Differential hemispheric and pathway contributions to processing of emotional faces and crowds

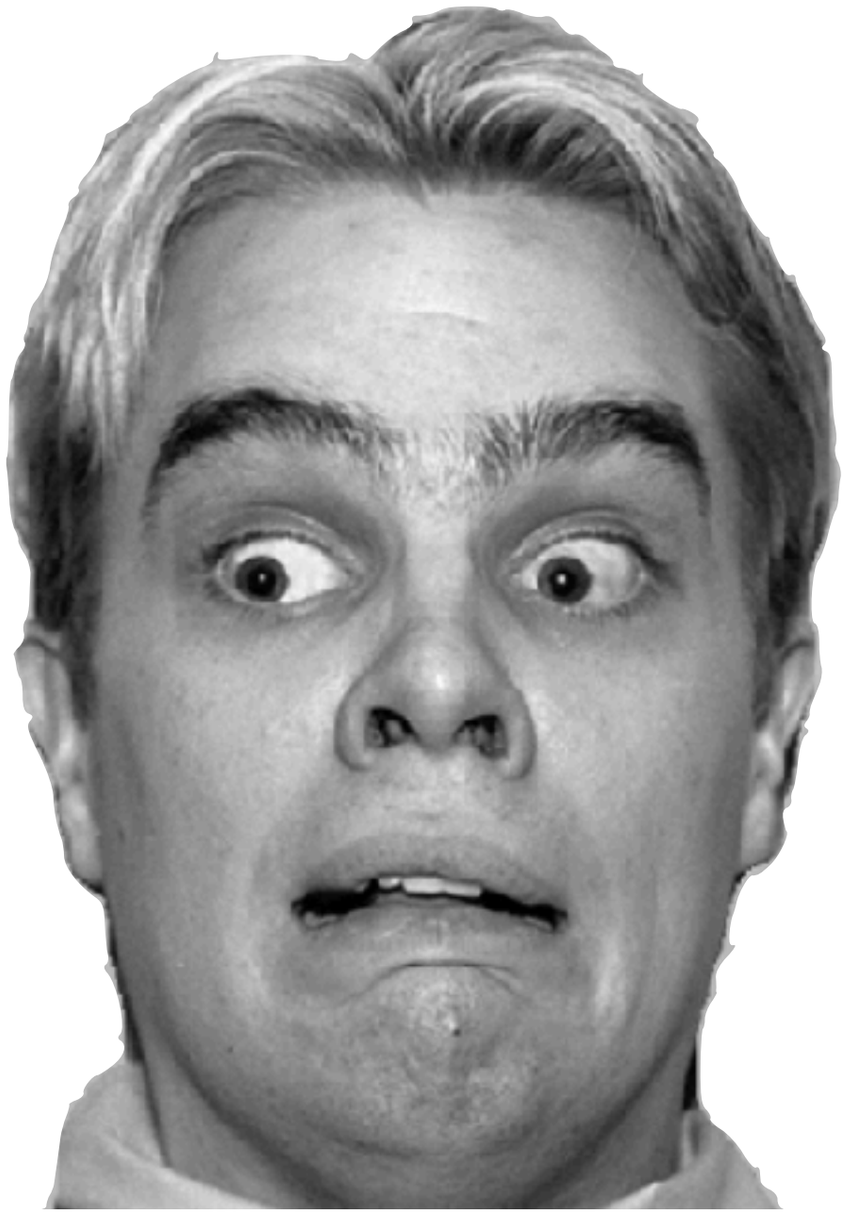
Hee Yeon Im

A. A. Martinos Center for Biomedical Imaging
Department of Radiology
Massachusetts General Hospital
Harvard Medical School

Seeing faces

… and even their emotions.

Facial cues as social signals



Identity

Sex

Age

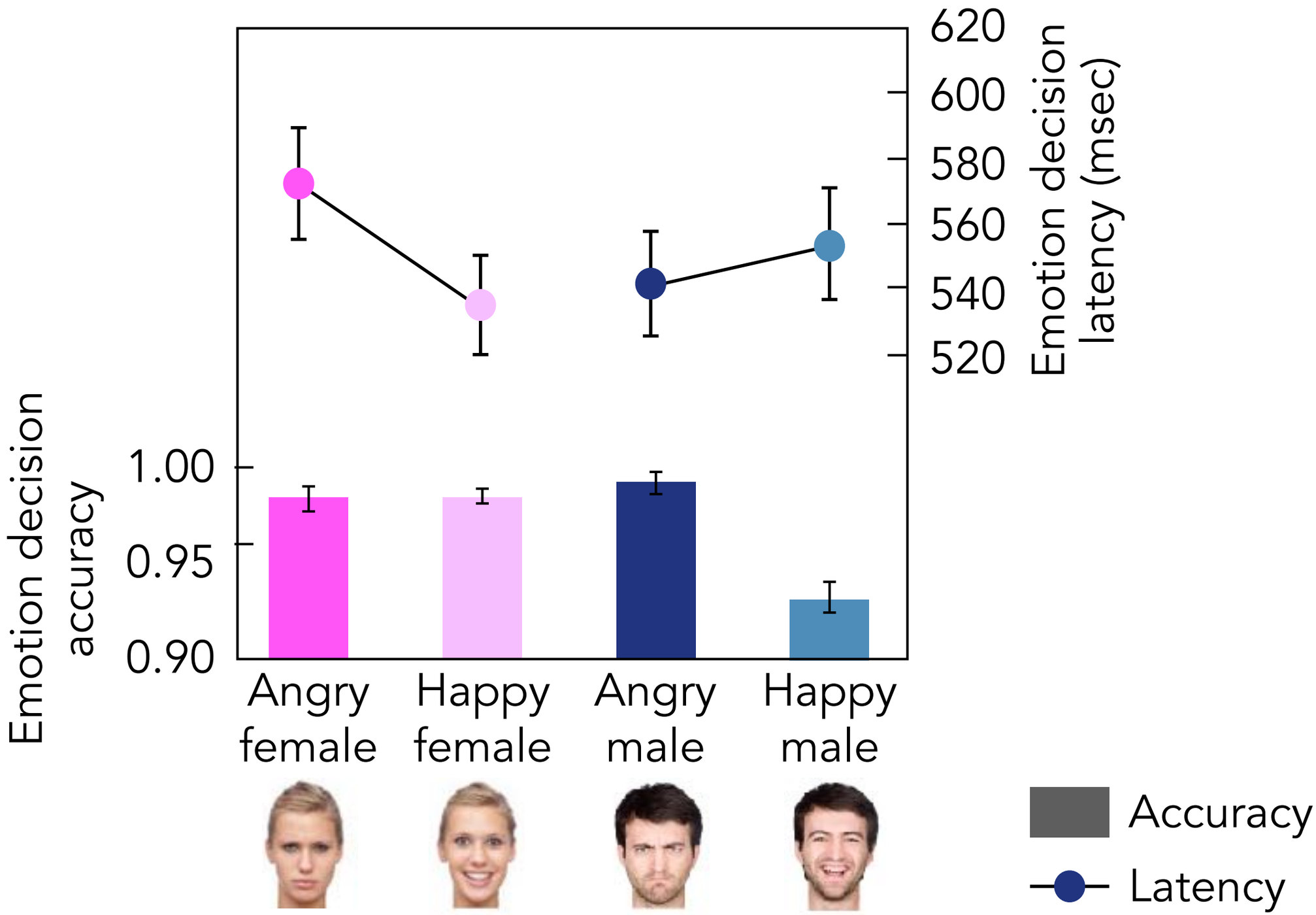
Race

Attentional focus

Mood

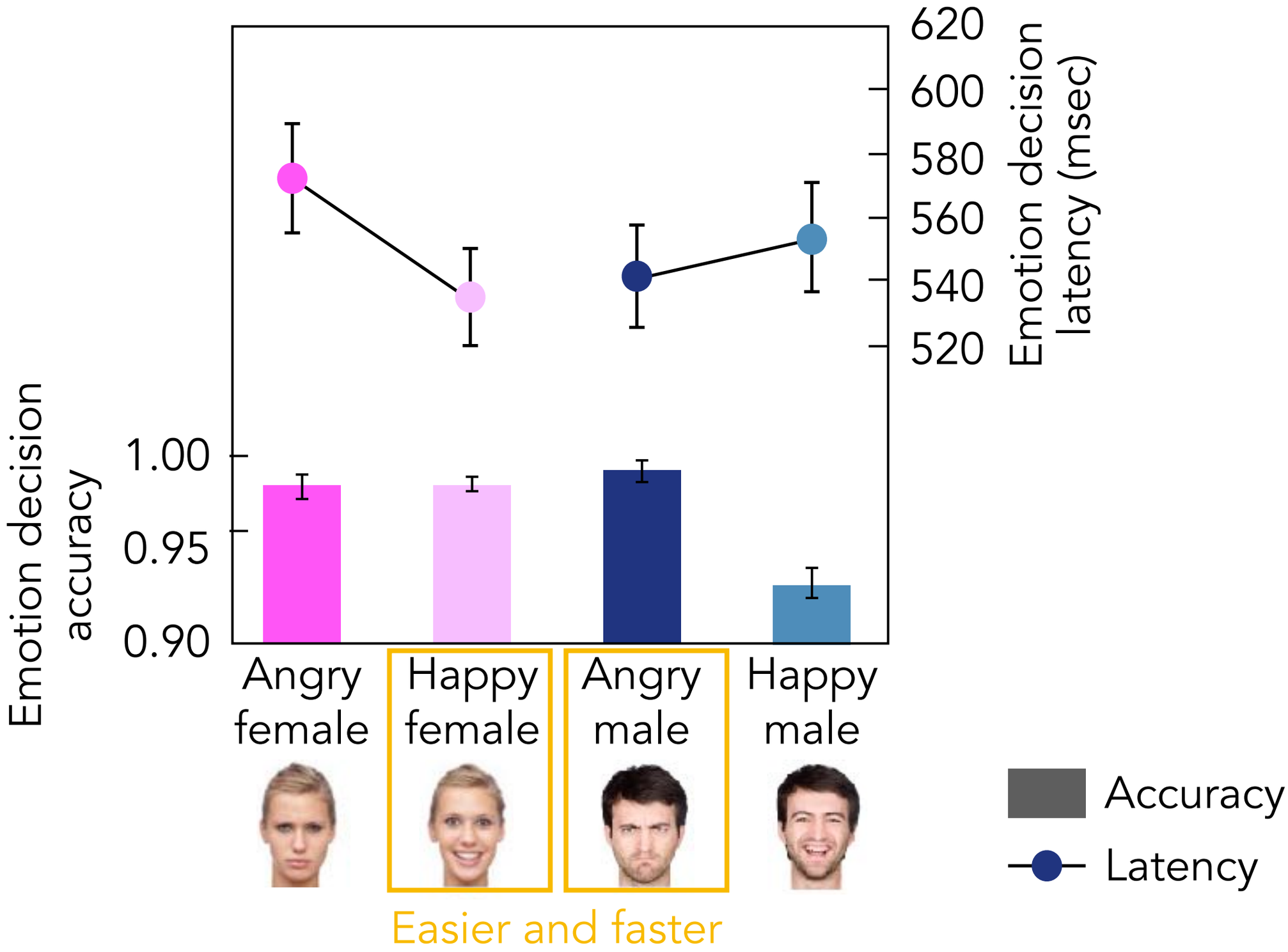
- Forecast expresser’s behavioral intentions
- Guide approach-avoidance behavior

Integrative processing of identity and expressive cues



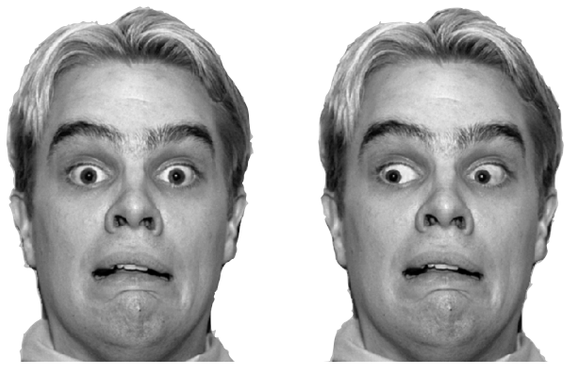
Becker et al. (2007)

Integrative processing of identity and expressive cues



Becker et al. (2007)

Pointing with eyes



Adams & Kleck, 2003, 2005; Hadjikhani et al., 2008

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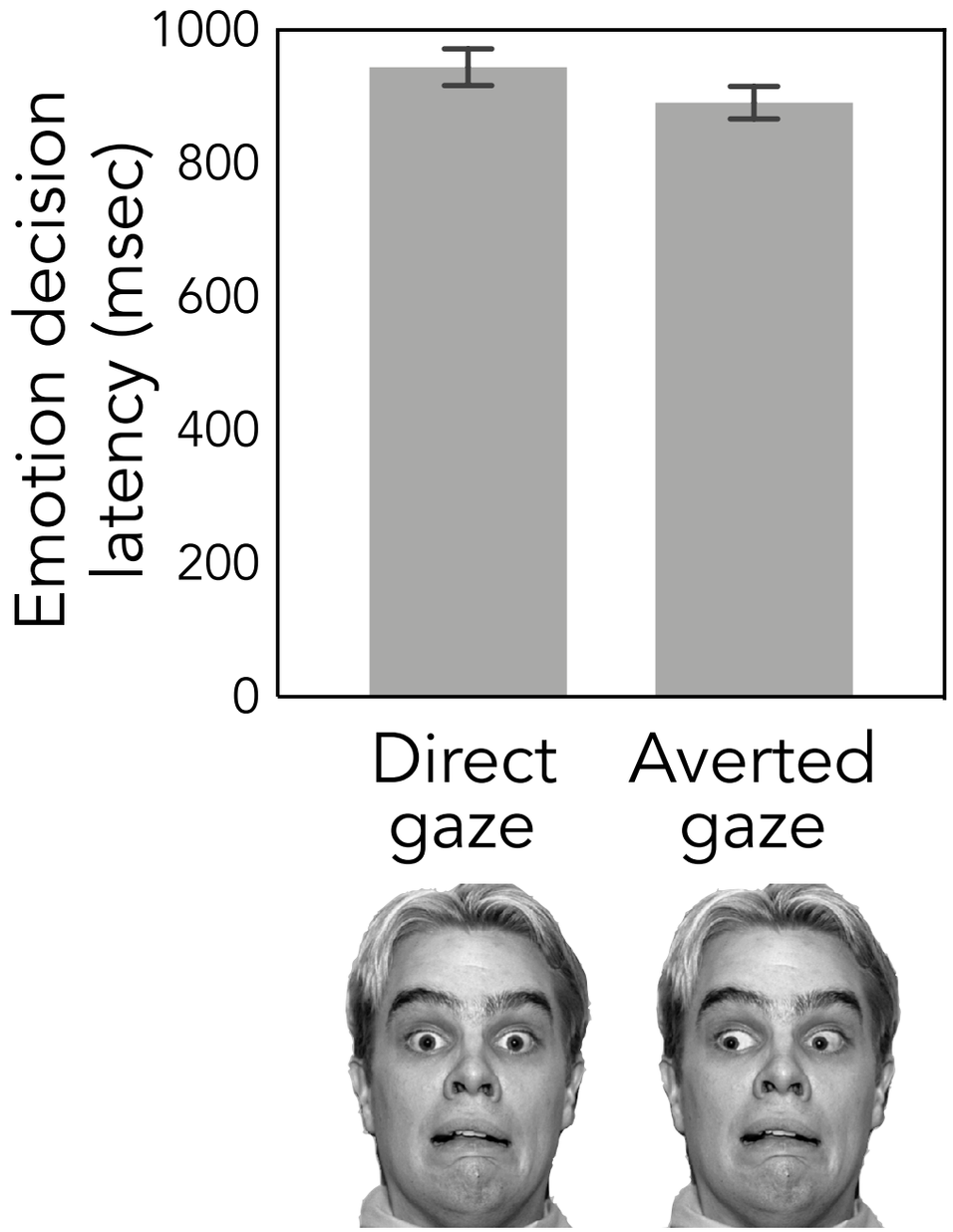

