **B)** Diffusion tensor imaging shows severe destruction of posterior corpus callosum fibres connecting the left and right early visual cortices in patient TN. **Behavioural:** Despite the many placed physical obstacles along the corridor and navigating the hallway without any assistance in form of a stick or personal assistant, TN never collided with any of the obstacles.



CONCLUSIONS

Research question: A clinically blind patient with bilateral striate cortex damage successfully navigated a corridor with physical obstacles. Theoretical: These findings suggest that a cortically blind patient, blind to the full visual field and without residual visual function, has preserved navigational skills. This suggests that navigational skills are intact even in absence of geniculo-striate pathways.

NOVELTY

This is the first study to demonstrate intact navigation skills following bilateral damage to early visual cortex.

De Gelder, B., Tamietto, M., Van Boxtel, G., Goebel, R., Sahraie, A., Van den Stock, J., ... & Pegna, A. (2008). Intact navigation skills after bilateral loss of striate cortex. *Current biology*, *18*(24), R1128-R1129.

Recognizing emotions expressed by body pose: A biologically inspired neural model

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[a] BIWI, Eidgenössische Technische Hochschule, Zürich, Switzerland; [b] VISICS, Katholieke Universiteit Leuven, Belgium; [c] Cognitive and Affective Neurosciences Lab, Tilburg University, Netherlands

BACKGROUND

The majority of research in affective neuroscience has focused on emotive facial expressions. However, evidence suggests that, similarly to faces, whole-body expressions can be categorized into fundamental emotional categories. Despite abundant efforts of creating well-rounded computational models of human vision, hardly any approaches have focused on constructing an ecological model that can distinguish between fundamental emotional categories from images of emotional body language. Therefore, we have trained a computational model on static images of emotional whole-body poses to discriminate between the seven basic emotional categories (anger, fear, sadness, disgust, surprise, happiness, neutral) and evaluated the model on a different set of body pose images.

RESEARCH QUESTION

Can a computational model trained to discriminate emotions from body poses successfully classify an independent set of emotional whole-body expressions?

STIMULI

RESULTS

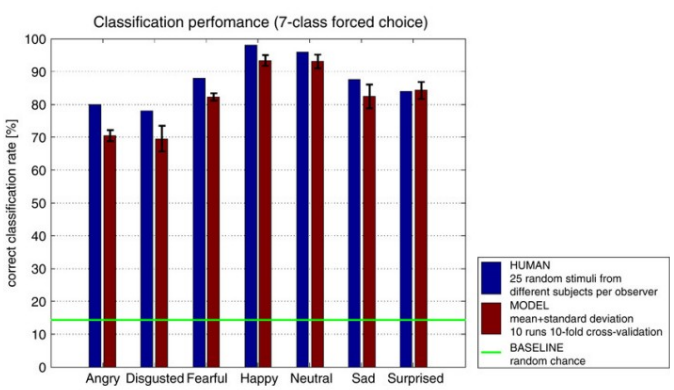

Fig. 5. Classification performance of the model compared to human subjects.

The model accurately classified 94% of the images relative to human performance. Moreover, it predicted well which categories are ‘‘easy’’ ad which are ‘‘difficult’’ to recognize, and confuses the same pairs (e.g. disgusted and fearful) as humans do.

CONCLUSIONS

Research: The model has demonstrated superior classification of human whole-body emotional expressions. Theoretical: These findings suggest that 3D processing and motion may not necessary for accurate classification of emotional body poses.

NOVELTY

This computational model is one of the first ones successfully trained to accurately classify whole-body emotional stimuli.

Schindler, K., Van Gool, L., & De Gelder, B. (2008). Recognizing emotions expressed by body pose: A biologically inspired neural model. *Neural networks*, *21*(9), 1238-1246.

Orienting to threat: faster localization of fearful facial expressions and body postures revealed by saccadic eye movements

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[1]Vision Research Laboratories, School of Psychology, University of Aberdeen, UK; [2]Cognitive and Affective Neurosciences Laboratory, Tilburg University, The Netherlands

BACKGROUND

Numerous studies have reported more efficient attentional orientation towards threat-related facial cues, e.g., expressions of fear or anger. However, the majority of studies employed manual responses as a measure of orienting towards threat, despite eye movements being a more naturalistic indicator of attentional orientation. Moreover, studies investigating localization of threat-related whole-body expressions are scarce. Therefore, this study aimed at investigating threat orientation towards fearful body expressions using hand- and saccadic-based measurements of visual attention orientation.

RESEARCH QUESTION

Is processing of threat-related facial and whole-body expressions facilitated compared to processing neutral stimuli?

STIMULI

RESULTS

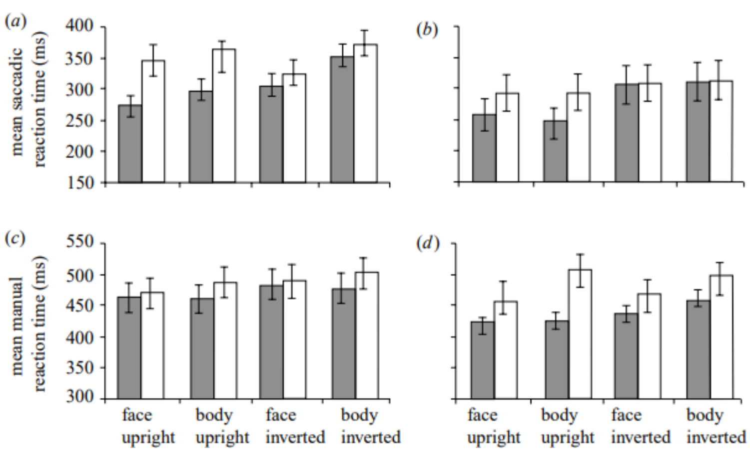

Figure shows average saccadic ((a) 20 ms and (b) 500 ms) and manual ((c) 20 ms and (d) 500 ms) reaction times. Grey and white bars represent fearful and neutral targets, respectively.

Compared to neutral targets, saccades towards fearful faces and bodies are faster when stimuli are presented for 20 ms. Interestingly, the effect is reversed for manual responses with manual reaction times being faster for fearful stimuli at 500 ms stimulus presentation rates.

CONCLUSIONS

Research question: Compared to neutral, orientation to threatening stimuli is enhanced for both facial and body stimuli. Theoretical: Attentional orientation towards threatening stimuli seems similar for both faces and bodies, meaning that threat signals from whole-body expressions can help guide survival responses.

NOVELTY

The demonstrates that threat related information can be successfully detected from body postures even in absence of information from facial expressions.

Bannerman, R. L., Milders, M., De Gelder, B., & Sahraie, A. (2009). Orienting to threat: faster localization of fearful facial expressions and body postures revealed by saccadic eye movements. *Proceedings of the Royal Society B: Biological Sciences*, *276*(1662), 1635-1641.

Unseen facial and bodily expressions trigger fast emotional reactions

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[a]Cognitive and Affective Neuroscience Laboratory, Tilburg University, The Netherlands; [b]Department of Psychology, University of Torino, Italy; [c]Institute for Scientific Interchange (ISI) Foundation, Italy; [d]Department of Neuroscience, University of Torino, , Italy; [e]Centro Ricerche in Neuroscienze (Ce.R.Ne.), Fondazione Carlo Molo, Italy; [f]Department of Experimental Psychology, University of Oxford, United Kingdom; [g]Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, MA

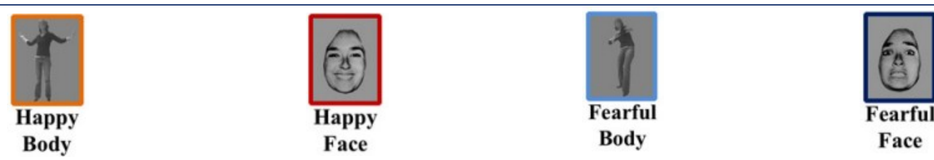
BACKGROUND

Emotional contagion corresponds to spontaneous synchronisation of facial expressions between humans in person-to-person interactions and is believed to be an important building block of human communication. Yet, its underlying mechanism remains unknown. Motor resonance theories suggest emotional contagion arises from spontaneous motor imitation of observed actions, i.e., emotional facial expressions. Alternatively, emotional contagion is defined as a response to a perceived emotional expression. Consequently, the observed emotion is induced in the observer himself. To reconcile the two theories, this study measured facial muscle responses in two patients with early visual cortex damage during conscious and unconscious vision of facial and whole-body emotional expressions.

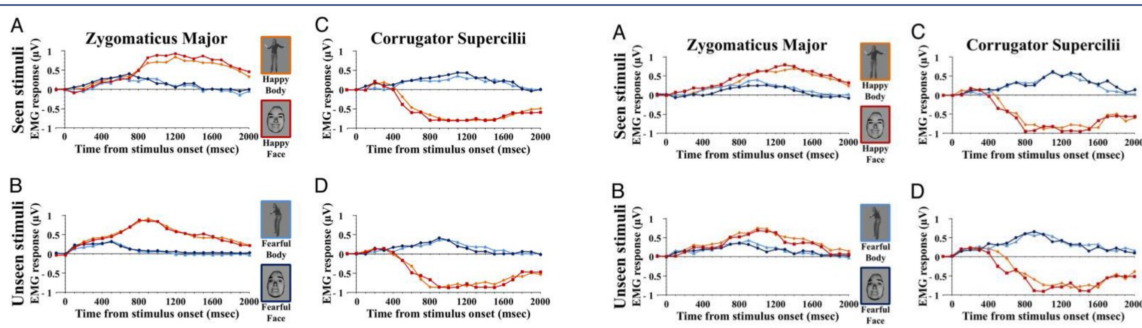
RESEARCH QUESTIONS

1. Does emotional contagion take place when emotional expressions are not consciously perceived?
2. Is emotional contagion a consequence of motor imitation or observation-induced emotional states?

STIMULI



RESULTS



EMG responses in patient DB (left) and GY (right).

(A) Mean responses in the ZM for seen stimuli. (B) Mean responses in the ZM for unseen stimuli. (C) Mean responses in the CS for seen stimuli. (D) Mean responses in the CS for unseen stimuli. EMG responses are comparable for the same emotional categories, regardless of whether the emotions are expressed via visually highly differing stimuli, i.e., faces or bodies, or whether the stimuli are consciously perceived or not.

CONCLUSIONS

Research question: Emotional contagion takes place even in absence of conscious perception. Moreover, EMG responses are comparable within emotional category, regardless of whether emotions are expressed via faces or bodies. Theoretical: The findings suggest that emotional contagion is driven by an affective response towards the observed emotional expression, rather than motor mimicry.

NOVELTY

This study is one of the first to demonstrate that humans do not simply mimic observed emotional expressions, but that emotional contagion is likely are a result of observation-induced emotional states within the observer.

Tamietto, M., Castelli, L., Vighetti, S., Perozzo, P., Geminiani, G., Weiskrantz, L., & de Gelder, B. (2009). Unseen facial and bodily expressions trigger fast emotional reactions. *Proceedings of the National Academy of Sciences*, *106*(42), 17661-17666.