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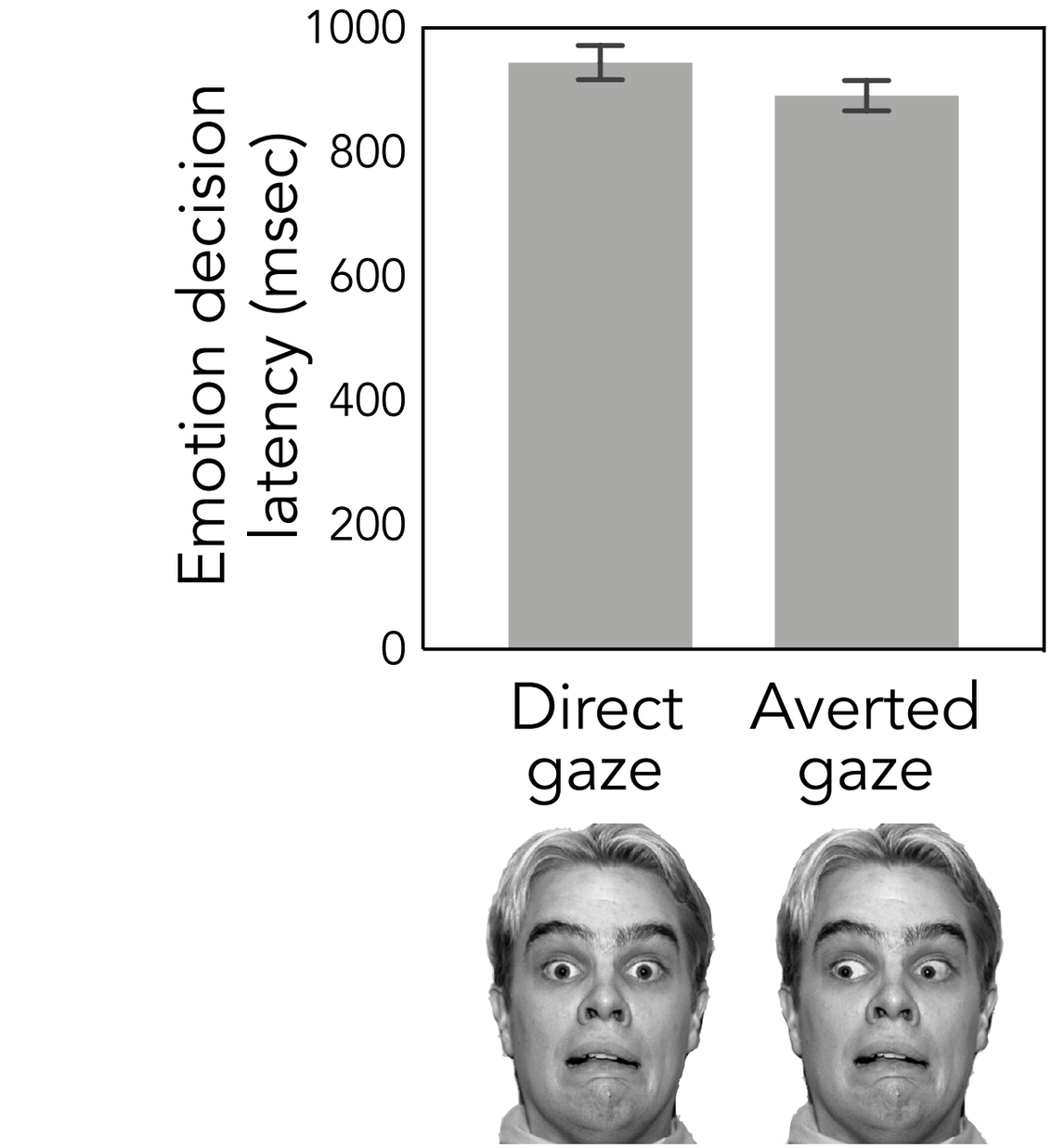

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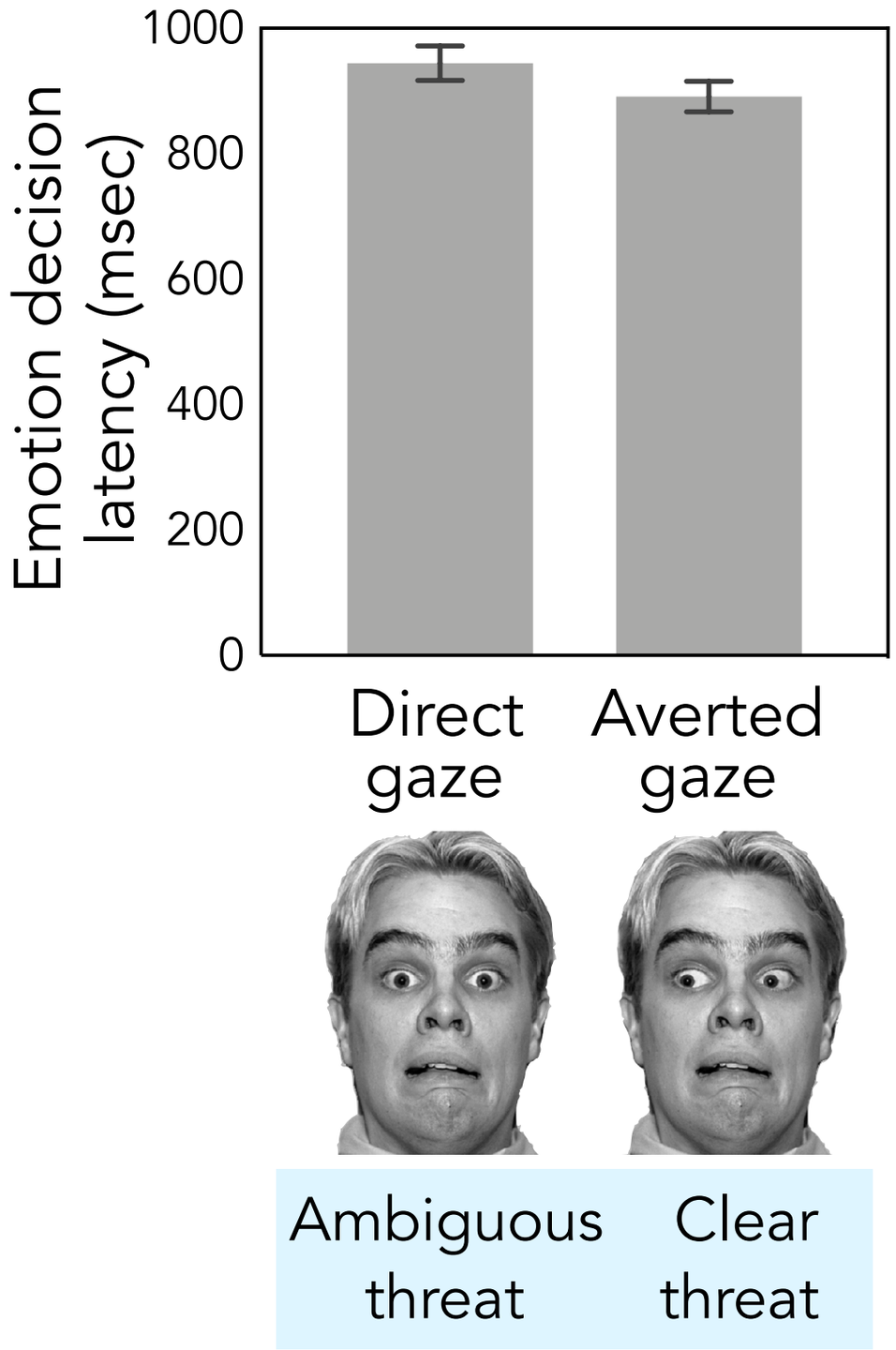
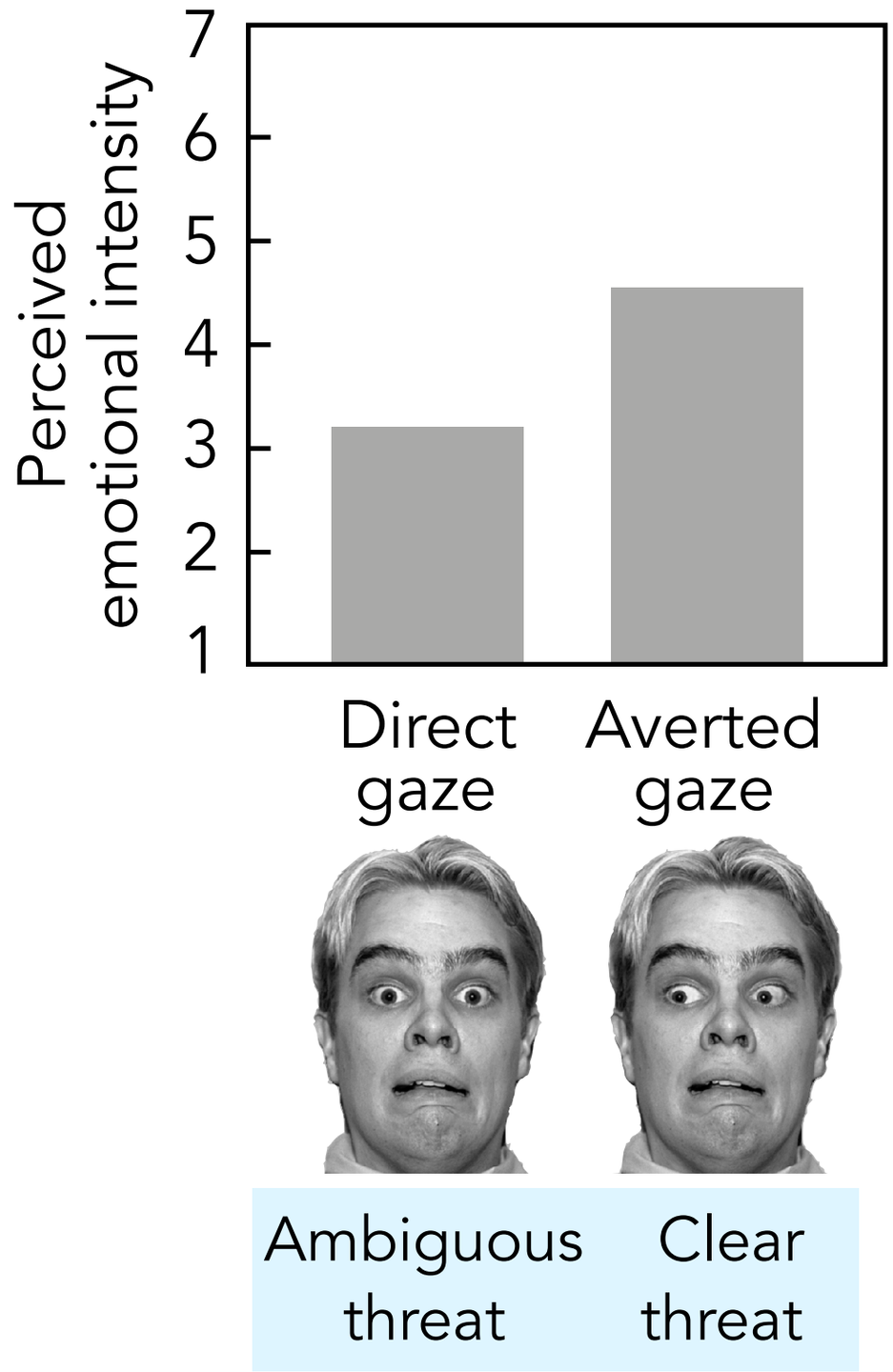