The bodily expressive action stimulus test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions

Beatrice de Gelder[1,2,3] and Jan Van den Stock[1,2]

[1] Laboratory for Cognitive and Affective Neuroscience, Tilburg University, Netherlands; [2] Brain and Emotion Laboratory Leuven, Department of Neurosciences, Katholieke Universiteit Leuven, Belgium; [3] Martinos Center for Biomedical Imaging, Massachusetts General Hospital and Harvard Medical School, Boston, USA

BACKGROUND

Despite a long history of emotion research, a comprehensive database of emotional whole-body expressions for wide use is still missing. Therefore, the aim of this study is to provide validation data for an image stimulus set of emotional body postures to be used in neuroscientific research.

RESEARCH QUESTION

Can stimuli showing emotional whole body expressions be successfully categorized?

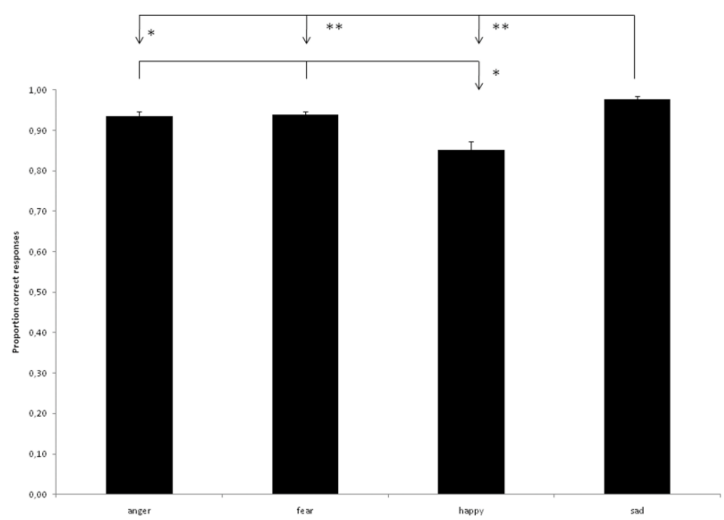
STIMULI

Stimuli showing female (left) and male (right) actors. The expressions display (from left to right): anger, fear, happiness, sadness.

RESULTS

Proportion correct categorizations according to bodily expression

Sadness is the easiest to recognize, followed by fear, whereas happiness was the most difficult



CONCLUSION

Research question: The results show that all emotions are well recognized, with sadness being the easiest, followed by fear, whereas happiness was the most difficult. Theoretical: The BEAST is a valuable addition to currently available tools for assessing recognition of emotional signals.

NOVELTY

This is the first comprehensive and validated stimulus set of emotional whole-body expression images.

De Gelder, B., & Van den Stock, J. (2011). The bodily expressive action stimulus test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions. *Frontiers in psychology*, *2*, 181.

The neural basis of the bystander effect — The influence of group size on neural activity when witnessing an emergency

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BACKGROUND

The gruesome murder of Kitty Genovese encouraged abundant research of the bystander effect – the reduced probability of an individual helping a person in need as the number of spectators increases. Numerous attempts to explain this human behavior have been made. For instance, social scientists have proposed diffusion of responsibility or simply citizen apathy as explanations. Yet, studies investigating the underlying neural correlates of this social phenomenon are still missing. Therefore, the aim of this study was to determine whether the number of bystanders influences brain activity in action preparation areas while participants witness an emergency.

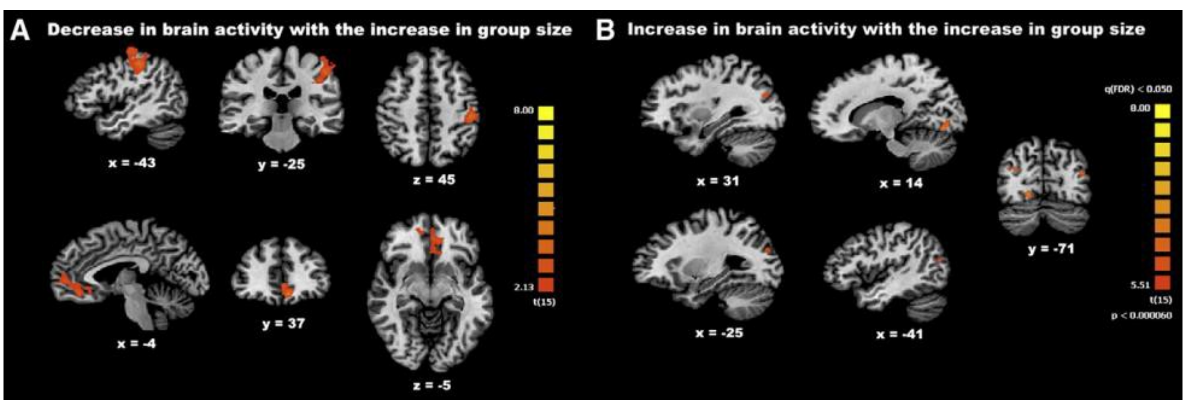
RESEARCH QUESTION

Will an increase in bystander group size decrease activity in brain areas involved in action preparation?

STIMULI

A video of a **woman fainting** with varying numbers of bystanders (0-4) passing by

RESULTS



CONCLUSION

Research question: The left precentral and postcentral gyri and the left medial frontal gyrus showed a decrease in activity with the increase in group size, indicating a reduction in motor preparation. In contrast, regions involved in visual processing and attention showed an increase in activity with increasing group sizes. Theoretical: Group size during an emergency already influences activity in brain regions sustaining preparation for action.

NOVELTY

This is the first study investigating the neural underpinnings of the bystander effect.

Hortensius, R., & de Gelder, B. (2014). The neural basis of the bystander effect—The influence of group size on neural activity when witnessing an emergency. *Neuroimage*, *93*, 53-58.

The Body Action Coding System I: Muscle activations during the perception and expression of emotion

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[1]Department of Medical and Clinical Psychology, Tilburg School of Social and Behavioral Sciences, Tilburg University, the Netherlands; [2]Department of Cognitive Neuropsychology, Tilburg School of Social and Behavioral Sciences, Tilburg University, the Netherlands; [3]Department of Psychology and Neuroscience, Maastricht University, the Netherlands

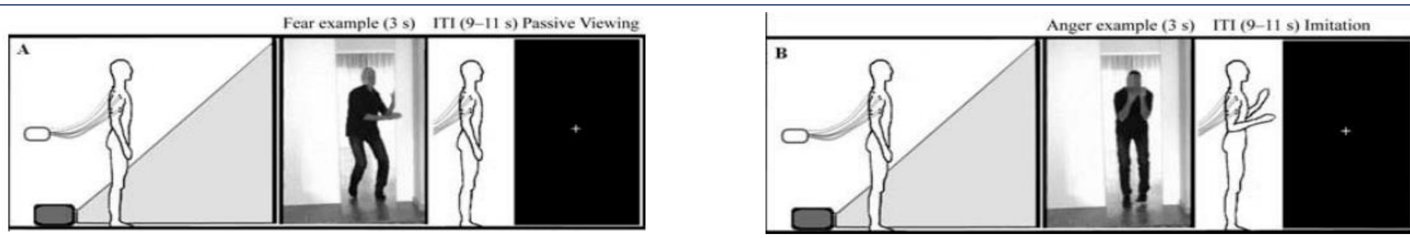
BACKGROUND

Plenty of studies have investigated emotion perception from bodies. Yet, research on muscle activation patterns during perception or performance of whole-body emotional expressions has not been explored so far. Using electromyography (EMG), this study determined which arm and shoulder muscles are activated while viewing or performing angry vs. fearful body postures.

RESEARCH QUESTION

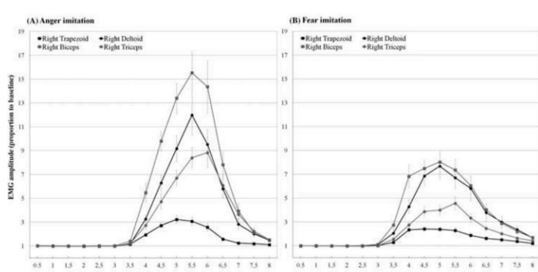
Which arm and shoulder muscles will be activate during passive exposure and imitation of angry and fearful whole-body expressions?

STIMULI

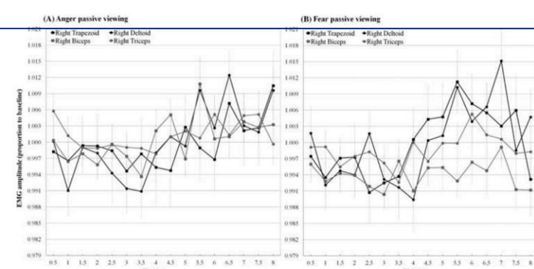


Life size videos of **angry** and **fearful** body expressions

RESULTS



(Left) EMG amplitudes during active anger and fear imitation on the left and right, respectively. (Right) EMG amplitudes and during anger and fear passive viewing on the left and right, respectively.



CONCLUSION

Research question: The results show that the four measured muscles in the shoulders and arms are used in both angry and fearful bodily expressions. However, the extent to which the muscles are recruited show a different pattern across emotions. Muscles in the body also responded automatically to the observation of emotional bodily expressions. Theoretical: The study shows that anger and fear recruit the same body muscles, but to a different extent.

NOVELTY

This is the first study to investigate the underlying muscle activations while viewing or imitating emotional body expressions.

Huis in 't Veld, E. M., Van Boxtel, G. J., & de Gelder, B. (2014). The Body Action Coding System I: Muscle activations during the perception and expression of emotion. *Social neuroscience*, 9(3), 249-264.

The facial expressive action stimulus test. A test battery for the assessment of face memory, face and object perception, configuration processing, and facial expression recognition

Beatrice de Gelder [1, 2], Elisabeth M. J. Huis in 't Veld[1, 3] and Jan Van den Stock [4, 5]

[1] Department of Cognitive Neuroscience, Maastricht University, Netherlands, [2] Department of Psychiatry and Mental Health, University of Cape Town, South Africa, [3] Department of Medical and Clinical Psychology, Tilburg University, Netherlands, [4] Laboratory for Translational Neuropsychiatry, Department of Neurosciences, KU Leuven, Belgium, [5] Old Age Psychiatry, University Hospitals Leuven, Belgium

BACKGROUND

Many studies investigating face perception have been conducted so far. However, a comprehensive multi-task assessment of facial processing skills is still lacking. Therefore, the aim of this study was to develop and validate multiple tasks for assessing face processing (i.e., face memory, face and object perception, configuration processing and facial expression recognition) for general use in research and industry.

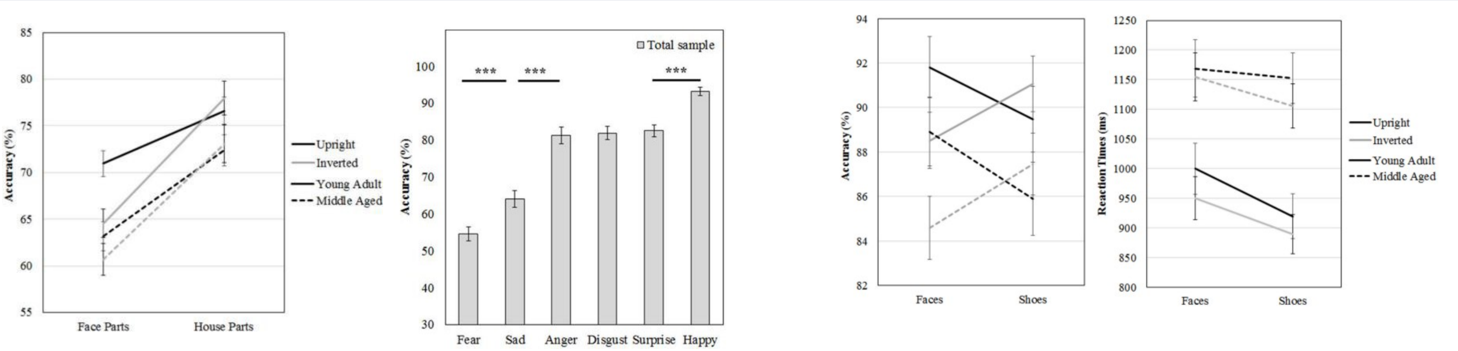
RESEARCH QUESTION

How do healthy controls perform on the FEAST tasks?