Adams & Kleck, 2003, 2005; Hadjikhani et al., 2008

Different processing speed of compound facial threat cues

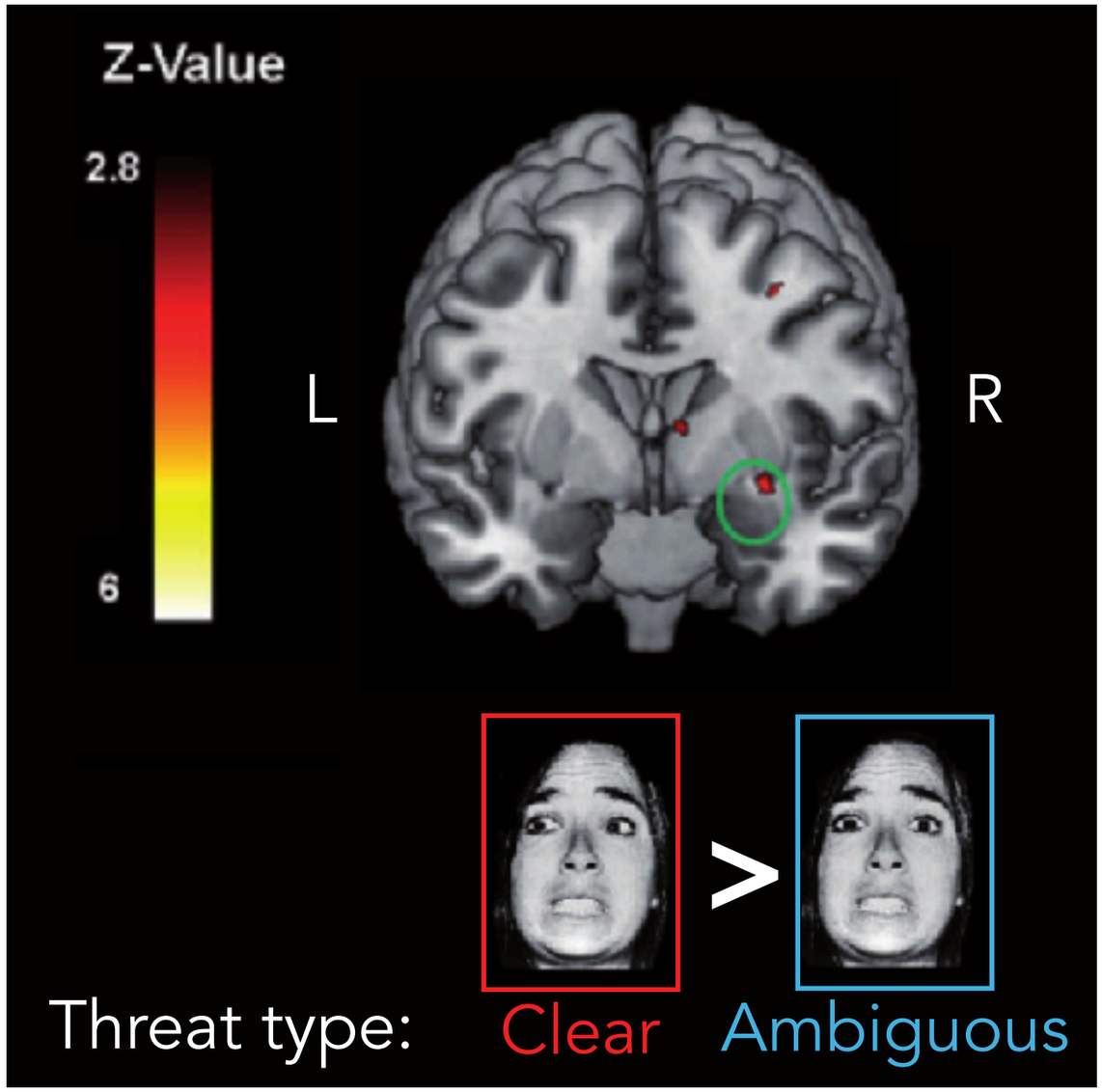
Clear

Ambiguous

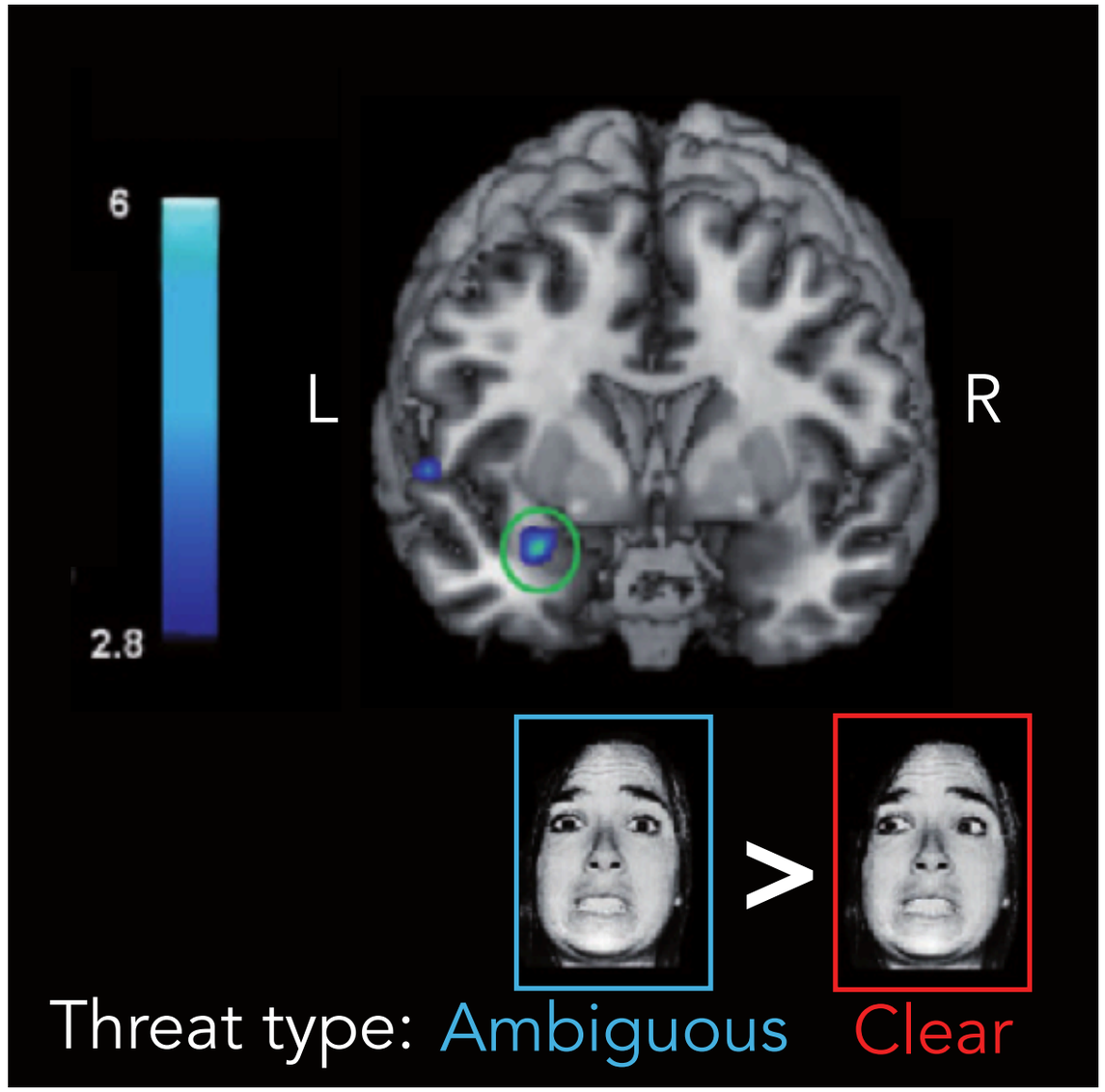
Adams et al., 2012

Different processing speed of compound facial threat cues

Short exposure
(300 msec)



Long exposure
(1000 msec)



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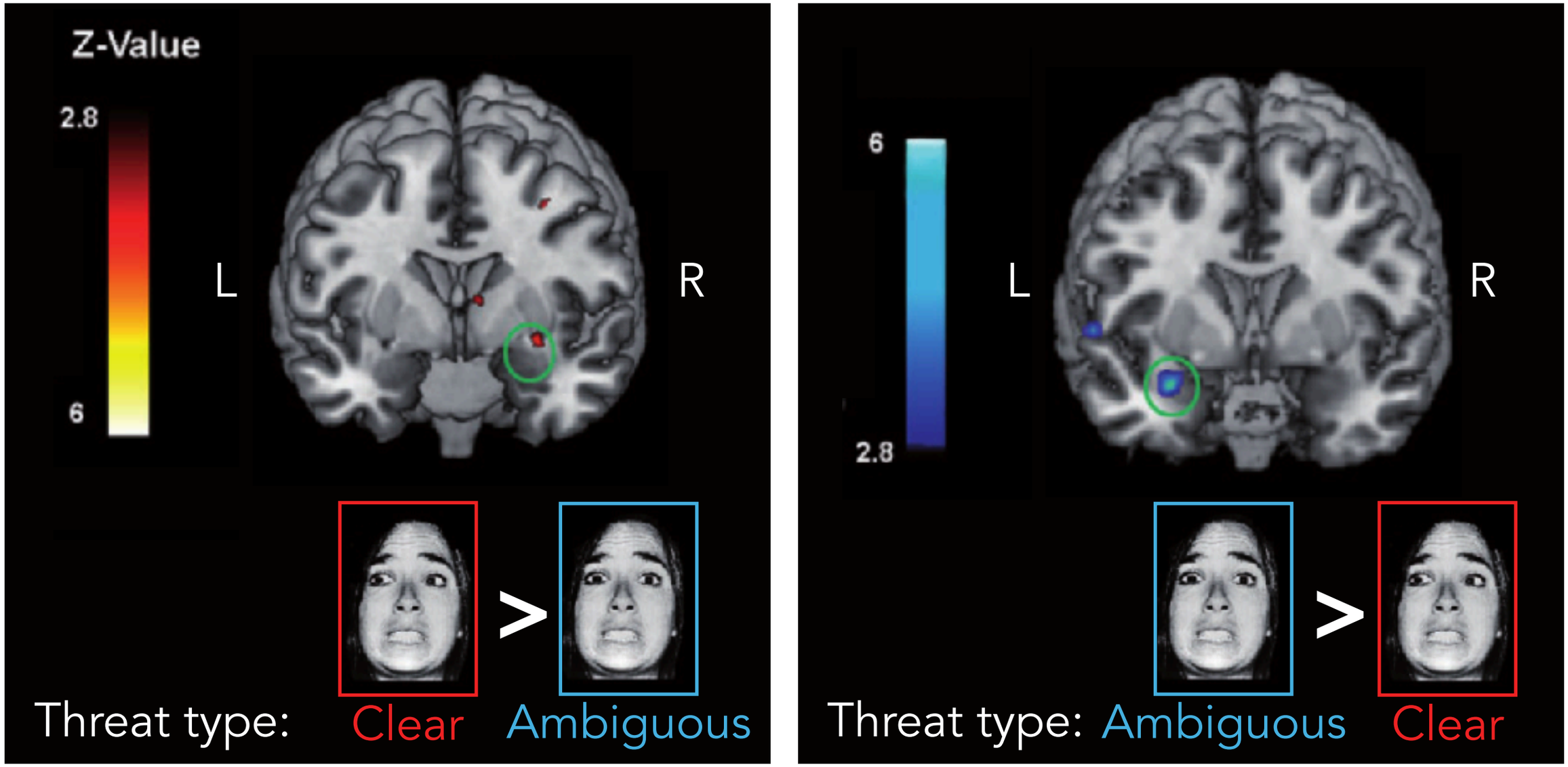

Early, reflexive right amygdala response more tuned to clear threat cue

Later, reflective left amygdala response more tuned to ambiguous threat

Adams et al., 2012

Reflexive and reflective processing

Clear

Ambiguous

Cushing et al., 2018

Reflexive and reflective processing

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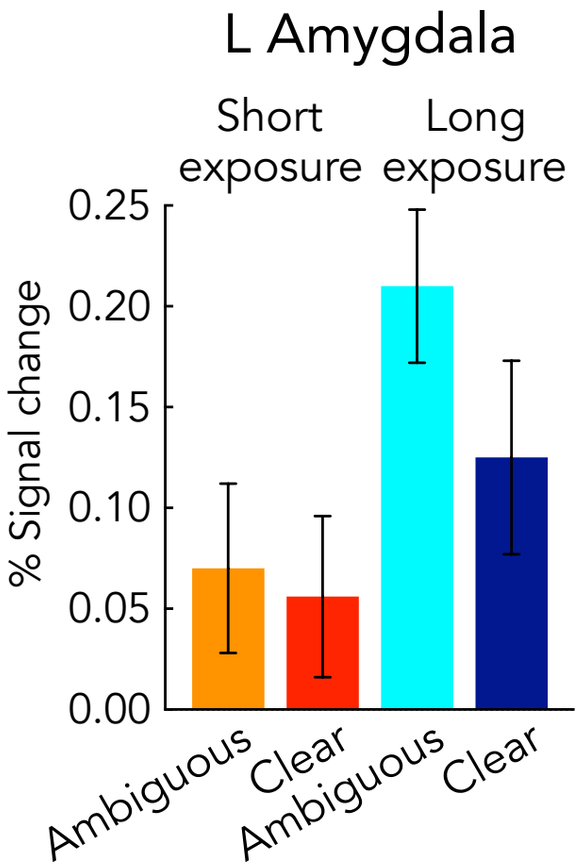

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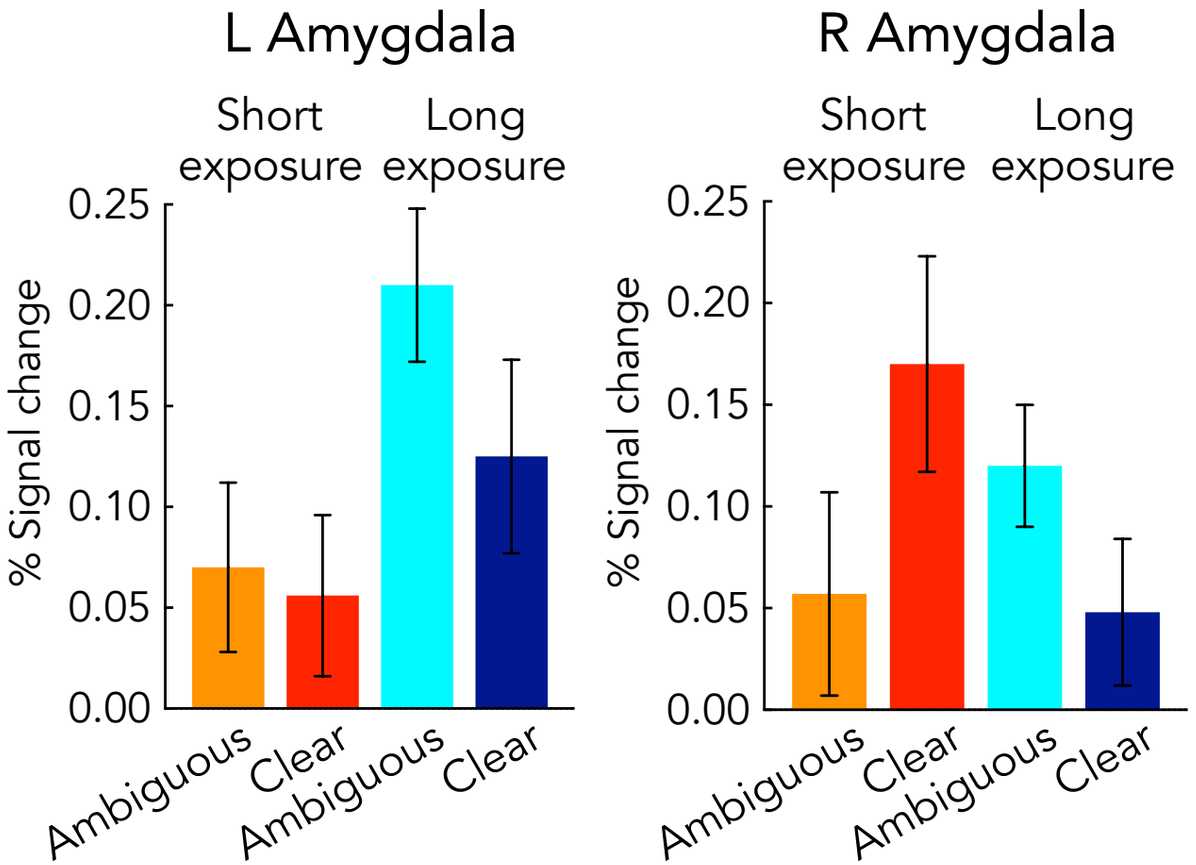