STIMULI

(From left to right) Face identity matching task, Face part-to-whole matching task, Facial expression matching task, Memory task – neutral

RESULTS



(From left to right) Results for the Face part-to-whole matching, Facial expression matching and Face identity matching tasks

CONCLUSION

Research question: Results show that upright face recognition is more accurate than inverted face recognition and that the face and house part to whole matching task is a more difficult task than the whole face and shoe matching task. Fear and sadness recognition on the FEM-H task was low, whereas anger, disgust, surprise and happiness were recognized with above 80% accuracy. Theoretical: The FEAST provides researchers with an extensive battery for face processing assessment.

NOVELTY

This is the first comprehensive test battery for assessing facial processing.

de Gelder, B., Huis in 't Veld, E. M., & Van den Stock, J. (2015). The facial expressive action stimulus test. A test battery for the assessment of face memory, face and object perception, configuration processing, and facial expression recognition. *Frontiers in Psychology*, *6*, 1609.

Body-selective areas in the visual cortex are less active in children than in adults

Paddy D. Ross[1], Beatrice de Gelder[2], Frances Crabbe[1] and Marie-Helene Grosbras[1]

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BACKGROUND

Like many other skills, nonverbal communication is refined throughout childhood to adulthood. Affective developmental neuroscience has focused on the development of face processing brain areas. However, it is likely that cortical areas involved in emotion processing from body expressions progress with age. Hence, this study aimed at comparing body selective brain regions between children (6-11 years old) and adults.

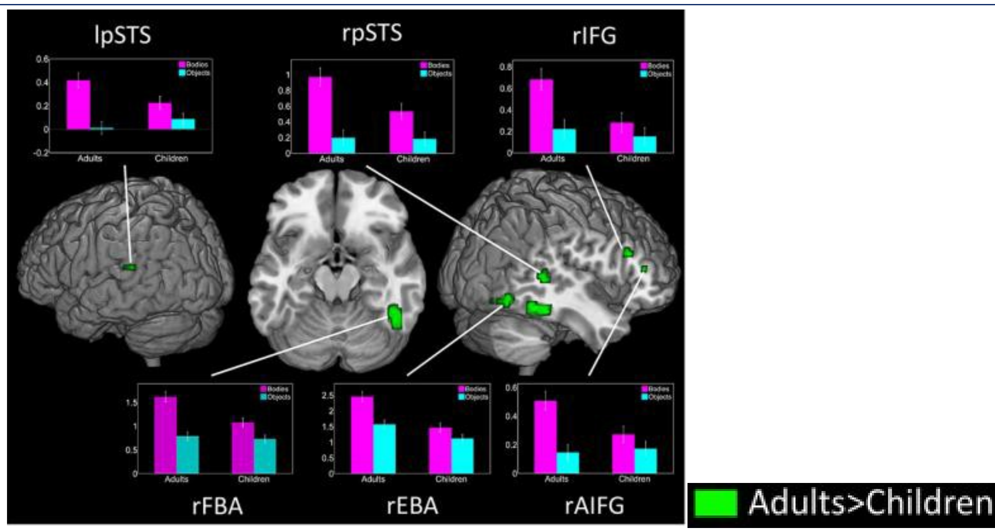
RESEARCH QUESTION

Is EBA, pSTS and FBA activity during body movement perception comparable between children and adults in terms of signal amplitude and spatial extent?

STIMULI

Videos of meaningful body and object movements

RESULTS



CONCLUSION

Research question: There was a right lateralisation of the body-selective regions, while the extent of activation became more right lateralised in adults. On average, activations were spatially overlapping between children and adults, however they were less strong in children. Theoretical: Similar body circuits are recruited in children and adults during passive body movement perception.

NOVELTY

This is the first study to comparing brain activity elicited by body movement perception in children to that of adults.

Ross, P. D., de Gelder, B., Crabbe, F., & Grosbras, M. H. (2014). Body-selective areas in the visual cortex are less active in children than in adults. *Frontiers in Human Neuroscience*, *8*, 941.

Visual imagery influences brain responses to visual stimulation in bilateral cortical blindness

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BACKGROUND

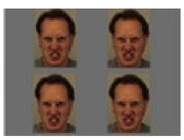
It has been long known that both vision and mental imagery activate the primary visual cortex (V1). This has led to the conclusion that V1 is necessary for visual mental imagery. However, recent case studies in patients with unilateral or bilateral V1-damage have demonstrated that mental imagery of certain stimulus categories, such as faces and houses, activates the corresponding category-specific areas in the ventral visual processing stream. In this present study, we aimed at settling this debate by investigating visual mental imagery in a patient with bilateral V1 damage which is, importantly, behaviorally supported by total clinical blindness.

RESEARCH QUESTION

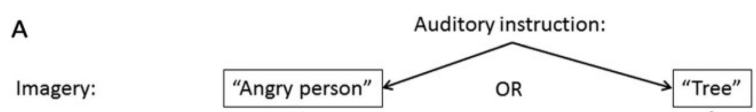
Will visual mental imagery in a patient with bilateral V1 destruction activate similar brain areas as those of healthy controls?

STIMULI

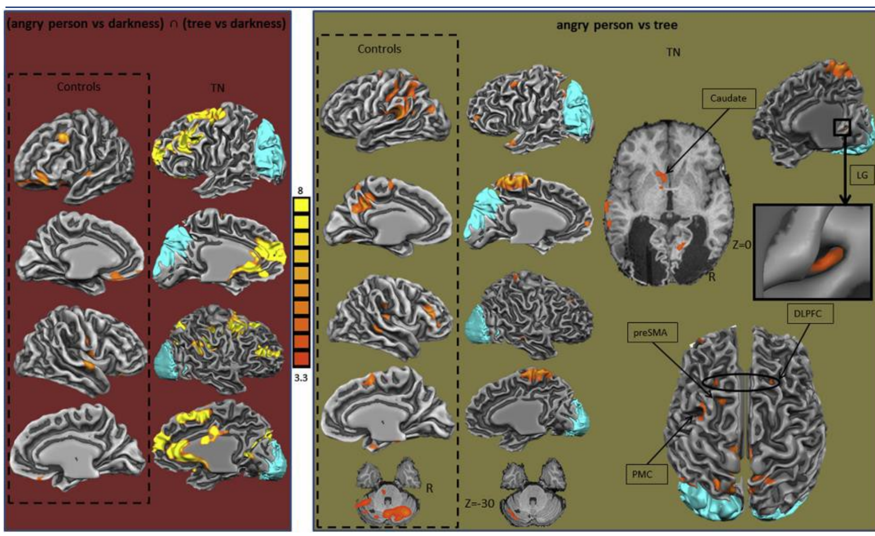
face



scene



RESULTS



(Left) Statistical activation maps of conjunction analysis of angry person versus darkness imagery and tree versus darkness imagery for controls and patient TN.

(Right) Statistical activation maps of imagining an angry person compared to imagining a tree for controls and TN. The lesion is displayed in cyan. Statistical color coding is presented in the center.

Note the similar activation patters between controls and patient TN.

CONCLUSION

Research question: A bilateral fronto-parietal network was activated during visual imagery in patient TN, with partial activation of the same areas in controls. Theoretical: An intact V1 are is not a necessary prerequisite for mental imagery.

NOVELTY

This is the first study to persuasively demonstrate that V1 is non-essential for mental imagery.

de Gelder, B., Tamietto, M., Pegna, A. J., & Van den Stock, J. (2015). Visual imagery influences brain responses to visual stimulation in bilateral cortical blindness. *Cortex*, *72*, 15-26.

From Personal Fear to Mass Panic: The Neurological Basis of Crowd Perception

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BACKGROUND

Despite many studies investigating emotion processing from whole-body expressions, little is known about emotion perception from dynamic crowds. Yet, it is conceivable that perceiving the mood of a crowd carries evolutionary importance, for instance in situations of panic. Therefore, the aim of this study was to investigate emotion perception from a crowd of unrelated individuals versus a crowd of interacting individuals.

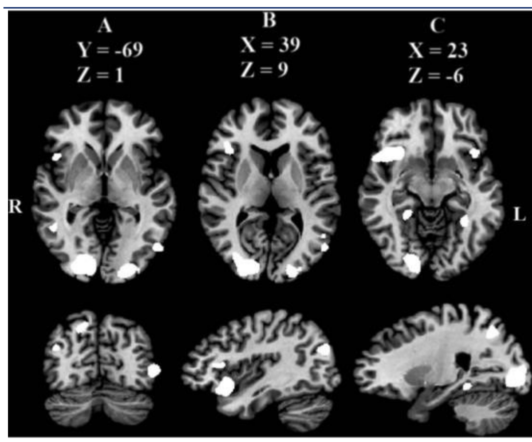
RESEARCH QUESTIONS

Is the brain sensitive to the difference between individual and interactive emotional expressions of a crowd and is this effect emotion dependent?

STIMULI

Videos of a crowd expressing **happy, fearful** or **neutral** emotions

RESULTS



Areas with an emotion by dynamics interaction effect in the whole brain analysis. In a large number or areas, the interaction effect was a result of a stronger response to the interactive fear than to the individual fear condition, whereas there was no such difference in the other two emotional conditions. These include the bilateral parahippocampal gyrus, the bilateral extrastiate visual cortex, the right inferior temporal gyrus (ITG), a cluster in the right insula, the right precuneus and the left lingual gyrus.

(A) Left insula, right ITG, bilateral lingual gyrus, right MOG (hMT). (B) Right insula, bilateral lingual gyrus, left MOG, left MOG (hMT), right extrastriate area. (C) Bilateral insula, bilateral parahippocampal gyrus, right lingual gyrus, right precuneus.

CONCLUSION

Research question: Numerous brain areas were more strongly activated by interactive compared to individual crowd dynamics. Moreover, multiple brain areas showed increased activity for the interactive fear condition in comparison with other emotionally expressive interactive crowd conditions. Theoretical: The human brain seems to be more sensitive to interactive crowd expressions of fear compared to happy or neutral emotional states.

NOVELTY

This is one of the first studies to investigate crowd emotion perception.

Huis in ‘t Veld, E. M., & de Gelder, B. (2015). From personal fear to mass panic: The neurological basis of crowd perception. *Human brain mapping*, *36*(6), 2338-2351.

Body Recognition in a Patient with Bilateral Primary Visual Cortex Lesions

Jan Van den Stock, Marco Tamietto, Alexis Hervais-Adelman, Alan J. Pegna and Beatrice de Gelder

BACKGROUND

Patients with lesions to the primary visual cortex have been demonstrated to have residual recognition abilities for stimuli presented to their blind field. For instance, they can successfully discriminate the orientation of lines were presented in their blind visual field, without conscious awareness of the stimuli. However, residual recognition abilities of more complex stimuli, such as human bodies, has not been frequently investigated in this population. Therefore, the aim of this study was to investigate residual object recognition abilities in a patient with bilateral primary visual cortex lesions.

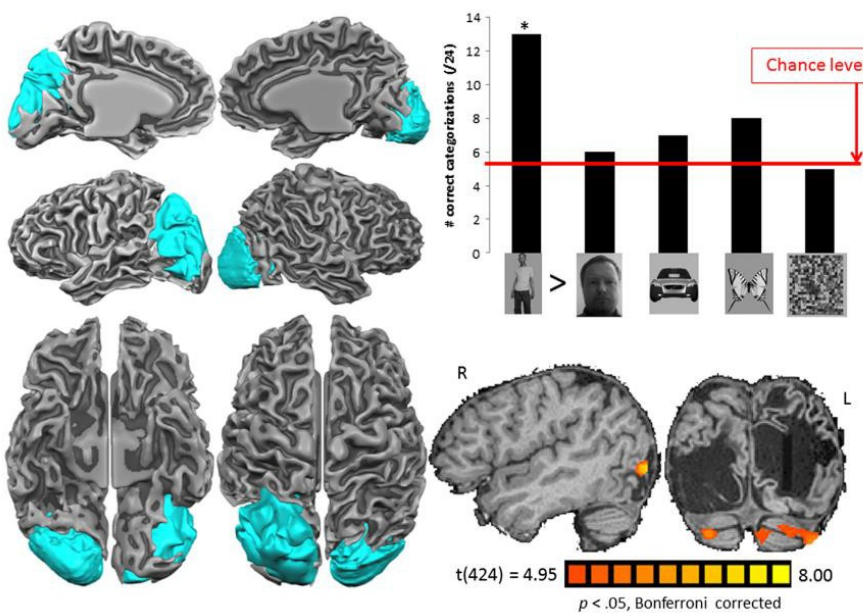
RESEARCH QUESTION

Will a patient with bilateral destruction of V1 exhibit above-chance recognition of objects, including human bodies?

STIMULI

Images of faces, whole bodies (without faces), butterflies, cars and scrambled images

RESULTS



The left panel shows a cortical reconstruction of the patient's brain with the lesions colored in turquois. The top right panel shows the behavioral results indicating above-chance categorization of human body shape stimuli. The bottom right panel shows the statistical activation maps when comparing presentation of body stimuli with the other.

CONCLUSION

Research question: Despite bilateral damage to the primary visual cortex, a patient can successfully discriminate human bodies. Theoretical: The results suggest a neural mechanism underlying visual object perception not accompanied by visual awareness.

NOVELTY

This is the first study to demonstrate above-chance recognition of human bodies in a patient with bilateral damage to the primary visual cortex.

Van den Stock, J., Tamietto, M., Hervais-Adelman, A., Pegna, A. J., & de Gelder, B. (2015). Body recognition in a patient with bilateral primary visual cortex lesions. *Biological psychiatry*, *77*(7), e31-e33.

Mental imagery follows similar cortical reorganization as perception: intra-modal and cross-modal plasticity in congenitally blind

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BACKGROUND

In the recent years, mental imagery has been extensively studied in healthy controls. However, mental imagery in blindness is not sufficiently explored. Therefore, we investigated cortical plasticity and mental imagery in a sample of congenitally blind individuals.

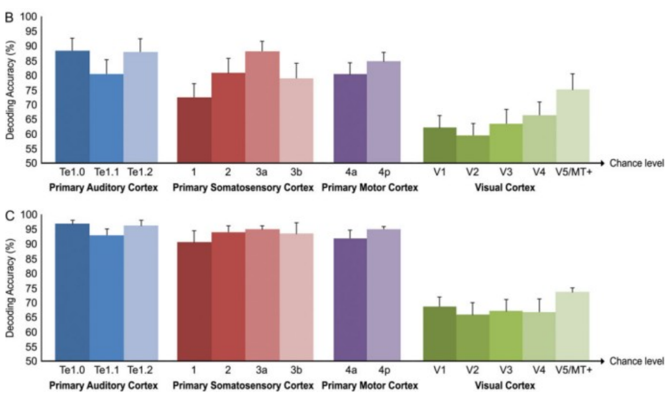
RESEARCH QUESTION

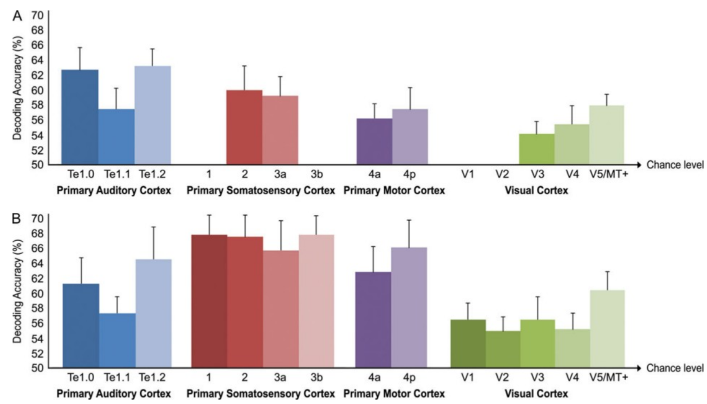
Does mental imagery follow similar cortical reorganization as perception in blind individuals?

STIMULI

- Four male 3D-printed figures expressing **fear** or **anger**
- Male human voices expressing **fear** (wailing) or **anger** (growling) without speech

RESULTS





(Left) Classification of auditory versus tactile perception. B, C) Classification accuracies of anatomical regions that contain significant information about perception modality on the group level in blind (B) and sighted (C) participants are shown. **(Right) Classification of auditory versus tactile imagery**. Classification accuracies of anatomical regions that contain significant information about imagery modality on the group level in blind (A) and sighted (B) participants are shown.

CONCLUSION

Research question: Auditory vs. tactile perception evokes similar intra-modal discriminative patterns in congenitally blind compared with sighted participants. Both the blind and sighted participants showed cross-modal discriminative patterns for perception modality in the visual cortex. During mental imagery, both groups showed similar decoding accuracies for imagery modality in the intra-modal primary sensory cortices. However, no cross-modal discriminative information for imagery modality was found in early visual cortex of blind participants, in contrast to the sighted participants. Theoretical: Results indicate that cortical plasticity following visual deprivation does not influence broad intra-modal organization of auditory and tactile perception. After visual deprivation mental imagery follows a similar intra-modal reorganization as perception.

NOVELTY

This is the first study to investigate intra-modal and cross-modal multivariate representations of mental imagery in the blind brain.

De Borst, A. W., & De Gelder, B. (2019). Mental imagery follows similar cortical reorganization as perception: intra-modal and cross-modal plasticity in congenitally blind. *Cerebral Cortex*, *29*(7), 2859-2875.

The basolateral amygdala is essential for rapid escape: a human and rodent study

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[1]Department of Psychology, Utrecht University, the Netherlands; [2]Department of Psychiatry and Mental Health, University of Cape Town, South Africa; [3]Center for Psychiatric Neuroscience, Lausanne University and University Hospital Center, Switzerland; [4]Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen Medical Centre, the Netherlands; [5]Global Risk Governance Program, Institute for Safety Governance and Criminology, Law Faculty, University of Cape Town, South Africa; [6]Department of Psychology and Neuroscience, Maastricht University, the Netherlands; [7]MRC Unit on Risk and Resilience in Mental Disorders, University of Cape Town, South Africa; [8]Institute of Infectious Disease and Molecular Medicine, University of Cape Town, South Africa

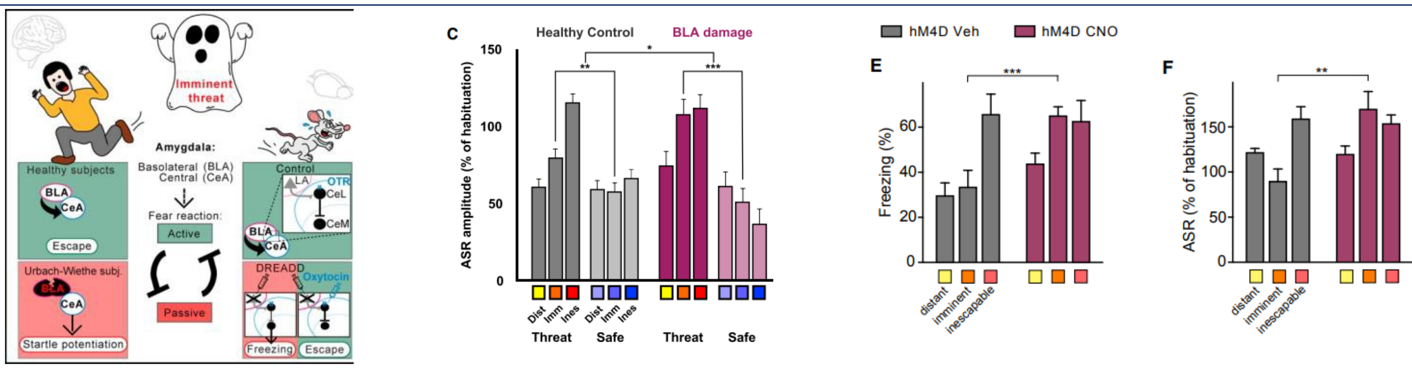
BACKGROUND

Despite able research in rodents, the role of the basolateral amygdala (BLA) in defensive behavior of humans is still unclear. To bridge this gap, we compared humans with natural-selective bilateral BLA lesions to rats with a chemogenetically silenced BLA. This way we investigated the role BLA plays in the occurrence of active escape over freezing behavior in humans and rodents.

RESEARCH QUESTIONS

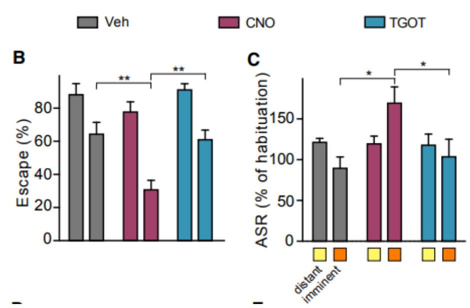
Does damage/inhibition of the BLA induce passive freezing behavior when presented with imminent threat? Does activating central amygdala (CeA) neurons by oxytocin restore deficient escape behaviour in BLA-silenced rats?

DESIGN AND RESULTS



C) **BLA Damage Leads to Over-potentiation of the ASR during Anticipation of Imminent yet Escapable Threat in Humans.** Imminent threat potentiation was significantly stronger in BLA-damaged subjects and, although healthy controls showed significantly lower threat potentiation in imminent compared to inescapable conditions this was not the case in BLA-damaged. ASR = Acoustic startle reflex, measure of passive threat reaction. E, F) **BLA Neuronal Downregulation Induces Passive Defensive Reactions upon Imminent Threat in Rats.** hM4D Veh = viral vector carrying the inhibitory designer receptors targeting glutamatergic neurons injected in the rat BLA, serves as control condition; hM4D CNO = hM4D receptor agonist, CNO injection inhibits the BLA.