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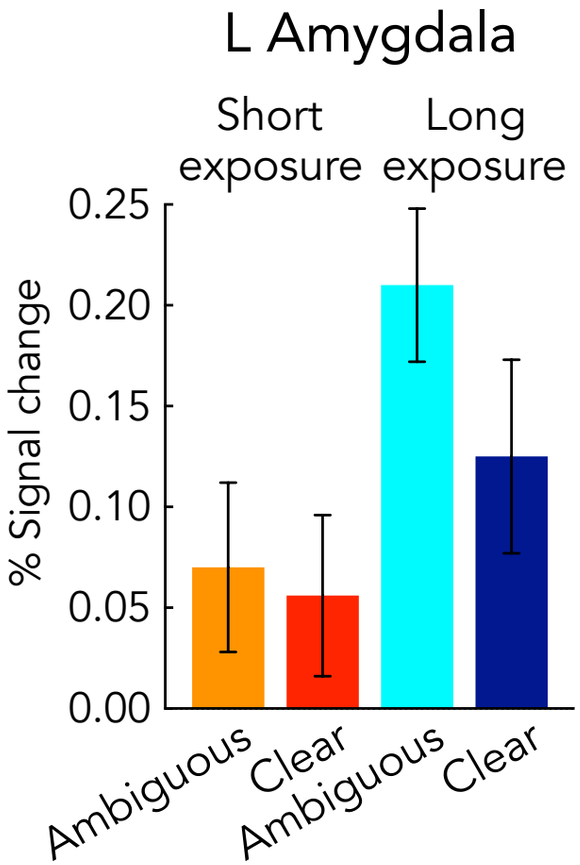

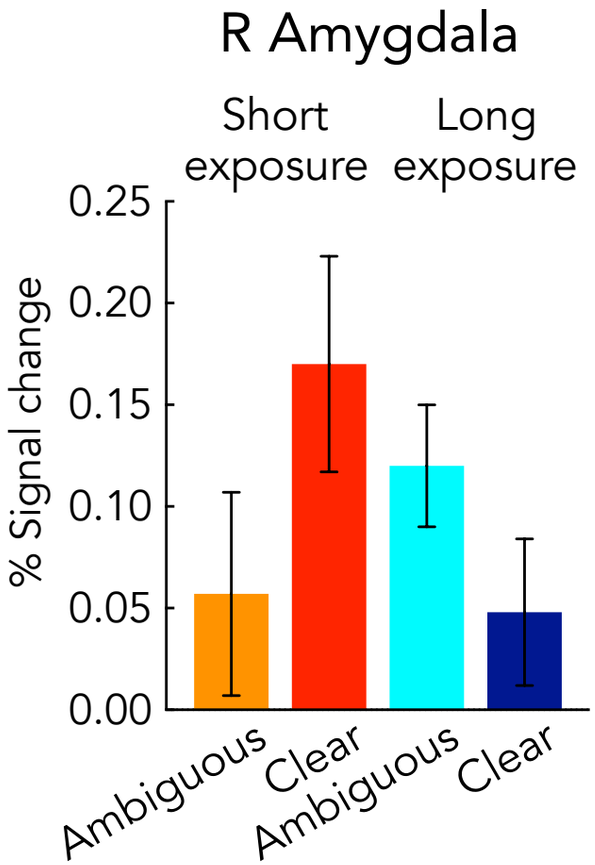

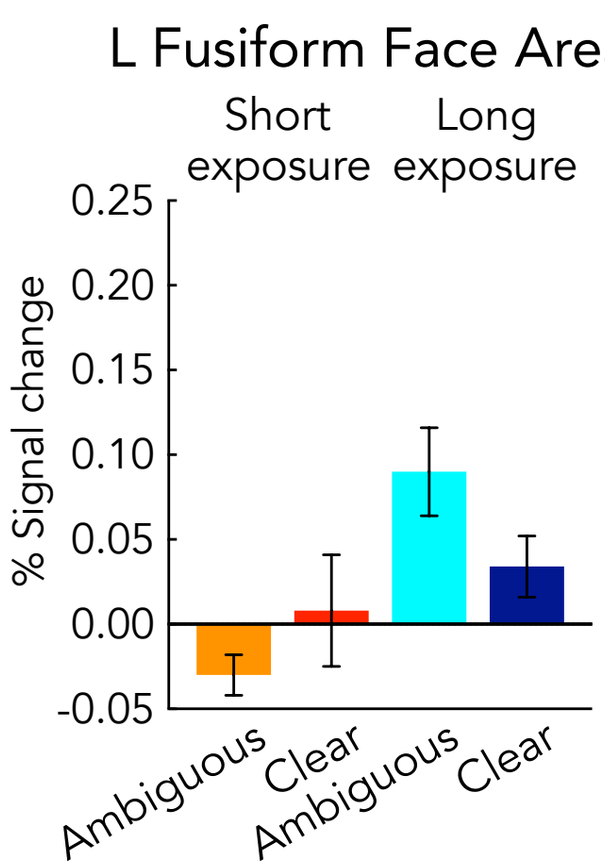

Cushing et al., 2018

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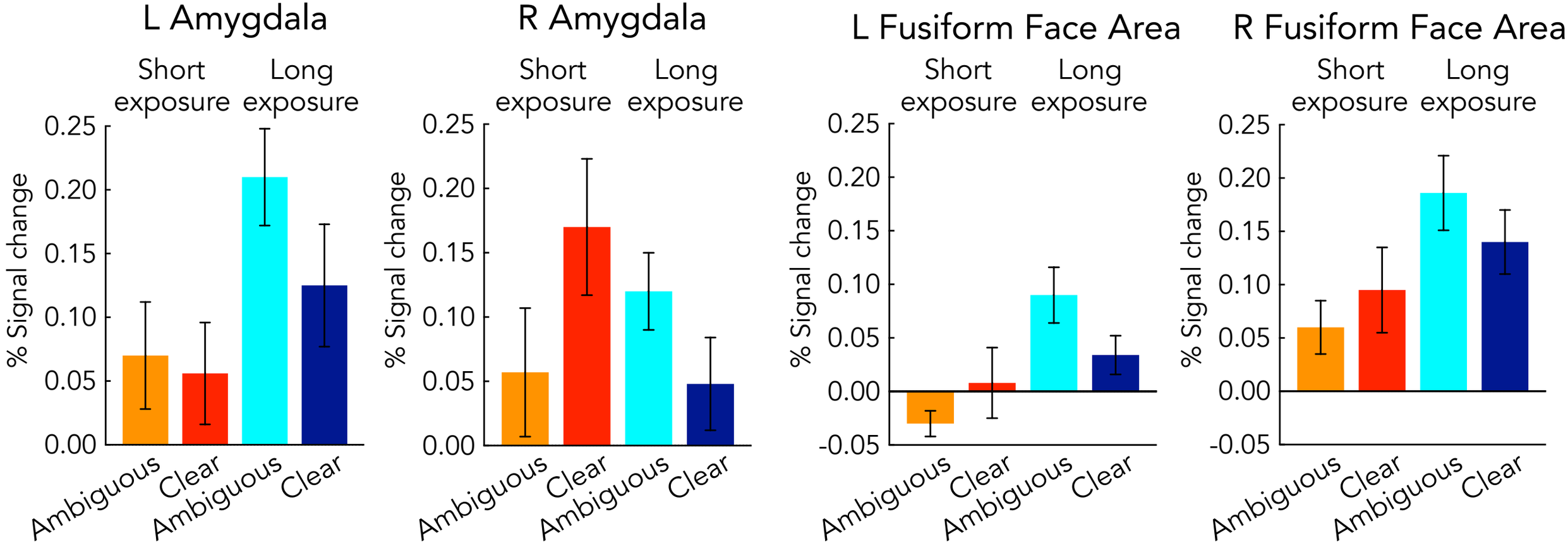

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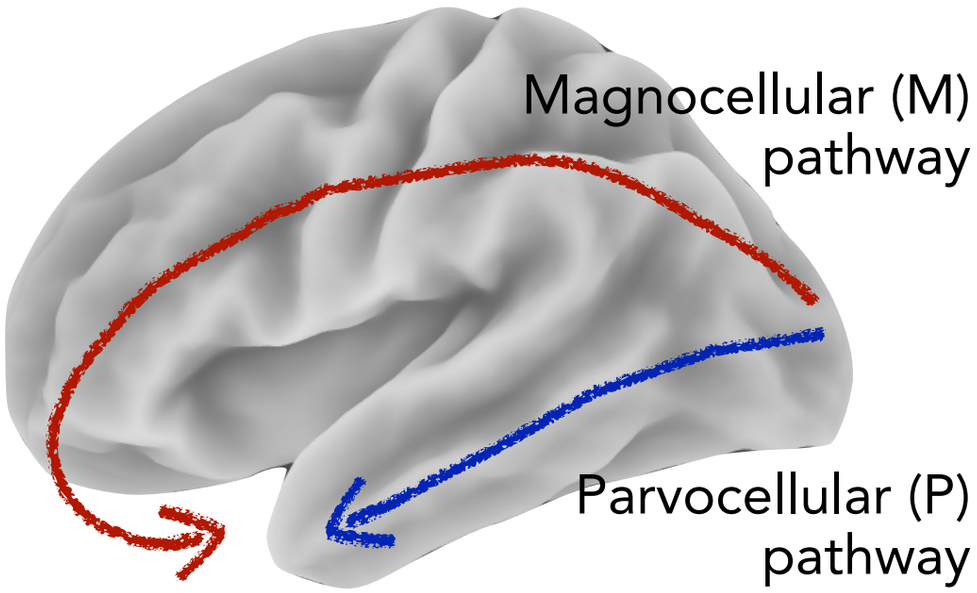
Two different routes of facial threat processing



- M-pathway: Early, reflexive processing of clear threat cues for rapid reaction

- P-pathway: Slower, reflective processing of ambiguous threat cues (direct gaze fear) for detailed analysis

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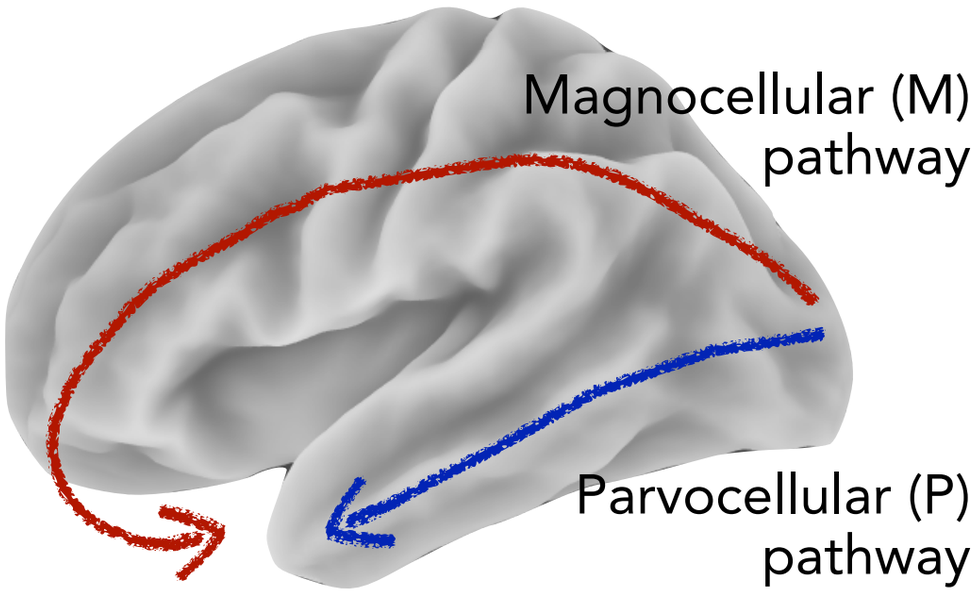

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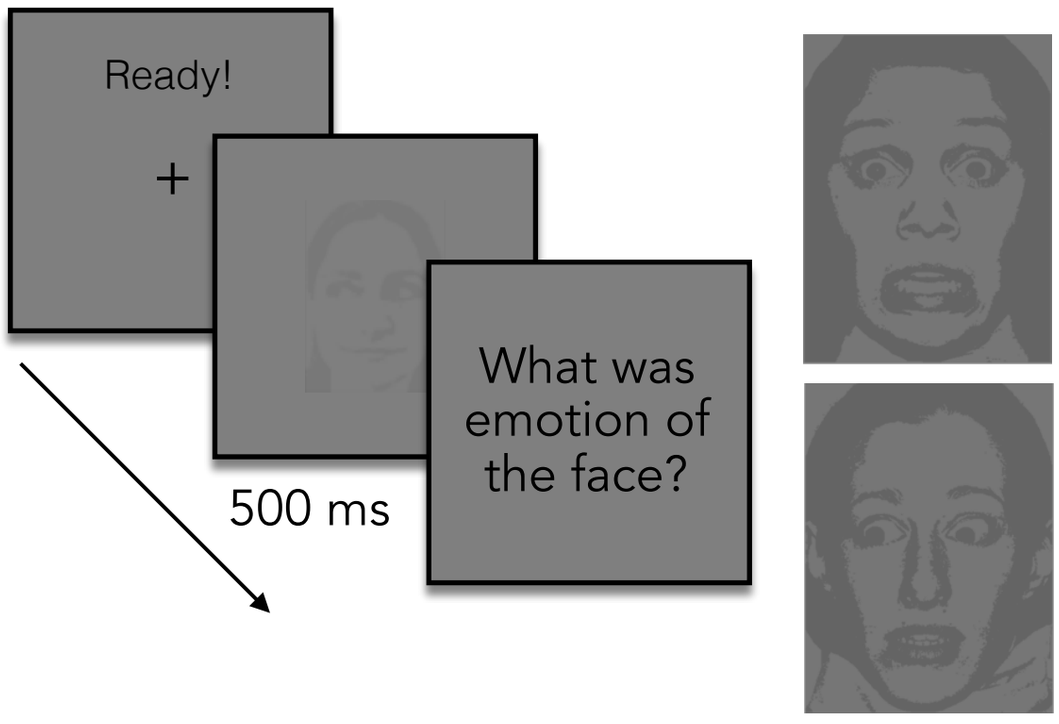
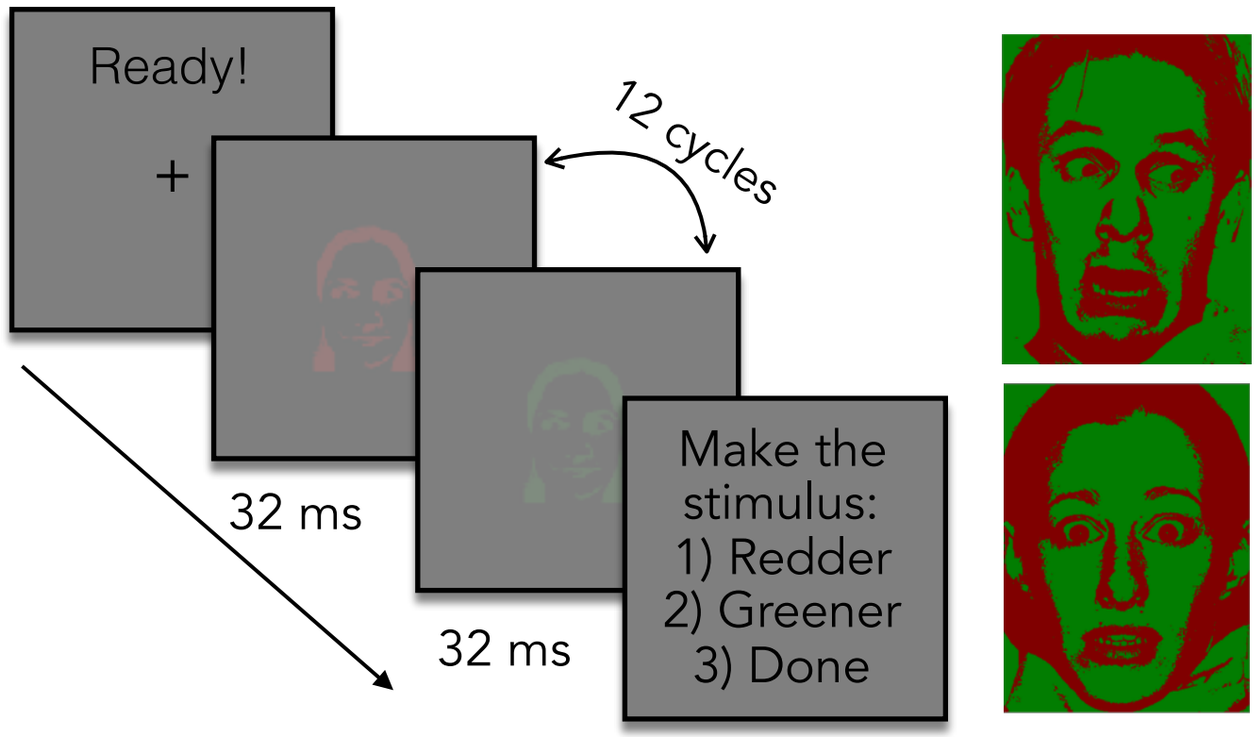
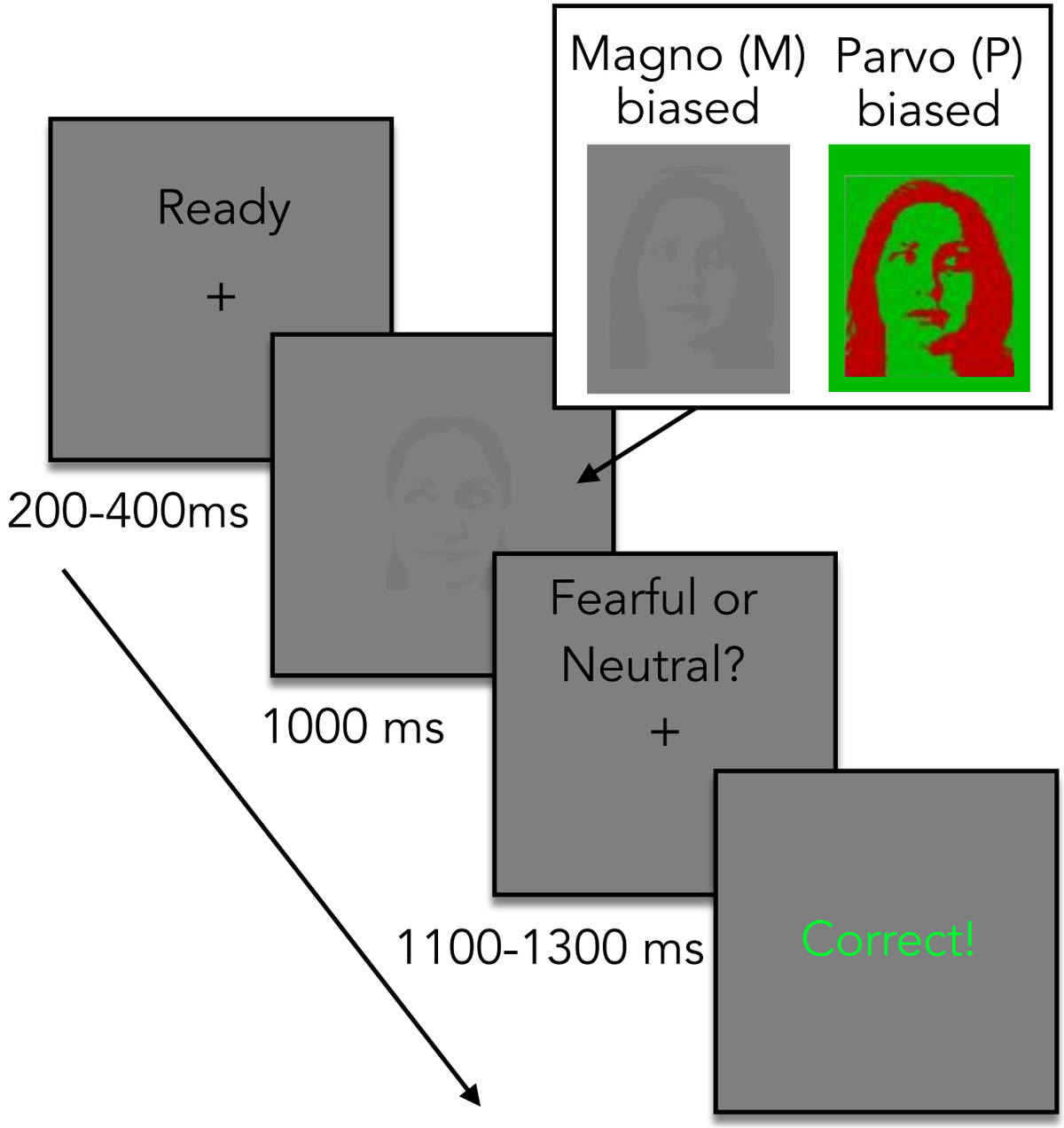
M-biased stimulus



P-biased stimulus



Magnocellular and Parvocellular processing of facial threat cues



Im et al., *Scientific Reports* (2017); Im et al., *in preparation*

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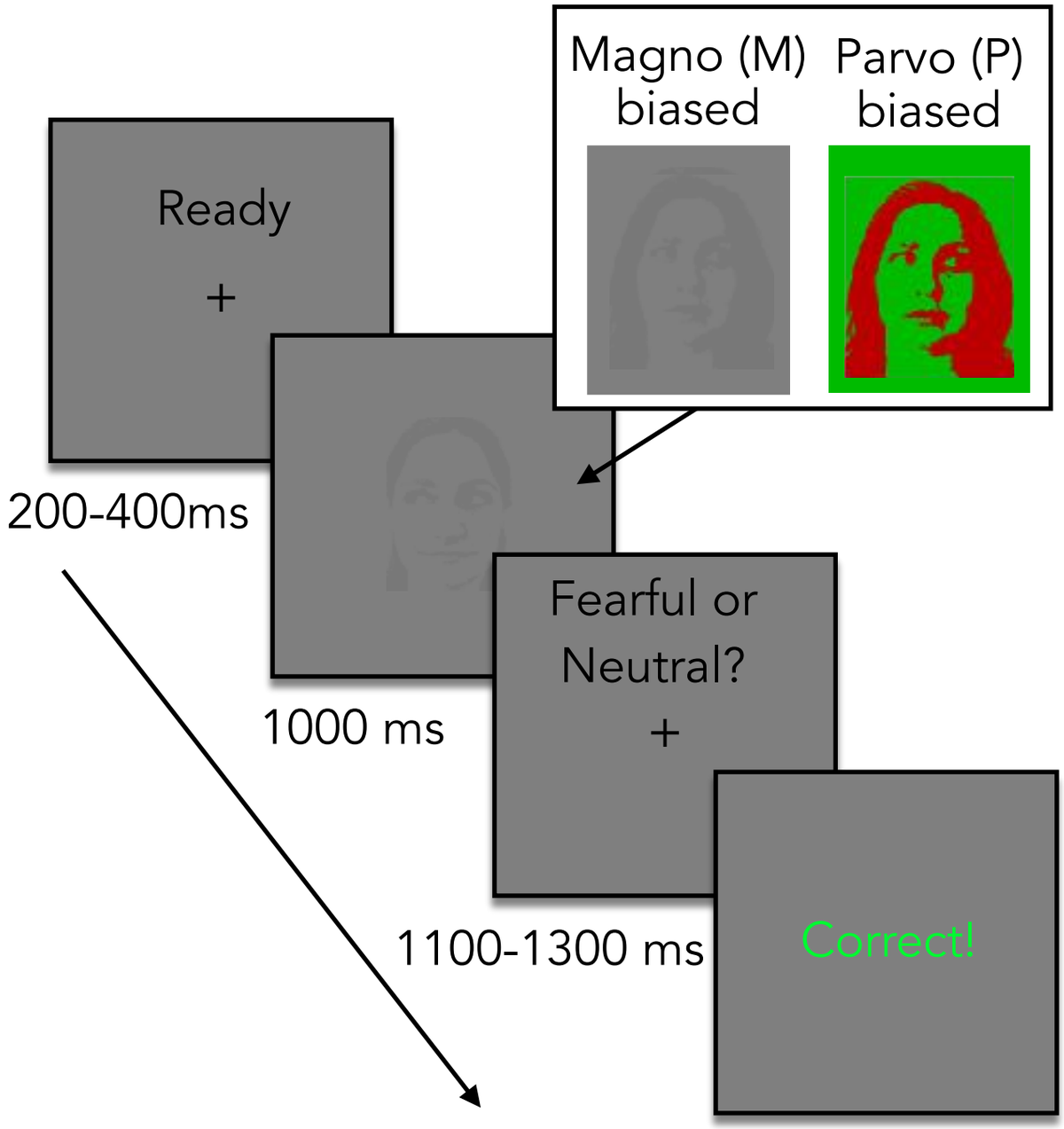