B, C) **Activation of Oxytocin-Sensitive Neurons during Downregulation of the BLA Rescues the Switch between Active and Passive Responses to Imminent Threat in Rats.** Oxytocin injections (TGOT condition) into the central amygdala (CeA) restores freezing behavior in rats with CNO chemogenetically induced lesions in the BLA.



CONCLUSION

Research question: Human bilateral BLA damage and silencing in rats results in maladaptive passive fear, whereas the BLA prevents passive freezing responses via the CeA if active escape is feasible. Activation of CeA neurons by oxytocin restores deficient escape behaviour in BLA-silenced rats. Theoretical: When rodents and humans are under imminent escapable threat, the BLA is essential for the selection and execution of rapid escape behavior.

NOVELTY

This is the first study to reveal the mechanism behind adaptive escape behavior in humans and rodents.

Terburg, D., Scheggia, D., Del Rio, R. T., Klumpers, F., Ciobanu, A. C., Morgan, B., ... & van Honk, J. (2018). The basolateral amygdala is essential for rapid escape: a human and rodent study. *Cell*, *175*(3), 723-735.

Looking at the face and seeing the whole body. Neural basis of combined face and body expressions

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[1]Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, The Netherlands; [2]Department of Computer Science, University College London, UK

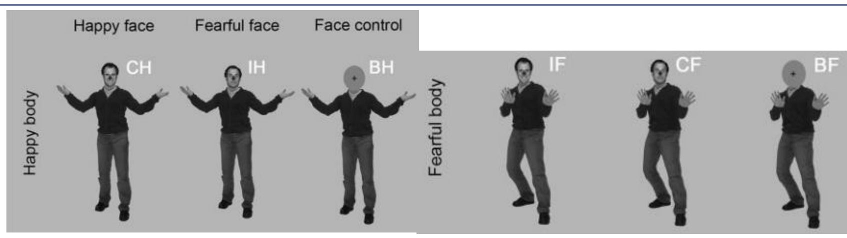
BACKGROUND

Ample research has been conducted on emotion processing from faces. Nonetheless, in naturalistic settings the processing of emotional facial expressions does not take place in isolation. Yet, not many studies investigated the role of combined faces and bodies using neuroimaging techniques. Therefore, the aim of this study was to explore the influence of body expressions on the neural processing of the face.

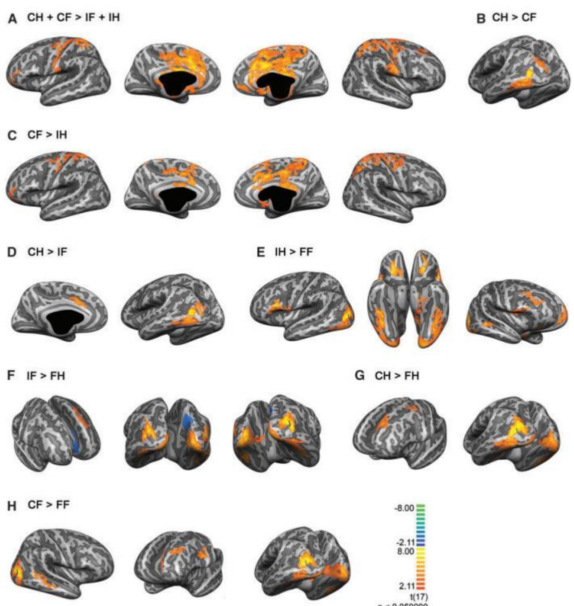
RESEARCH QUESTION

Do body expressions influence the neural processing of the face? What is the role of the amygdala in this process?

STIMULI



RESULTS



(A) The two congruent face–body compound conditions (CH + CF) are compared with the two incongruent ones (IF + IH); **(B)** CH > CF: congruent happy compounds vs congruent fearful compounds; **(C)** CF > IH: congruent fear compounds vs incongruent compounds with happy bodies; **(D)** CH > IF: congruent happy compounds vs incongruent compounds with fearful bodies; **(E)** IH > FF: incongruent compounds with happy bodies vs isolated fearful faces; **(F)** IF > FH: incongruent compounds with fearful bodies vs isolated happy faces; (G) CH > FH: congruent happy compounds vs isolated happy faces; **(H)** CF > FF: congruent fear compounds vs isolated fearful faces

CONCLUSION

Research question: Activity in motor, prefrontal and visual areas increases when facial expressions are presented together with bodies rather than in isolation. A facial expression combined with a congruent body enhanced both cortical activity and amygdala functional connectivity when compared to an incongruent face–body compound. Theoretical: Emotional body postures influence the processing of facial expressions, especially when the emotion conveyed by the body implies danger.

NOVELTY

This is the first study investigating face-body interactions in emotional processing by employing neuroimaging methods.

Poyo Solanas, M., Zhan, M., Vaessen, M., Hortensius, R., Engelen, T., & de Gelder, B. (2018). Looking at the face and seeing the whole body. Neural basis of combined face and body expressions. *Social cognitive and affective neuroscience*, *13*(1), 135-144.

First-person virtual embodiment modulates the cortical network that encodes the bodily self and its surrounding space during the experience of domestic violence

Aline W. de Borst[1], Maria V. Sanchez-Vives[2,3], Mel Slater[4,5] and Beatrice de Gelder[5,6]

[1]University College London Interaction Centre, University College London, United Kingdom; [2]Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Barcelona, Spain; [4]Event Laboratory, Department of Clinical Psychology and Psychobiology, University of Barcelona, Spain; [5]Institute of Neurosciences of the University of Barcelona, Spain; [6]Brain and Emotion lab, Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, The Netherlands

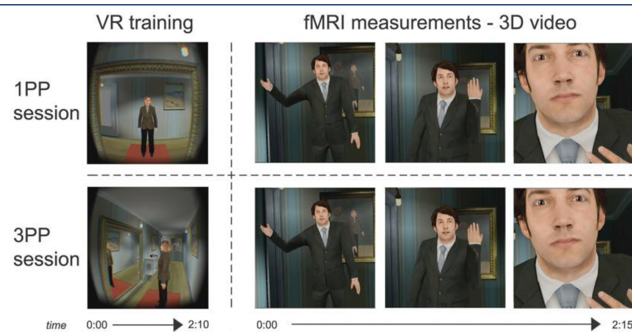
BACKGROUND

Domestic violence has been associated with a reduced ability to identify oneself with another person's perspective. Yet, not many studies have investigated the role of first (1PP) vs. third perspective (3PP) in witnessing domestic violence nor the brain's responses associated with it. Therefore, this study investigated changes in brain network activations when human participants take on a first-person embodied perspective while experiencing domestic abuse in a VR scenario.

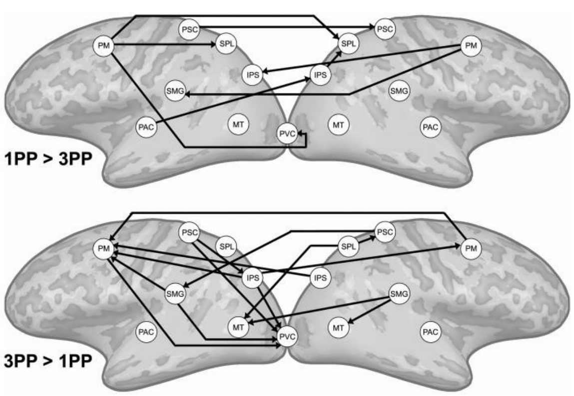
RESEARCH QUESTION

What are the changes in brain activity associated with witnessing domestic violence from first-person perspective?

STIMULI



RESULTS



Differences in effective connectivity between perception of an identical 3D threat video preceded by 1PP and 3PP exposure. The arrows indicate the direction of the connectivity between regions that is unique for each condition.

CONCLUSION

Research question: When the stimulus was perceived as directed toward oneself, the brain network that encodes the bodily self and its surrounding space was more strongly synchronized across participants and connectivity increased from premotor cortex and intraparietal sulcus towards superior parietal lobe. Additionally, when the stimulus came near the body, brain activity in the amygdala strongly synchronized across participants. Theoretical: The results suggest that 1PP embodiment training enhances experience from the viewpoint of the virtual victim, which is accompanied by synchronization in the fronto-parietal network to predict actions toward the body and in the amygdala to signal the proximity of the stimulus.

NOVELTY

This is the first study to investigate brain activity while viewing domestic abuse scenarios from different perspectives.

de Borst, A. W., Sanchez-Vives, M. V., Slater, M., & de Gelder, B. (2020). First-person virtual embodiment modulates the cortical network that encodes the bodily self and its surrounding space during the experience of domestic violence. *Eneuro, 7*(3).

The role of computational and subjective features in emotional body expressions

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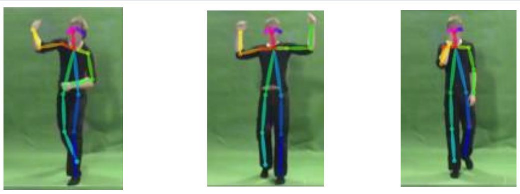
BACKGROUND

The majority of affective neuroscience research has focused on investigating body postures in the context of qualitative emotion categories. Yet, human movements provide other frequently disregarded information, such as kinematics and postural information. Therefore, this study used a computational model to compute kinematic and postural features from videos of whole-body movements and related these features to different emotion categories by employing representational similarity analysis.

RESEARCH QUESTION

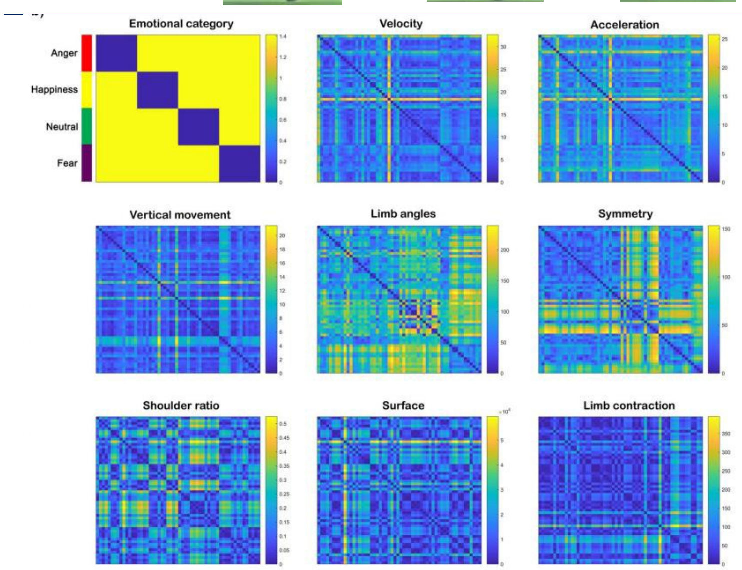
Do kinematic and postural features of human body movements differently reflect the affective content of body postures?