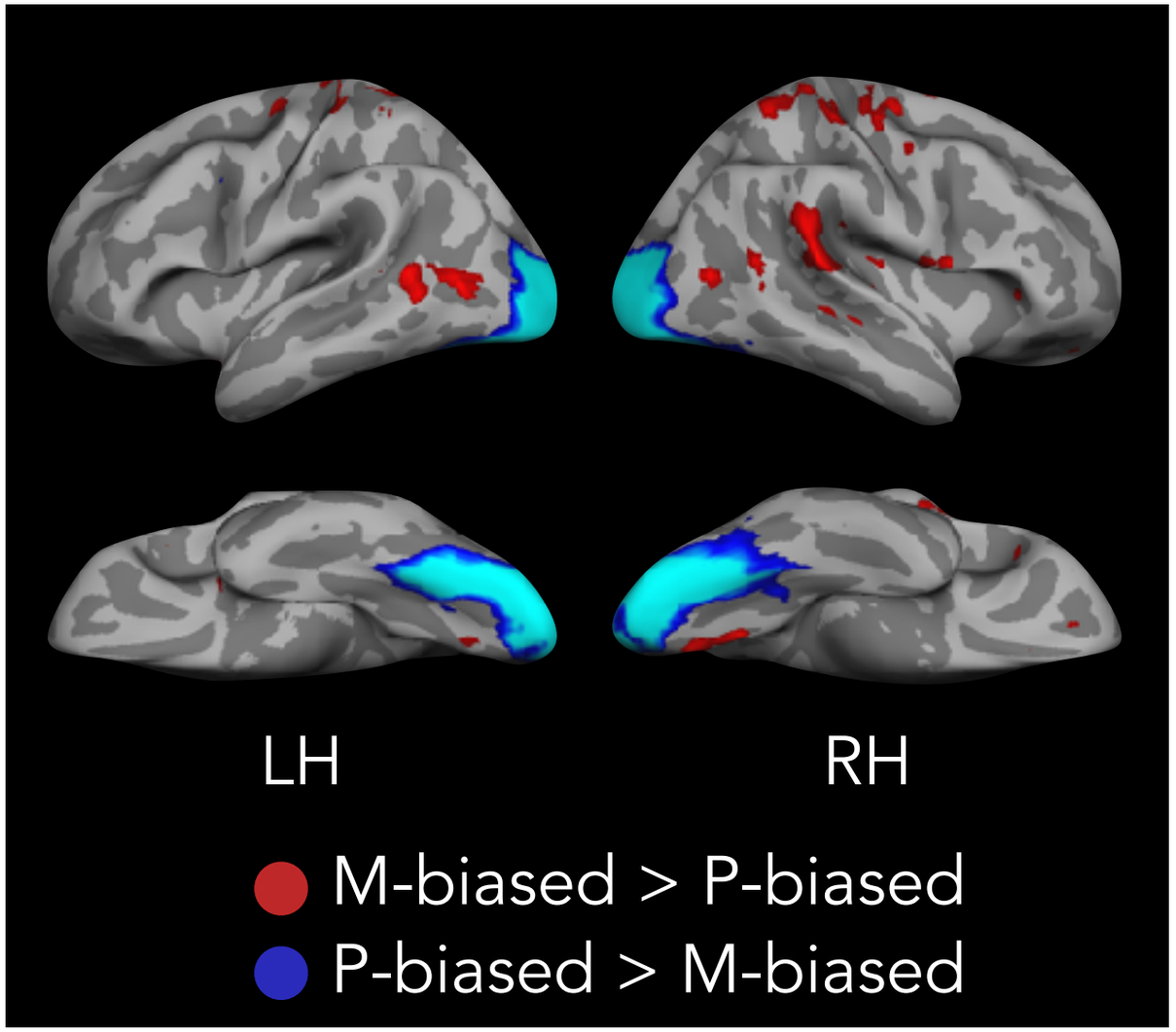

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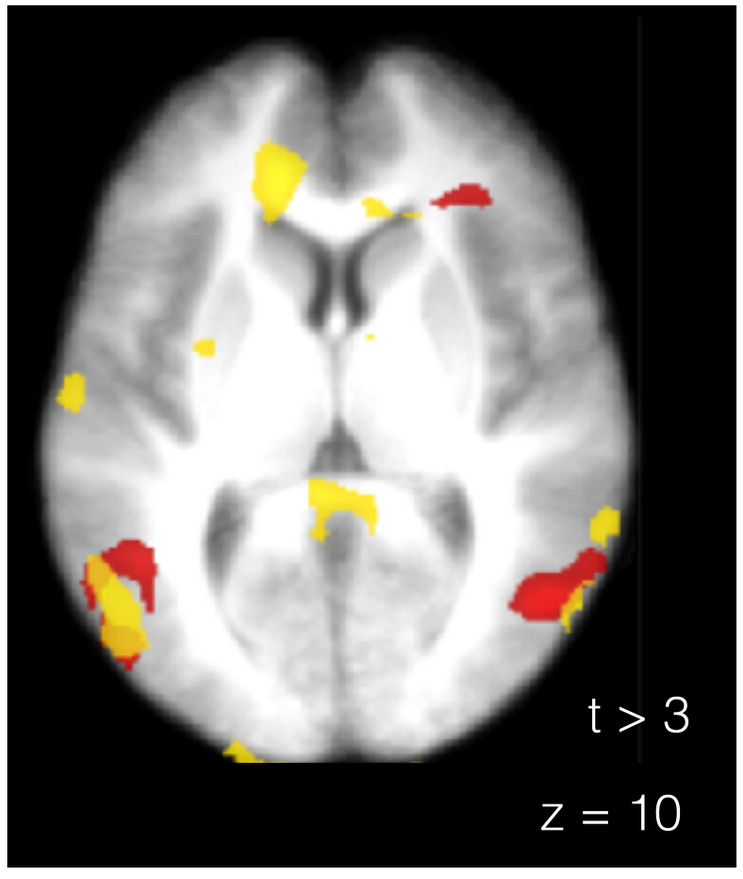
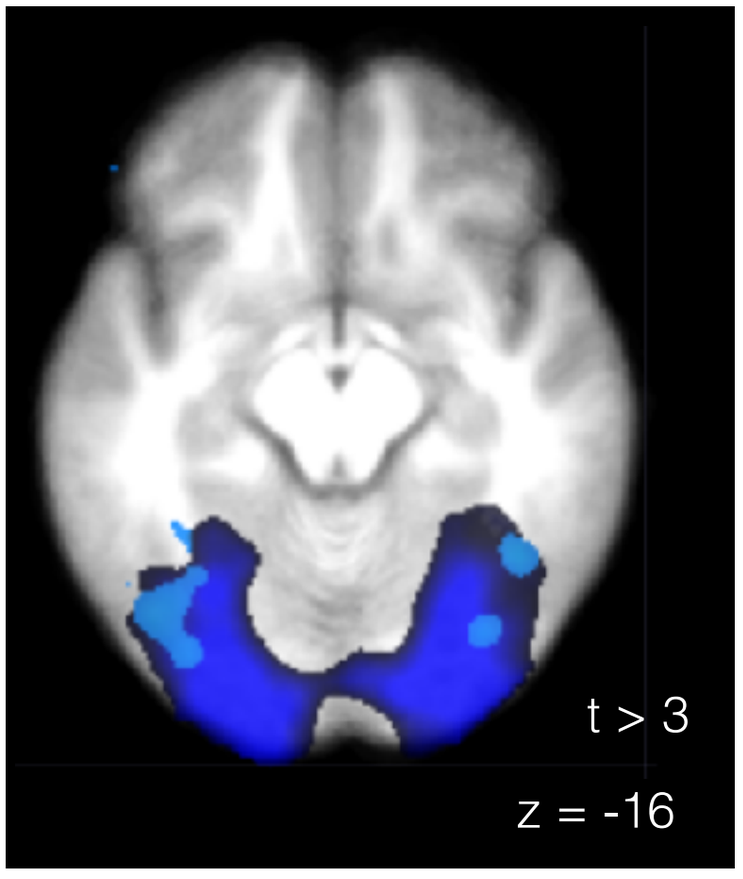
Magnocellular and Parvocelluar processing of facial threat cues

Overlaps between areas that prefer Magno processing and processing of clear threat



- M-biased > P-biased
- Clear > Ambiguous

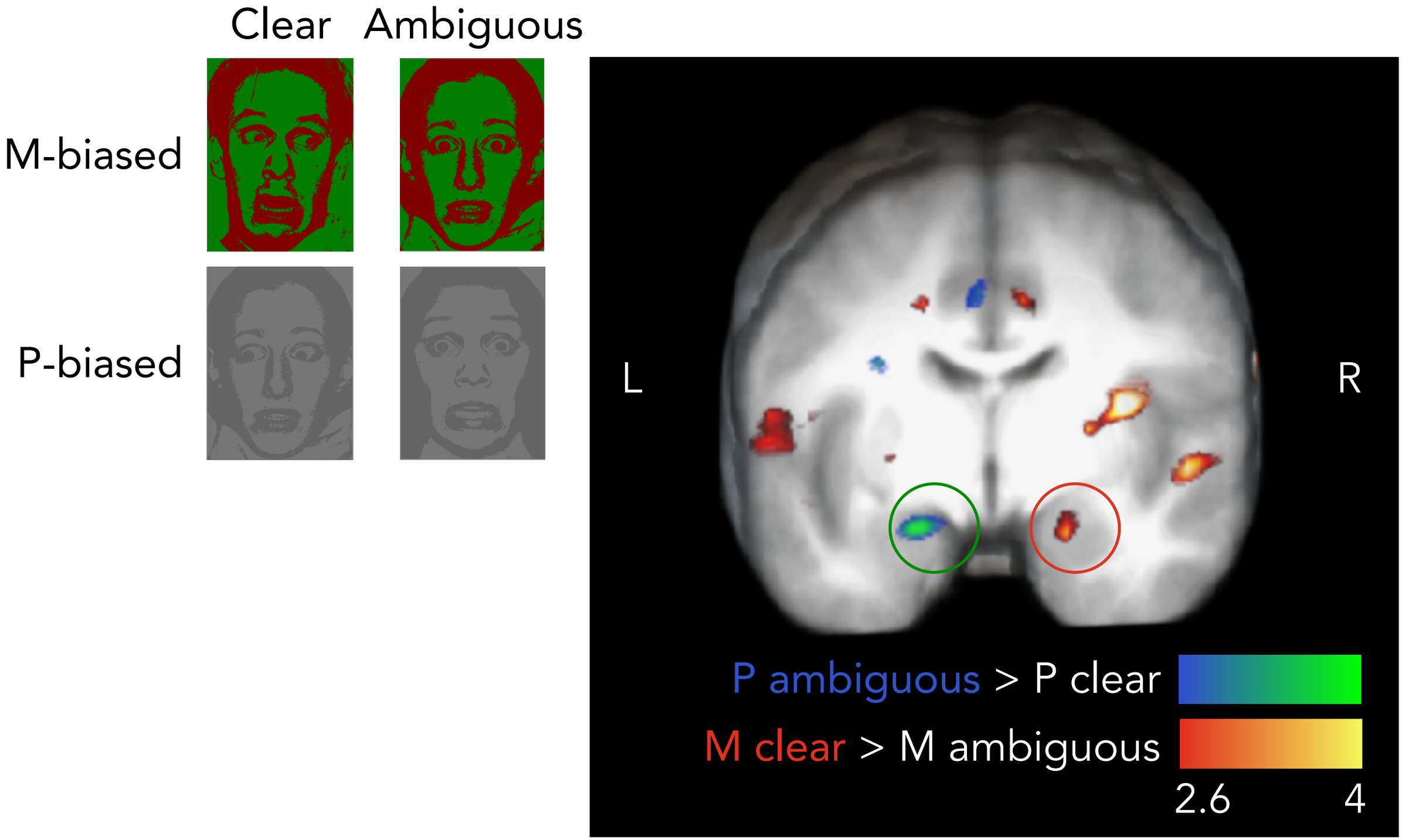
Overlaps between areas that prefer Parvo processing and processing of ambiguous threat



- P-biased > M-biased
- Ambiguous > Clear

Im et al., *in preparation*

Differential processing bias of the bilateral amygdala



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Interim summary

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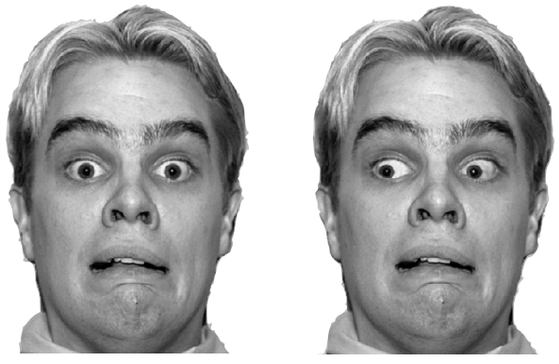
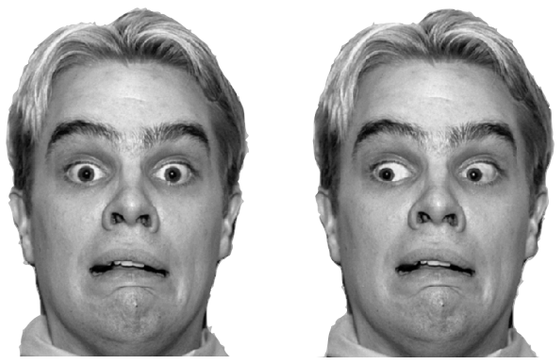


1) Integrative processing of facial cues

Interim summary



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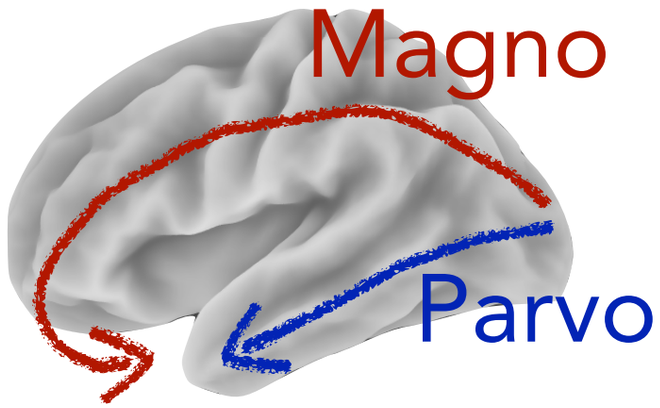

2) Differential pathway contributions to processing of facial threat cues

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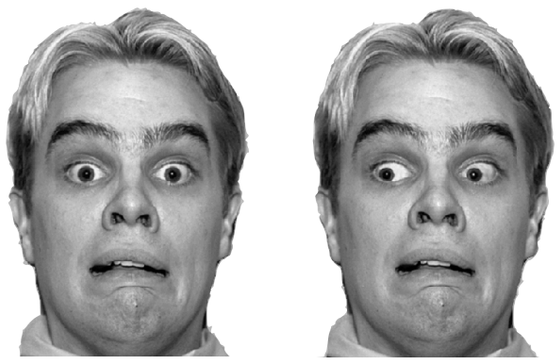

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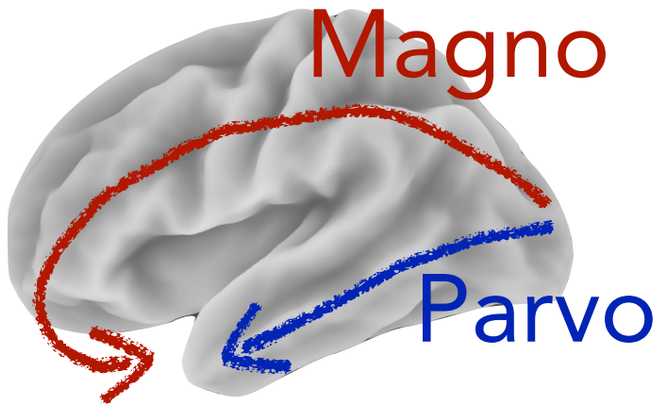

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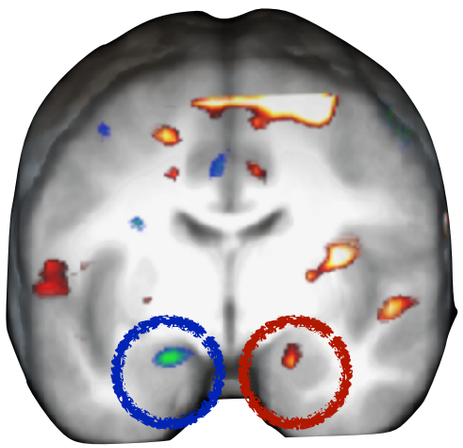


3) Hemispheric lateralization of Amygdala responses to facial threat cues

Reading the overall emotion of crowds of faces

- Snap judgement on the overall emotion of crowds of people
- Social behaviors towards / against emotional crowds

Emotional crowds

Angry 100%

Angry 68%
Happy 32%

Angry 60%
Happy 40%

Angry 50%
Happy 50%

Angry 40%
Happy 60%

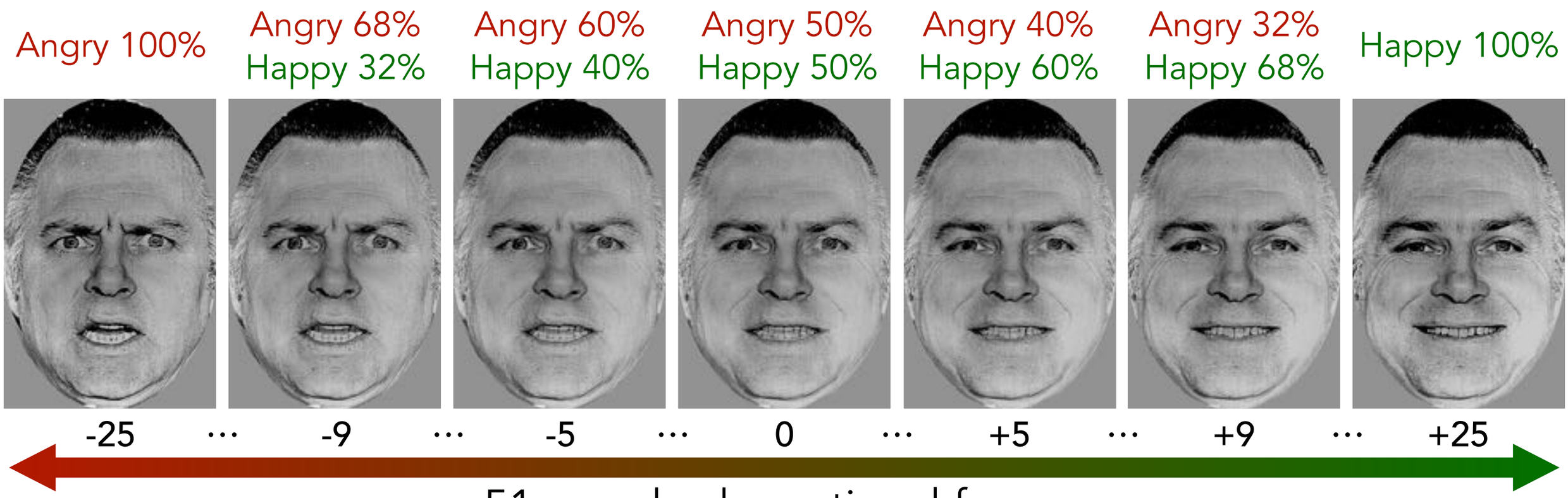
Angry 32%
Happy 68%

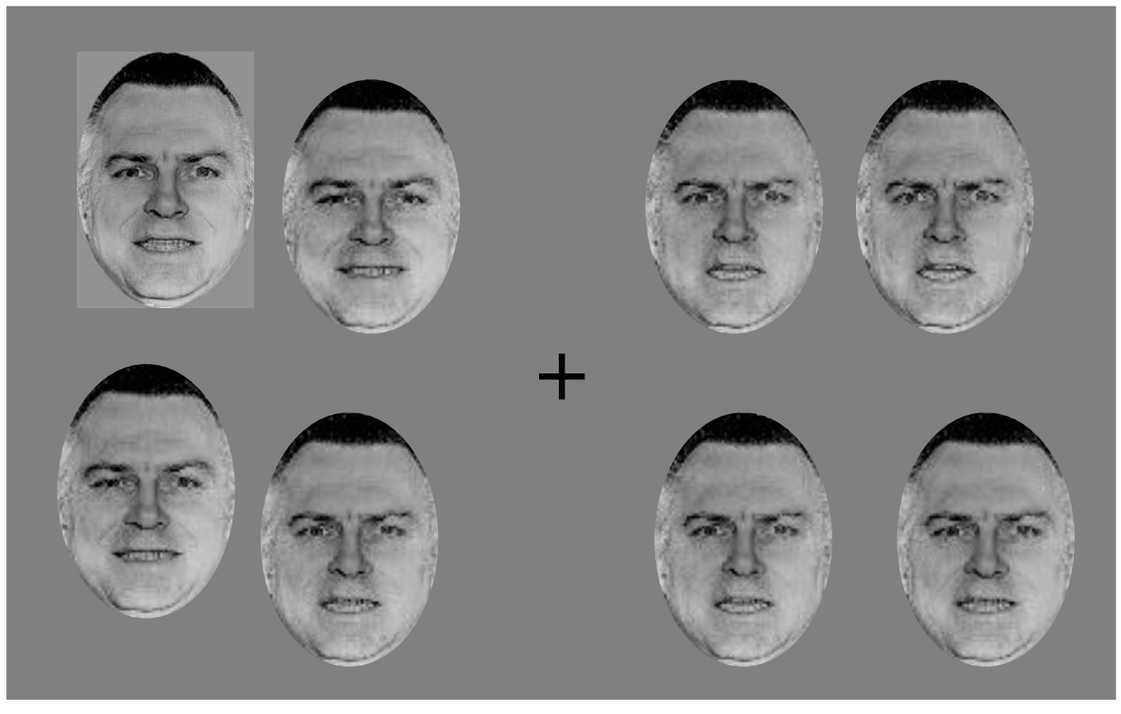
Happy 100%

-25 … -9 … -5 … 0 … +5 … +9 … +25

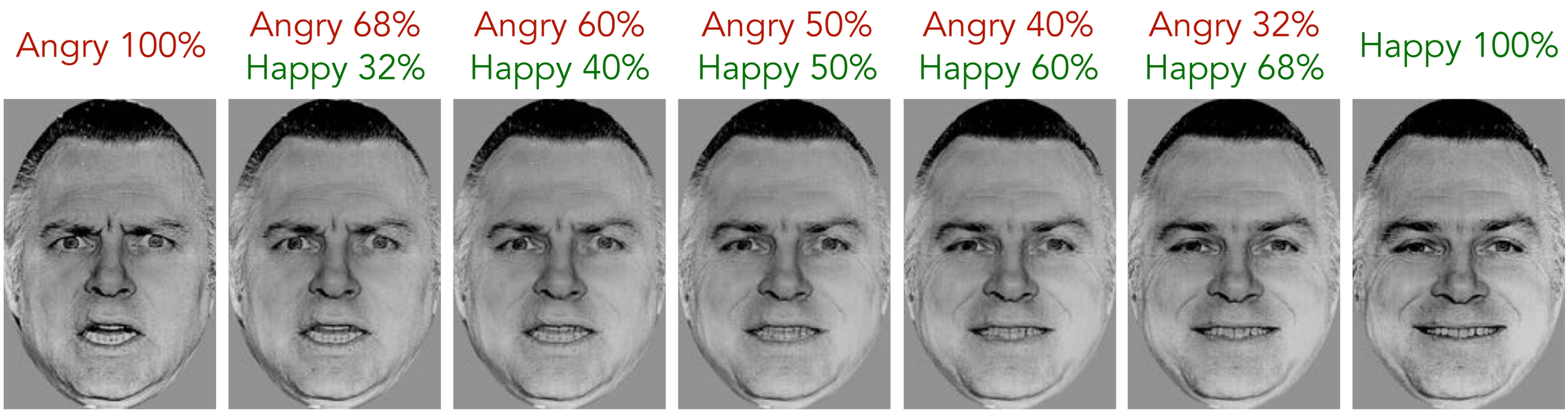
51 morphed emotional faces

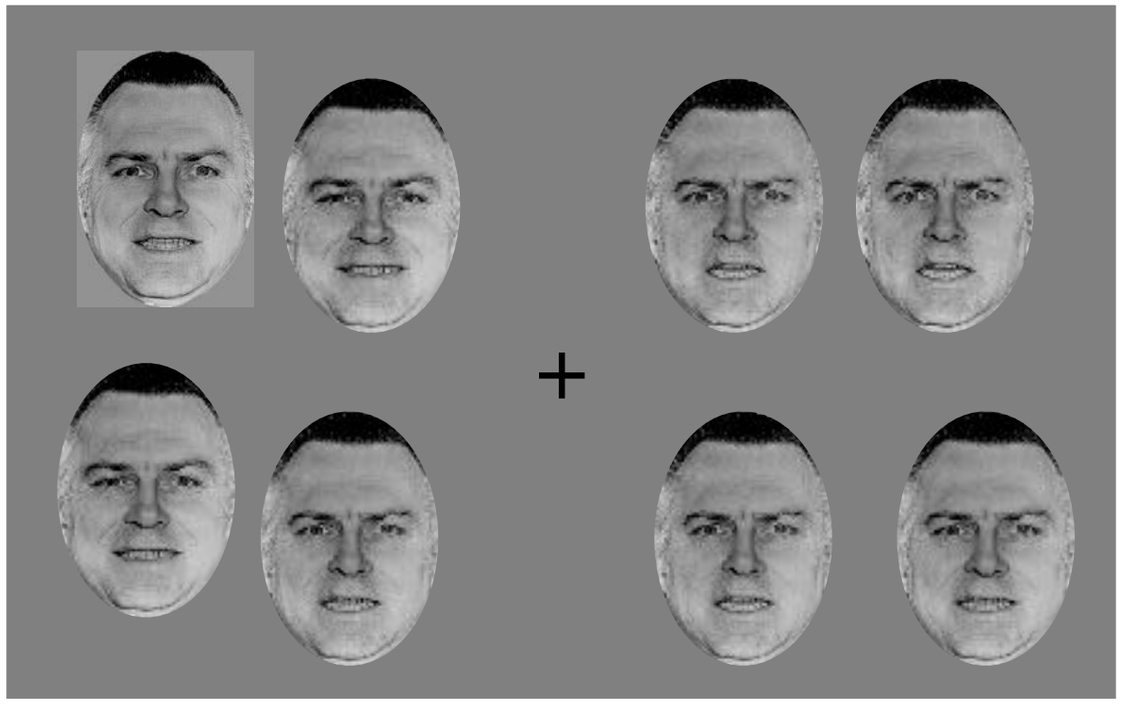
Emotional crowds





Emotional crowds





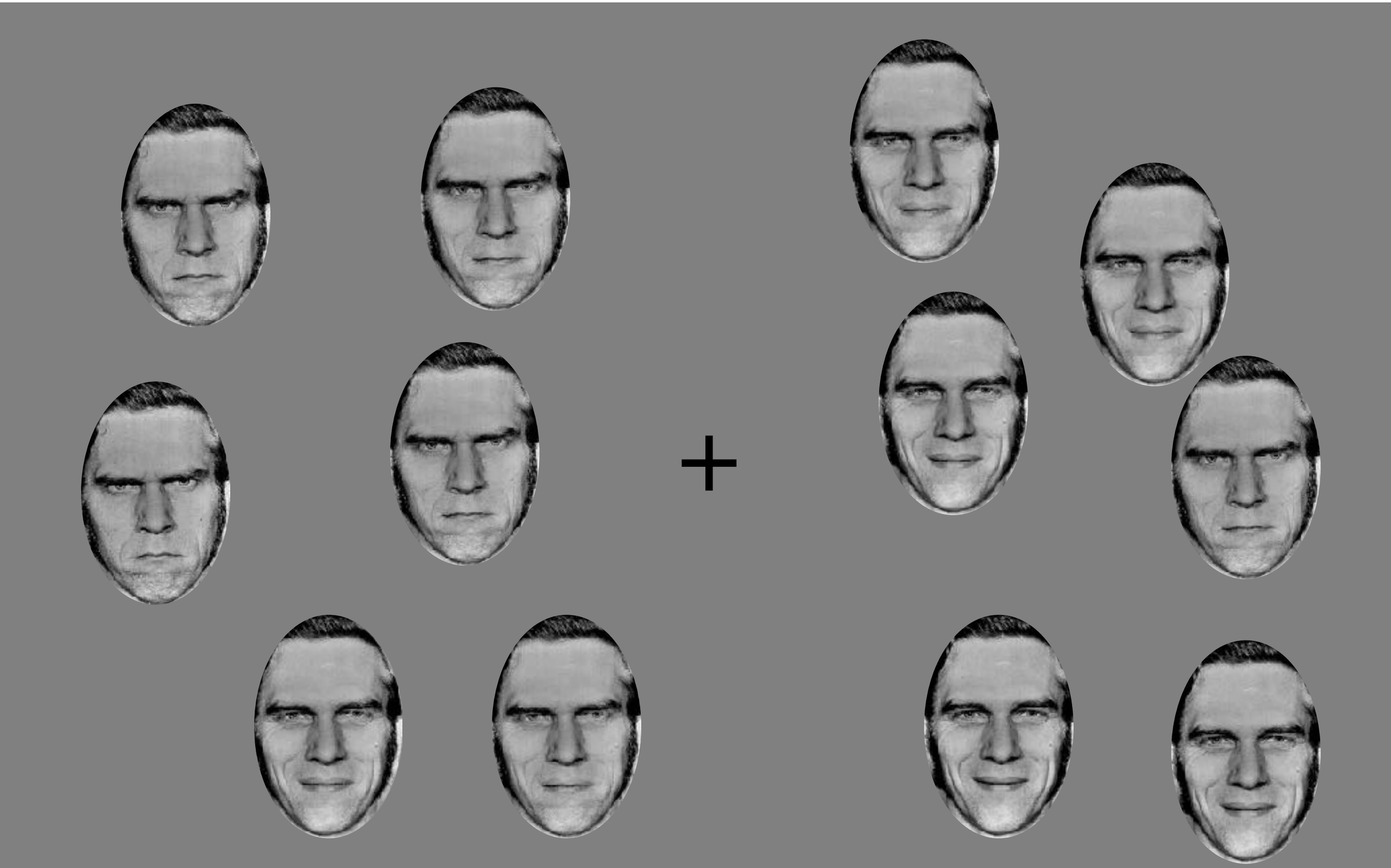
- Four distances in average emotion of crowds to be compared (-9, -5,+5, +9)
- Six identities (3 females, 3 males)
- Number of faces in a crowd: 4 or 6 (8 or 12 total)

Which crowd would you rather avoid?

Task: Which crowd would you rather avoid?

Ready

Which crowd would you rather avoid?