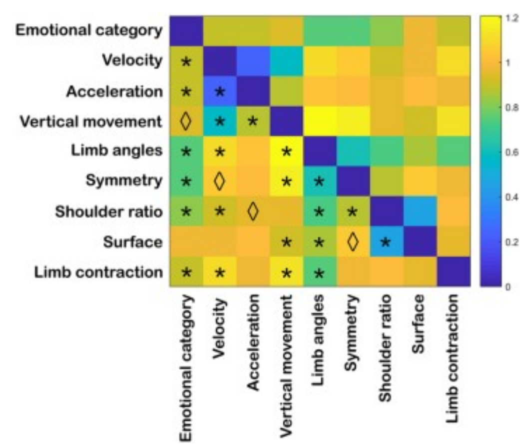
STIMULI



Videos of **angry, happy, neutral** and **fearful** whole-body movements

RESULTS





(Left) The RDMs represent pairwise comparisons between 56 stimuli with regard to the kinematic (i.e. velocity, acceleration and vertical movement) and postural (i.e. limb angles, symmetry, shoulder ratio, surface and limb contraction) computed features averaged over time. Blue indicates strong similarity and yellow strong dissimilarity. Colour lines in the upper left corner indicate the organization of the RDMs with respect to the emotional category (anger: red; happiness: yellow; neutral: green; fear: purple) of the video stimuli. (Right) Correlation between representational dissimilarity matrices of kinematic and postural features. The RDM represents the level of (dis)similarity between each of the kinematic (i.e. velocity, acceleration and vertical movement) and postural (i.e. limb angles, symmetry, shoulder ratio, surface and limb contraction) matrices (see Left). Distances are indicated in 1-Spearman's correlation values, with blue indicating strong similarity and yellow strong dissimilarity.

CONCLUSIONS

Research question: Postural and not kinematic computational features differentiated best between emotional categories. Further analyses showed that postural features of limb angles and symmetry correlated best with emotional category. Theoretical: This study provides evidence that postural body features play a role in emotion recognition.

NOVELTY

This is the first study to highlight the role of mid-level features playing a role in affective processing of bodies.

Poyo Solanas, M., Vaessen, M. J., & de Gelder, B. (2020). The role of computational and subjective features in emotional body expressions. *Scientific reports*, *10*(1), 6202.

Computation-based feature representation of body expressions in the human brain

Marta Poyo Solanas[1], Maarten Vaessen[1] and Beatrice de Gelder[1,2]

[1]Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, The Netherlands; [2]Department of Computer Science, University College London, UK

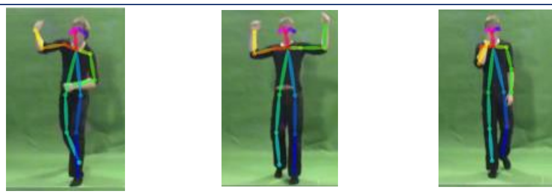
BACKGROUND

Emotional body expressions have a central meaning in nonverbal communication. Yet, the majority of affective neuroscience research on this topic has investigated brain activity related to symbolic emotion categories. Nonetheless, there is a plethora of mid-level body features, such as kinematic or postural information, that drive emotion perception. Therefore, the present study aimed at investigating how computationally derived body expression features are represented in the human brain.

RESEARCH QUESTION

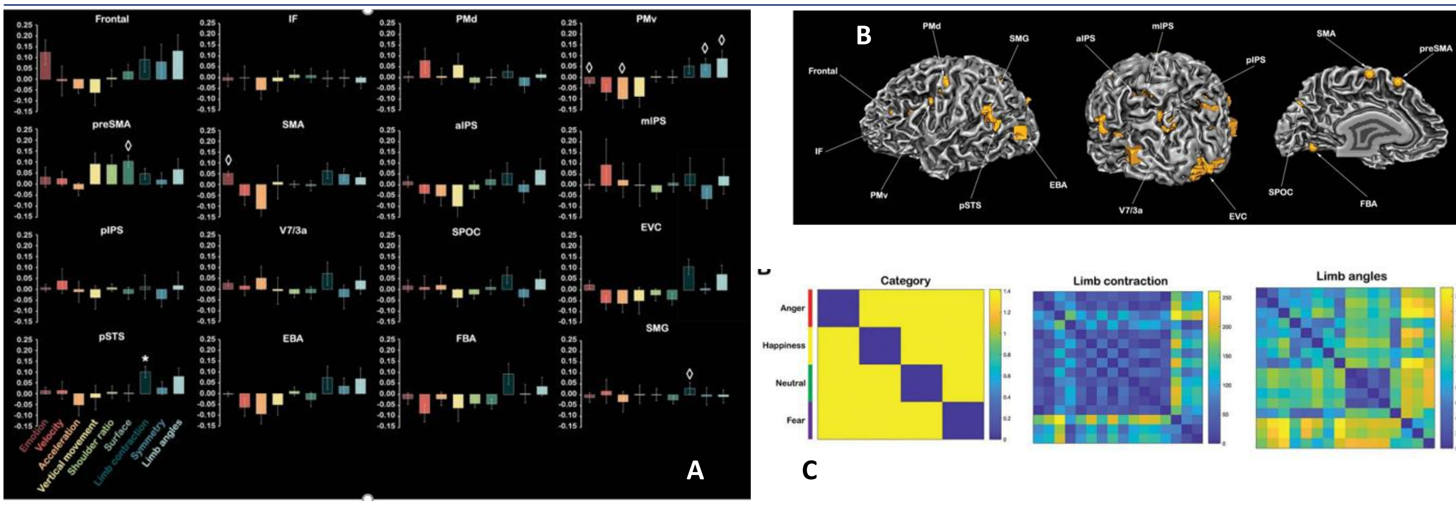
Which specific postural and kinematic features computed from affective whole-body movement videos can be related to brain activity?

STIMULI



Videos of **angry, happy, neutral** and **fearful** whole-body movements

RESULTS



A, B) Average Spearman's rank correlation across participants between the kinematic/postural feature RDMs and each ROI matrix. Kinematic features include velocity, acceleration, and vertical movement. Postural features comprise shoulder ratio, surface, limb contraction, symmetry, and limb angles. Positive r values indicate that a high (dis)similarity between a stimulus pair in the feature RDM also has a high (dis)similarity in the neural representation. A negative correlation means that a low (dis)similarity between two stimuli at the feature level would have a higher (dis)similarity in the neural representation. **C)** RDMs represent pairwise comparisons between the 16 stimuli with regard to the kinematic and postural features averaged over time.

CONCLUSION

Research question: Postural rather than kinematic features reflect the affective category of the body movements. The feature limb contraction contributes to fearful body expression perception, differentially represented in action observation, motor preparation, and affect coding regions, e.g., the amygdala. pSTS differentiated fearful from other affective categories using limb contraction rather than kinematics. EBA and FBA also showed greater tuning to postural features. Theoretical: The study highlights the role of body features in affective processing.

NOVELTY

This is the first study to explore the role of computationally derived postural and kinematic features in neural processing of affective whole-body movements.

Poyo Solanas, M., Vaessen, M., & de Gelder, B. (2020). Computation-based feature representation of body expressions in the human brain. *Cerebral Cortex*, *30*(12), 6376-6390.

Voxelwise encoding models of body stimuli reveal a representational gradient from low-level visual features to postural features in occipitotemporal cortex

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[a] Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, the Netherlands; [b] Center for Magnetic Resonance Research, Department of Radiology, United States and Department of NeuroInformatics, University of Minnesota, Minneapolis, USA; [c] Cuban Center for Neuroscience, Street 190 e/25 and 27 Cubanacán Playa Havana, CP 11600, Cuba

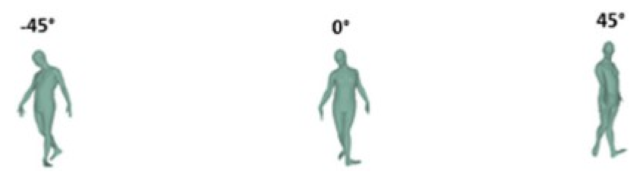
BACKGROUND

Despite plenty of previous research focusing on category-specific representations of bodies, little is known about the computations that take place in body selective regions. Therefore, this study compared possible mechanisms of encoding body images, by associating the performance of three encoding models to brain activity in occipitotemporal cortex, e.g. in the extrastriate body area (EBA).

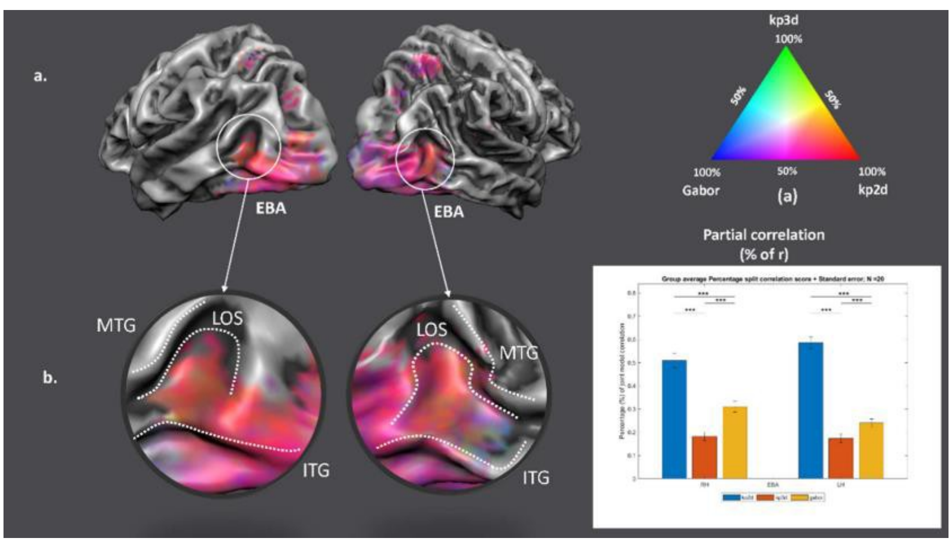
RESEARCH QUESTION

To what extent can responses in the EBA be explained by low-level visual features (Gabor) vs. by the features extracted by two computational models that represent postural body features (kp2d, kp3d)?

STIMULI



RESULTS



In EBA, the information contained in the joint model predictions which significantly correlates with BOLD activity is split across models with kp2d accounting for 50–60% of the variance, Gabor approximately 25–30% of the variance and kp3d the remaining 15–20%. The variance explained follows a gradient from the posterior part (posterior ITG/LOS) to the anterior (anterior LOS) of EBA, with darker shades of magenta in the posterior part indicating higher representation of low-level body features (Gabor), and lighter shades of magenta in the anterior part indicating higher representation of mid-level features (kp2d-kp3d).

CONCLUSION

Research question: Bodies are encoded in the EBA, with the posterior part encoding low-level body features, and the anterior part indicating higher representation of mid-level features. Theoretical: In the occipital cortex, bodes are encoded via a combination of low-level visual features and postural features.

NOVELTY

This is the first study to investigate the computational mechanisms behind the coding of body images.

Marrazzo, G., De Martino, F., Lage-Castellanos, A., Vaessen, M. J., & de Gelder, B. (2023). Voxelwise encoding models of body stimuli reveal a representational gradient from low-level visual features to postural features in occipitotemporal cortex. *NeuroImage*, 120240.

A large-scale brain network of species-specific dynamic human body perception

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RESULTS

The majority of studies investigating the processing of human bodies has focused on category-specific processing. However, it is possible that whole specific networks dedicated to body processing. Therefore, this study employed 7T fMRI imaging and Independent component analysis (ICA) to find body and species modulations at the brain network level.

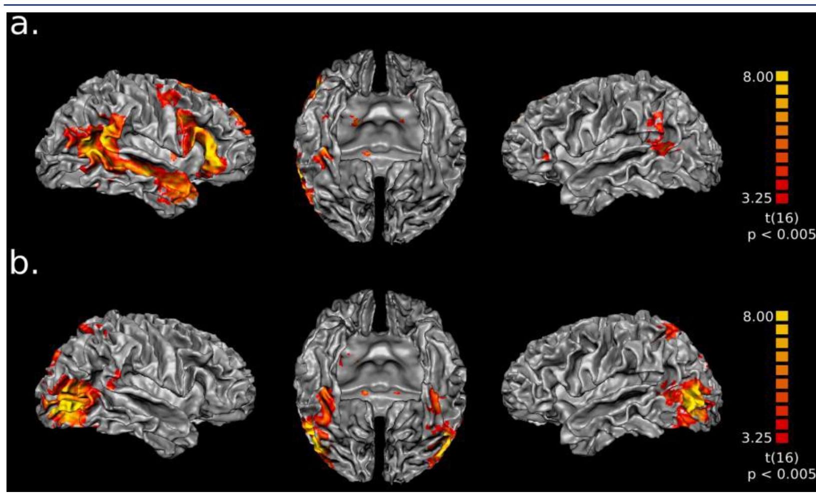
RESEARCH QUESTION

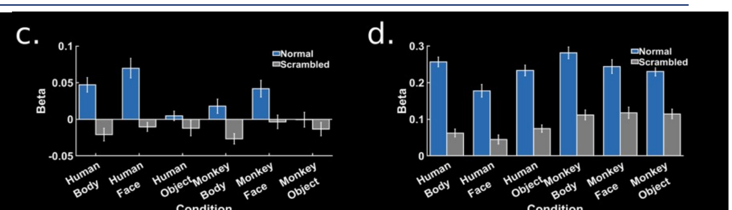
Are there brain networks dedicated to dynamic human body perception and are these species specific?

STIMULI

Naturalistic videos of monkey and human faces, bodies, and objects

RESULTS





Networks extracted by group-ICA. **(a) & (c).** rSTS network and its beta plot. **(b) & (d).** LOC network and its beta plot. Among the body areas, the highest species selectivity was found in the middle frontal gyrus and amygdala. Two large-scale networks were highly selective to bodies, dominated by the lateral occipital cortex and right superior temporal sulcus (STS), respectively. The right STS network showed high species selectivity, and its significant human body-induced node connectivity was focused around the extrastriate body area (EBA), STS, temporoparietal junction (TPJ), premotor cortex, and inferior frontal gyrus (IFG).

CONCLUSION

Research question: Two large-scale networks, the LOC network and the rSTS network, are specifically modulated by human body videos, whereas highest species specificity was observed in the MFG and amygdala. Theoretical: The human body-specific network may serve as a brain-wide internal model of the human body serving as an entry point for a variety of processes relying on body descriptions, e.g. action or expression recognition.

NOVELTY

This is the first study to investigate brain network modulations associated with body processing.

Li, B., Solanas, M. P., Marrazzo, G., Raman, R., Taubert, N., Giese, M., ... & de Gelder, B. (2023). A large-scale brain network of species-specific dynamic human body perception. *Progress in Neurobiology*, 221, 102398.

Gradual relation between perceptual awareness, recognition and pupillary responses to social threat

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BACKGROUND

Evidence shows affective stimulus processing outside awareness, but methodological and theoretical concerns over whether perceptual awareness is graded or dichotomous remain.

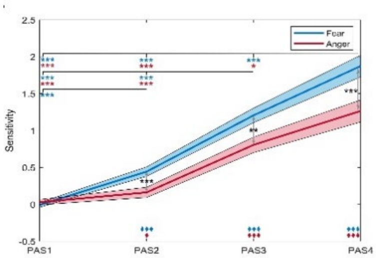
RESEARCH QUESTION

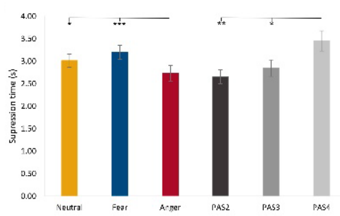
The aim of the current study was to investigate the relationship between perceptual awareness, emotion recognition and pupillary responses to social threat using a fine-grained measure of perceptual awareness rather than a dichotomous task.

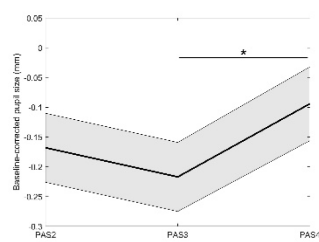
STIMULI

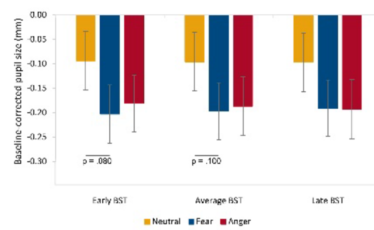
Fearful, angry and neutral body expressions presented in a continuous flash suppression paradigm where participants had to perform an emotional recognition (fear vs neutral; angry vs. neutral) and a Perceptual Awareness Scale rating (no experience, brief glimpse, almost clear and clear experience).

RESULTS









CONCLUSIONS

Our findings revealed a gradual relationship between emotional recognition and perceptual awareness, with higher recognition sensitivity for fearful than angry bodies across all visual awareness levels, except during perceptual unawareness where performance was at chance level. Interestingly, angry body expressions were suppressed for a shorter duration than neutral and fearful ones. Furthermore, pupil dilation responses were influenced by affective expression, suppression duration and perceptual awareness level and also showed a gradual relationship.

NOVELTY

This study challenges the idea of consciousness as purely all-or-none by showing that there are different levels of perceptual awareness using body expressions of threat.

Poyo Solanas, M., Zhan, M., & de Gelder, B. (2023). Gradual relation between perceptual awareness, recognition and pupillary responses to social threat. *Current Research in Behavioral Sciences, 5.* 100134.

Ultrahigh field fMRI reveals different roles of temporal and fronto-parietal cortices in subjective awareness

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BACKGROUND

Substantial evidence has been gathered over the years about affective stimulus processing outside awareness in cortically blind subjects as well as in healthy participants. However, these findings are often criticized for being artifacts of the methos used to assess awareness. In addition, there is substantial controversy regarding whether perceptual awareness is a graded or a dichotomous phenomenon.

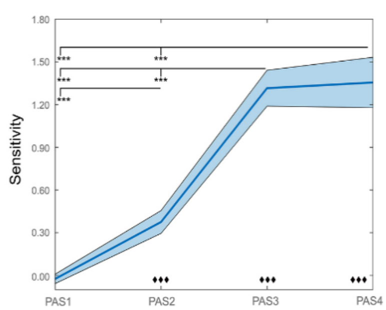
RESEARCH QUESTION

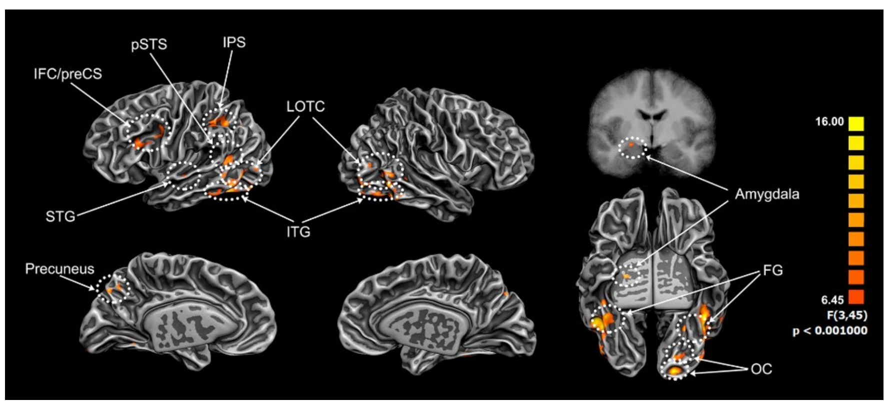
Investigate whether affective processing can occur under perceptual unawareness but also whether perpetual awareness shows a gradual or a dichotomous pattern, both behaviorally and at the brain level.

STIMULI

Fearful and neutral body expressions presented in a continuous flash suppression paradigm where participants had to perform an emotional recognition task (fear vs neutral) and a Perceptual Awareness Scale rating (no experience, brief glimpse, almost clear and clear experience)

RESULTS





CONCLUSIONS

We found a corticocortical network constituted by the fronto-parietal and temporal cortex involved in perceptual stimulus awareness. Different relationships to perceptual awareness were observed in fronto-parietal areas (dichotomous) and temporal regions (gradual) suggesting different roles: IFC and IPS may only detect perceptual conflict when the competing stimulus representations are perceptually different, leaving sensory areas in charge of resolving perceptual conflict when that is not the case8. In addition, our results argue against perceptual discrimination without subjective report in neurologically intact observers and support the view of subjective perceptual awareness as a gradual phenomenon.

NOVELTY

This study challenges the idea of consciousness as purely all-or-none by showing that perceptual awareness varies by brain region, shedding light on its underlying neural mechanisms.

Poyo Solanas, M., Zhan, M., & de Gelder, B. (2024). Ultrahigh Field fMRI Reveals Different Roles of the Temporal and Frontoparietal Cortices in Subjective Awareness. *Journal of Neuroscience, 44*(20), e0425232023.

Theta activity discriminates high-level, species-specific body processes

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BACKGROUND

Building on long-standing research on body selectivity in the brain, a recent 7-Tesla fMRI study revealed a large-scale network that is specifically selective for human body stimuli (Li et al., 2023). In addition, while EEG research has consistently shown body-related effects on stimulus-evoked broadband cortical responses, effects on oscillatory cortical responses have been investigated much less. Emerging studies have pointed to the relevance of oscillatory theta activity within 500 ms after image onset in body-related processes (Moreau et al., 2020; Celik et al., 2021; Bossi et al., 2020), but no oscillatory EEG studies to date have investigated the role of species-specificity. The present EEG study aims to bridge this gap by investigating the role of theta cortical activity in species-specific, human (versus monkey) body processing.

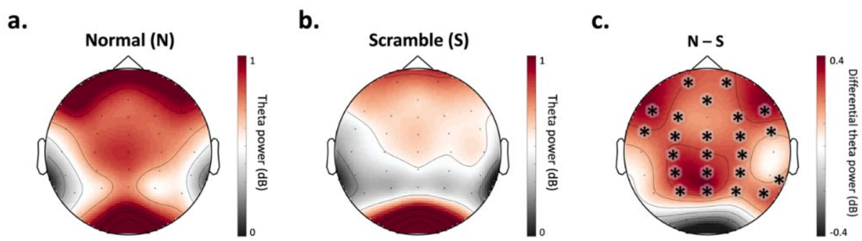
RESEARCH QUESTION

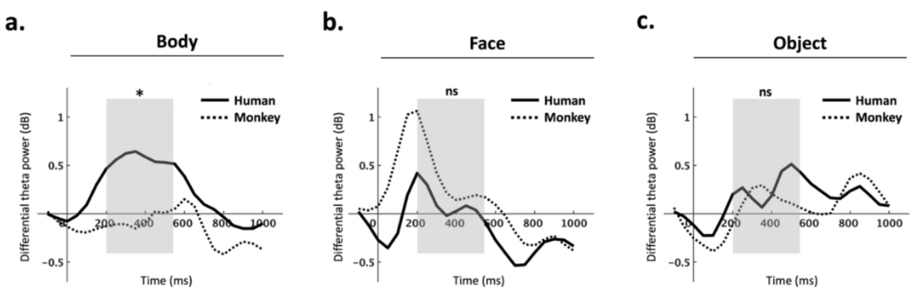
What is the oscillatory and temporal profile of species-specific, human body processing in the human brain?

STIMULI

Static images of bodies, faces and objects were used as stimuli. Body and face stimuli were from a human or a monkey. Object stimuli consisted of artificial objects with their aspect ratio matched to human bodies and monkey bodies. Mosaic-scrambled images were included as controls, in which each stimulus shape was destroyed, while low-level features of luminance, contrast and non-background area were preserved.

RESULTS





CONCLUSIONS

Analysis of event-related theta power (4 – 7 Hz) combined with data-driven methods revealed a strong, body-evoked neural response that is specific to human (versus monkey) bodies and spans a widespread scalp region during a time window of 200 – 550 ms after the onset of the body image. Our results corroborate recent research proposing a species-specific cortical network of human body processing. We submit that this network may play an essential role in linking body processes to movement intentions.

NOVELTY

This is the first investigation of the role of oscillatory EEG activity in species-specific body processing.

Chesley, J., Riecke, L., Lu, J., Vogels, R., & De Gelder, B. (2024). Theta activity discriminates high-level, species-specific body processes. Imaging Neuroscience, 2, 1–12. https://doi.org/10.1162/imag_a_00150

The contribution of body perception to self-identity: an event-related potential study

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[c] Event-Lab, Universidad de Barcelona, Spain.

BACKGROUND

We have a unique ability to recognize our own physical appearance. Previous research on self-perception has primarily focused on facial stimuli to investigate the behavioral and neural processes involved in identity perception and recognition. Much less is known about self perception based on the body and the combined perception of the self face and body. The importance of body perception for self-perception is illustrated by clinical studies showing that body perception-based self-awareness can sometimes lead to dissatisfaction with our physical appearance, contributing to conditions like eating disorders and body dissatisfaction, as evidenced by clinical studies.

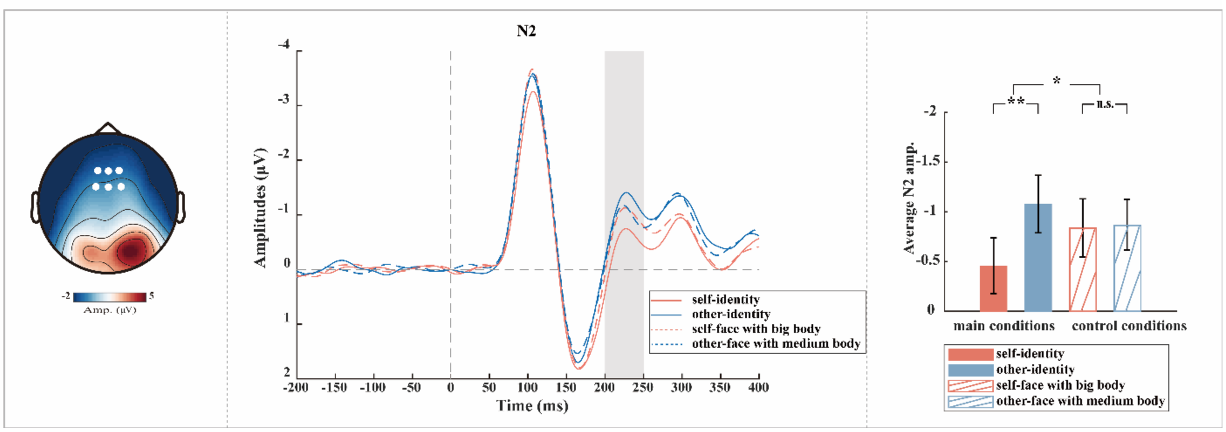
RESEARCH QUESTION

We explored the neural basis of self-identity perception using avatars synthesized from personalized face and body images.

STIMULI

Compound avatar images combining participants' own faces and bodies, as well as those of others, were generated from photographs.

RESULTS



CONCLUSIONS

Perception of self-identity (as defined jointly by the face and the body) leads to a reduced amplitude of the N2. This indicates that self-identity perception emerges rapidly in the brain within 200ms, suggesting that at this stage visual face and body information have been integrated into person identity.

NOVELTY

Our data highlight the critical role of body expression in perceiving self-identity.

Lu, J., Riecke, L., Ryan, B. E., & de Gelder, B. (2025). The contribution of body perception to self-identity: an event-related potential study. Social Cognitive and Affective Neuroscience, 20(1), nsaf020.

Neural encoding of biomechanically (im)possible human movements in occipitotemporal cortex

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[a] Department of Cognitive Neuroscience, Maastricht University, the Netherlands, [b] Hertie Institute, University Clinic Tübingen, Tübingen, Germany

BACKGROUND

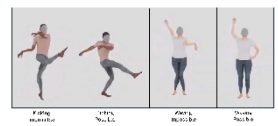
Previous research has shown that regions in occipitotemporal cortex, such as the extrastriate body area (EBA), are selective to bodies and body movements. However, the extent to which these areas encode the biomechanical plausibility of dynamic movements (i.e., whether a movement is physically possible for the human body) remains unclear. Understanding this helps to clarify how the brain uses body shape and motion to support action perception and social cognition.

RESEARCH QUESTION

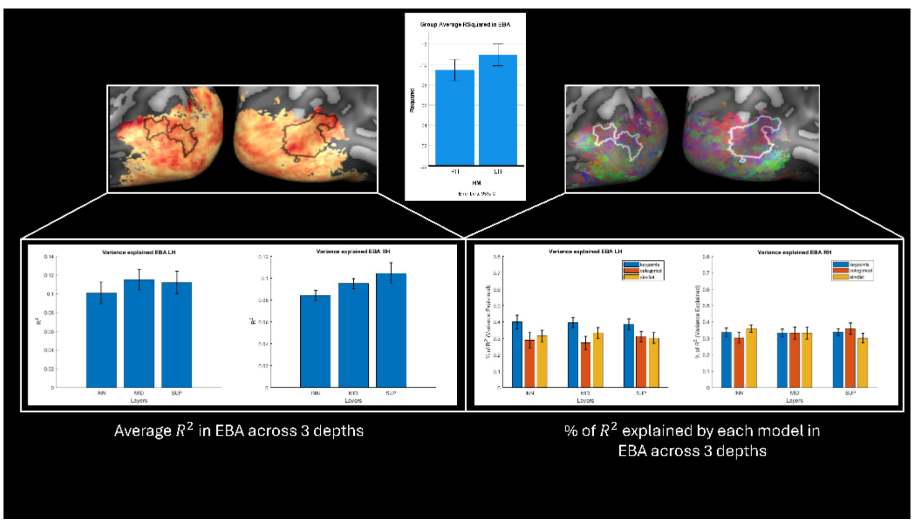
How does the human brain, particularly occipitotemporal cortex and the EBA, encode biomechanically possible versus impossible human body movements?

STIMULI

120 videos (60 biomechanically possible and 60 impossible) of animated avatars performing actions such as kicking, jumping, pointing, and waving. Impossible movements were generated by manipulating joint angles to violate biomechanical constraints, using 3D motion capture data.



RESULTS



CONCLUSIONS

We show that biomechanical plausibility is robustly represented in the visual cortex and especially within the EBA, which integrates both detailed movement kinematics and abstract categorization. This suggests EBA is functionally heterogeneous, with subregions supporting different levels of body movement analysis.

NOVELTY

This is the first study using ultra-high-field 7T fMRI and laminar analysis to show that human ventral visual cortex and EBA specifically, encodes biomechanical plausibility in body movement.

Marrazzo, G., De Martino, F., Mukovskiy, A., Giese, M. A., & de Gelder, B. (2025). *Neural encoding of biomechanically (im)possible human movements in occipitotemporal cortex*. bioRxiv. https://doi.org/10.1101/2025.01.07.631720

Disentangling dynamic information and temporal order processing of human action perception

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[a] Brain and Emotion Lab, Department of Cognitive Neuroscience, Maastricht University, the Netherlands

BACKGROUND

Through previous behavioural research, we have shown that action perception involves not only the processing of dynamic movements, but also specifically how these movements are organized over time. While a variety of brain areas have been identified by past research as involved in action perception from human bodies, the research has not yet clarified which of these areas may be processing the temporal continuity of actions.

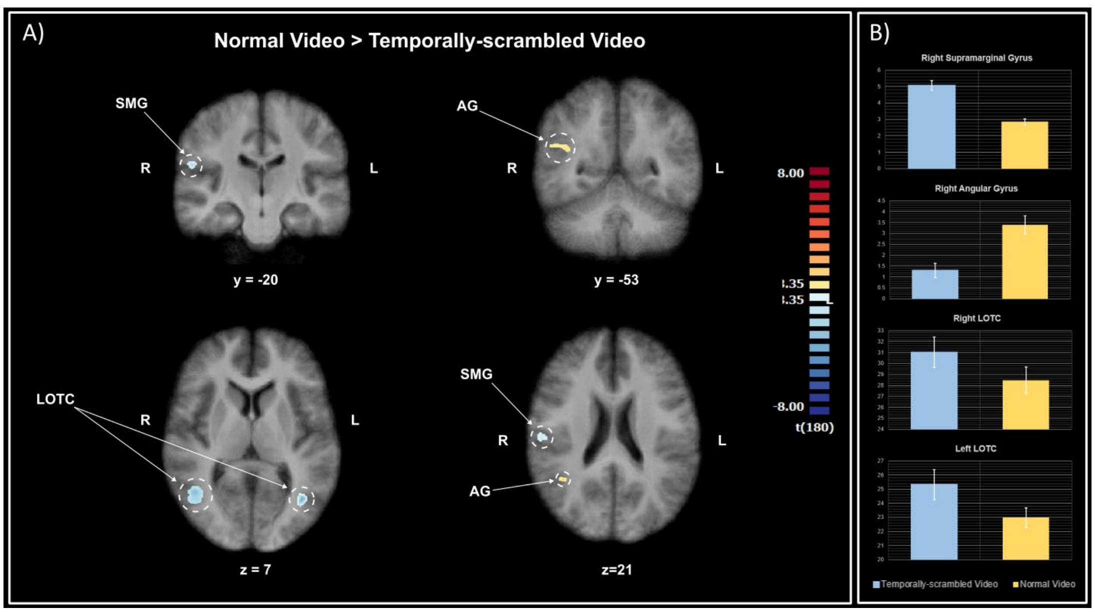
RESEARCH QUESTION

Which regions of the brain contribute to the processing of temporal continuity of movement in the perception of single, dynamic, human actions?

STIMULI

Static images and two types of dynamic videos (intact and temporally-scrambled) of six different actions (self-protecting, greeting a friend, expressing frustration, brushing off, peeling a banana, searching for an object) performed by a single actor.

RESULTS



CONCLUSIONS

We show two different clusters in the inferior parietal lobule (IPL), one showing preference for intact videos and one showing preference for incoherent, scrambled videos. Suggests evidence for a temporal processing hierarchy in the IPL. We also highlight the need to consider dynamic information and temporal order separately in investigations of action perception.

NOVELTY

This is the first investigation of differences between the processing of purely dynamic information versus specifically continuous temporal processing at the level of individual actions using fMRI.

Smekal, V., Poyo Solanas, M., & de Gelder, B. (2025). Disentangling dynamic information and temporal order processing of human action perception. *PNAS Nexus, 4,* pgaf067.