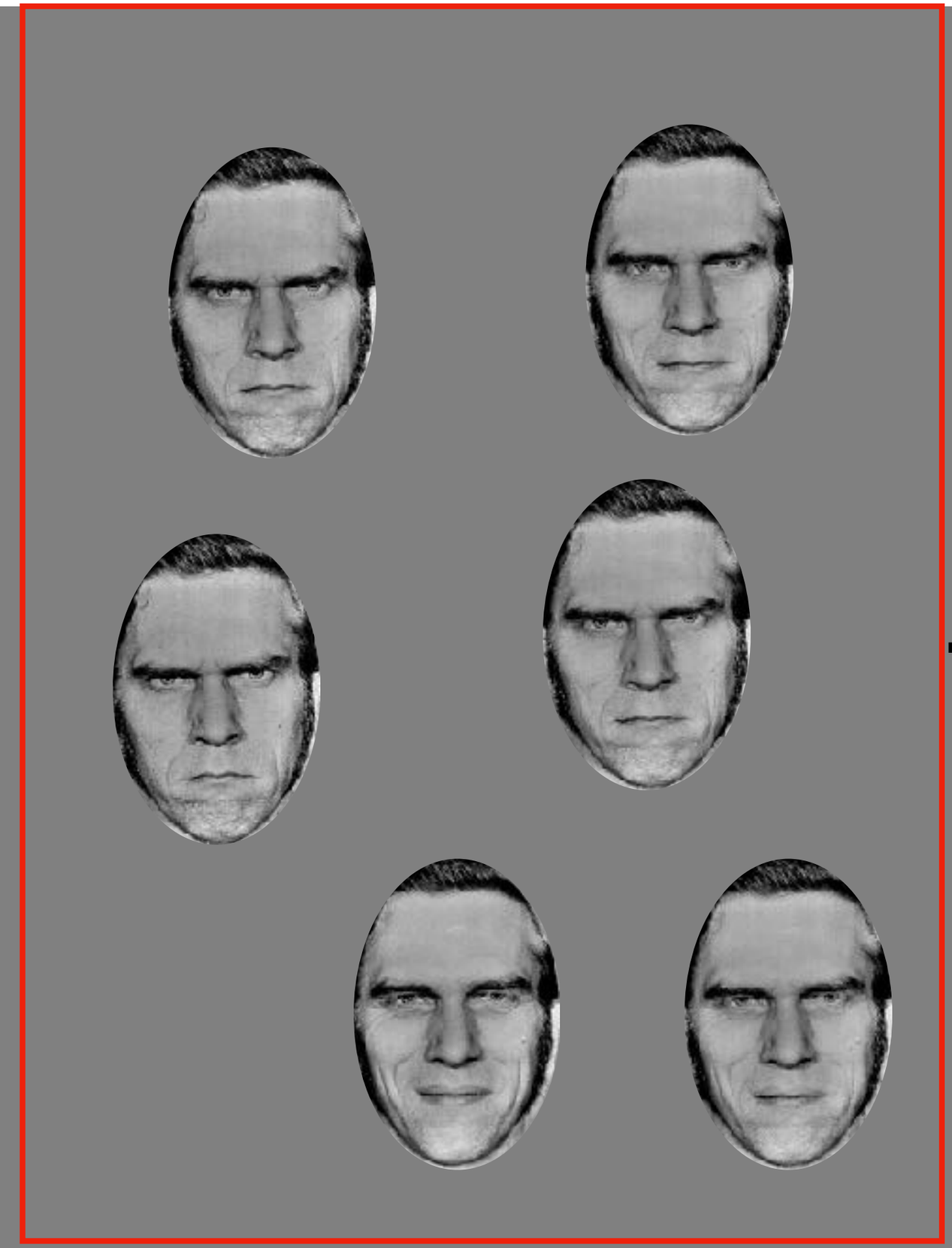


Which crowd would you rather avoid?

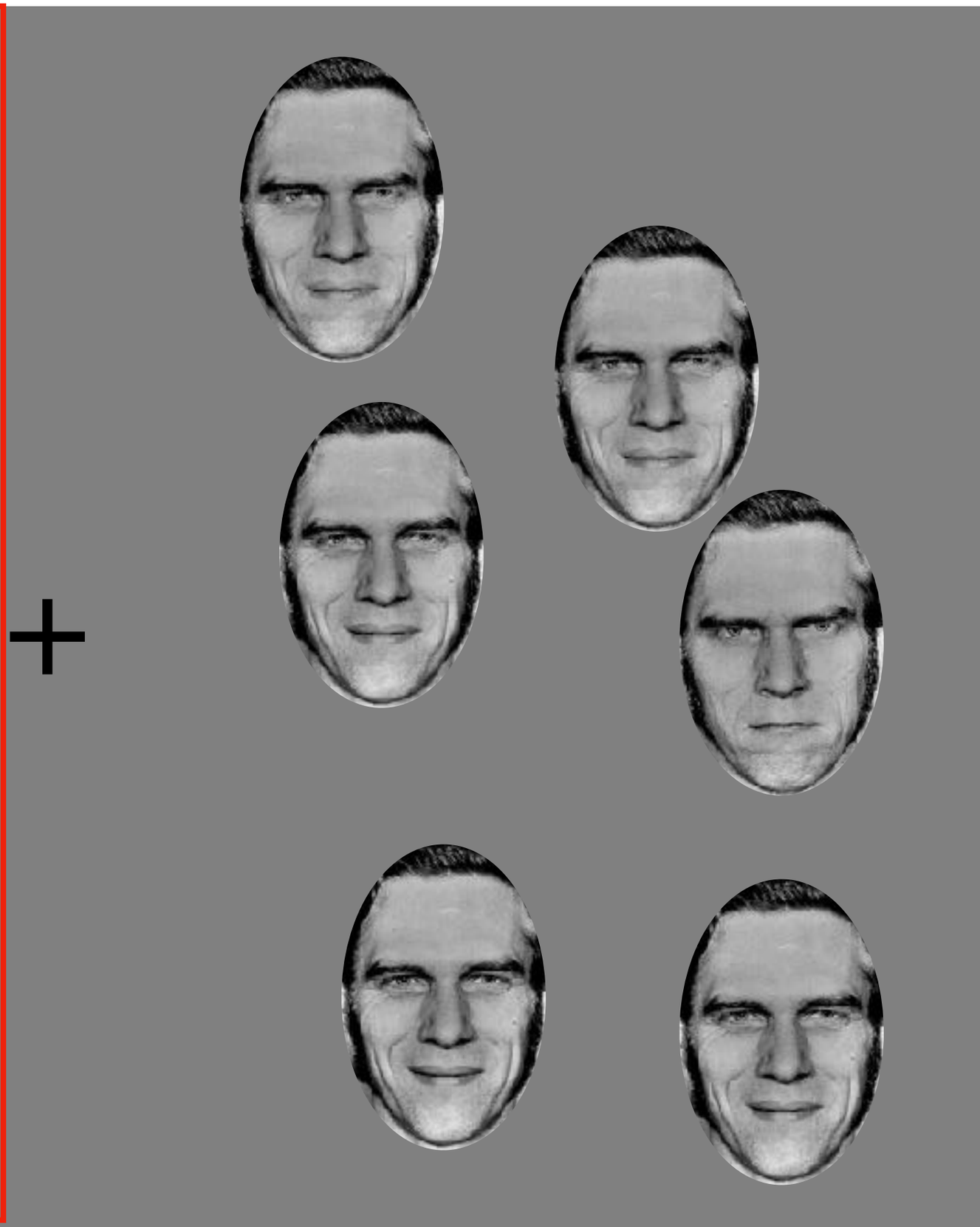
Which crowd would you rather avoid?

Left or Right?

Which crowd would you rather avoid?



+



Crowd emotion task

Exp.1A: Avoidance task
Exp.1B: Approach task

Crowd emotion task

Exp.1A: Avoidance task

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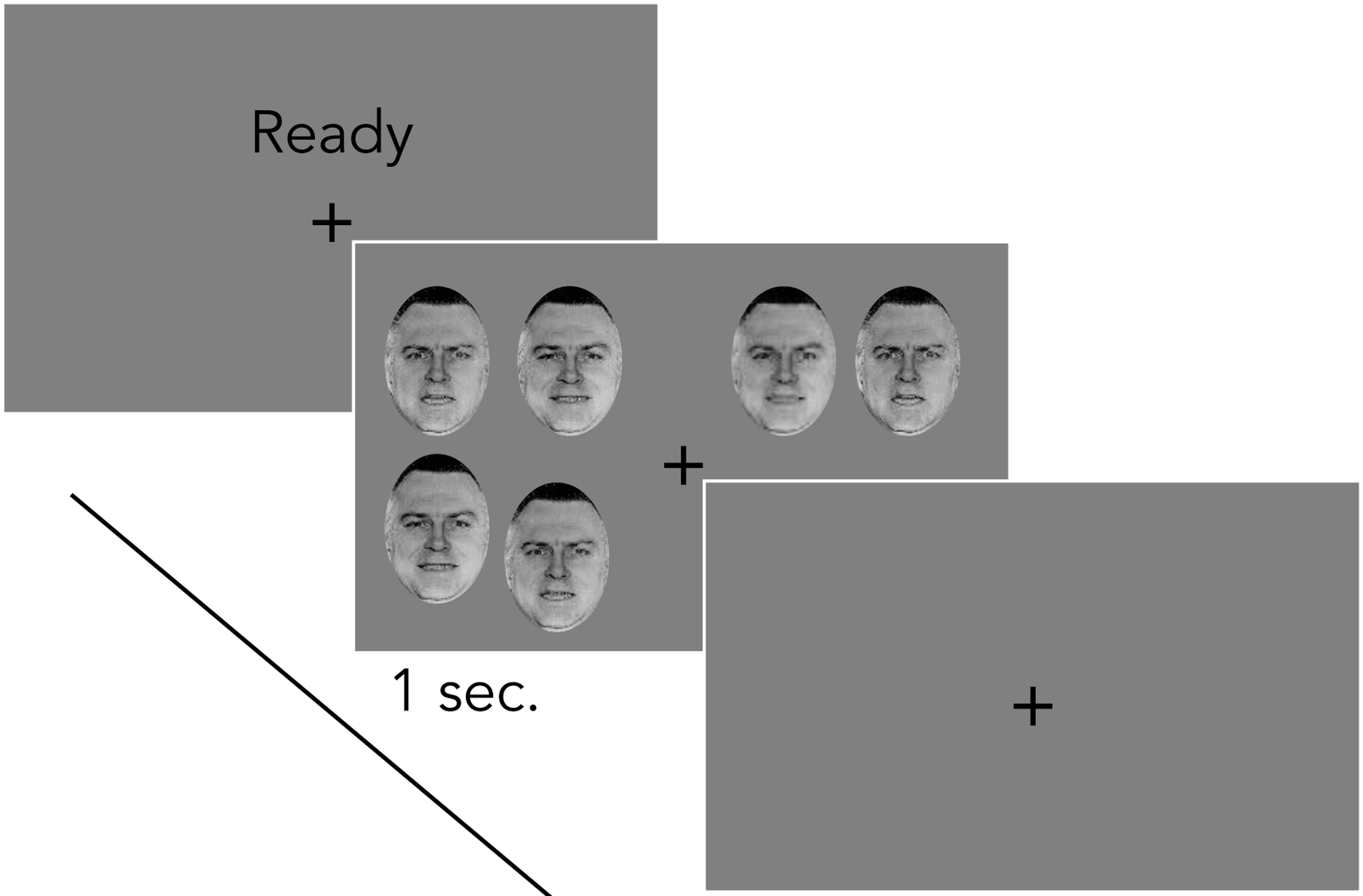
Crowd emotion task



Exp.1A: Avoidance task

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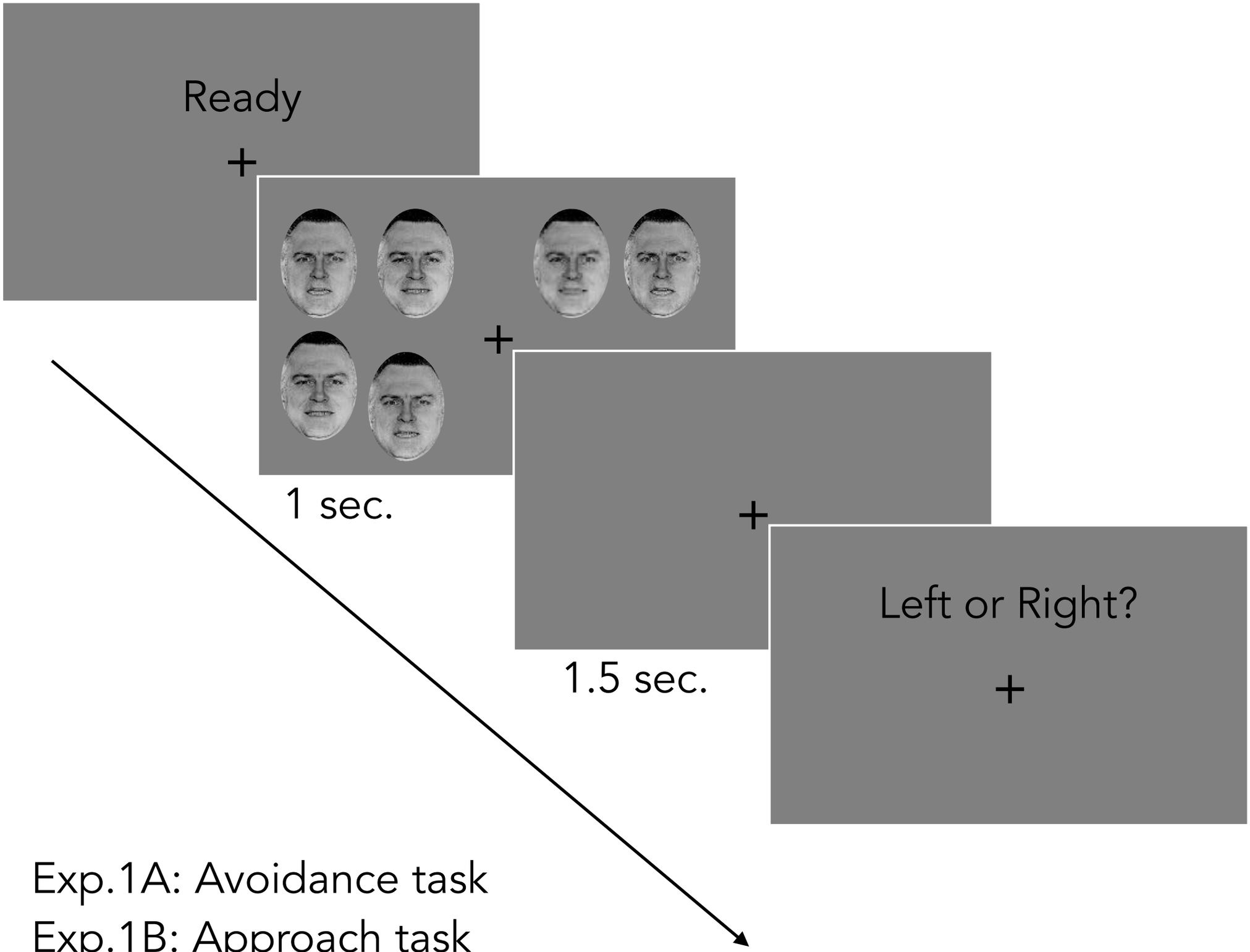
Crowd emotion task



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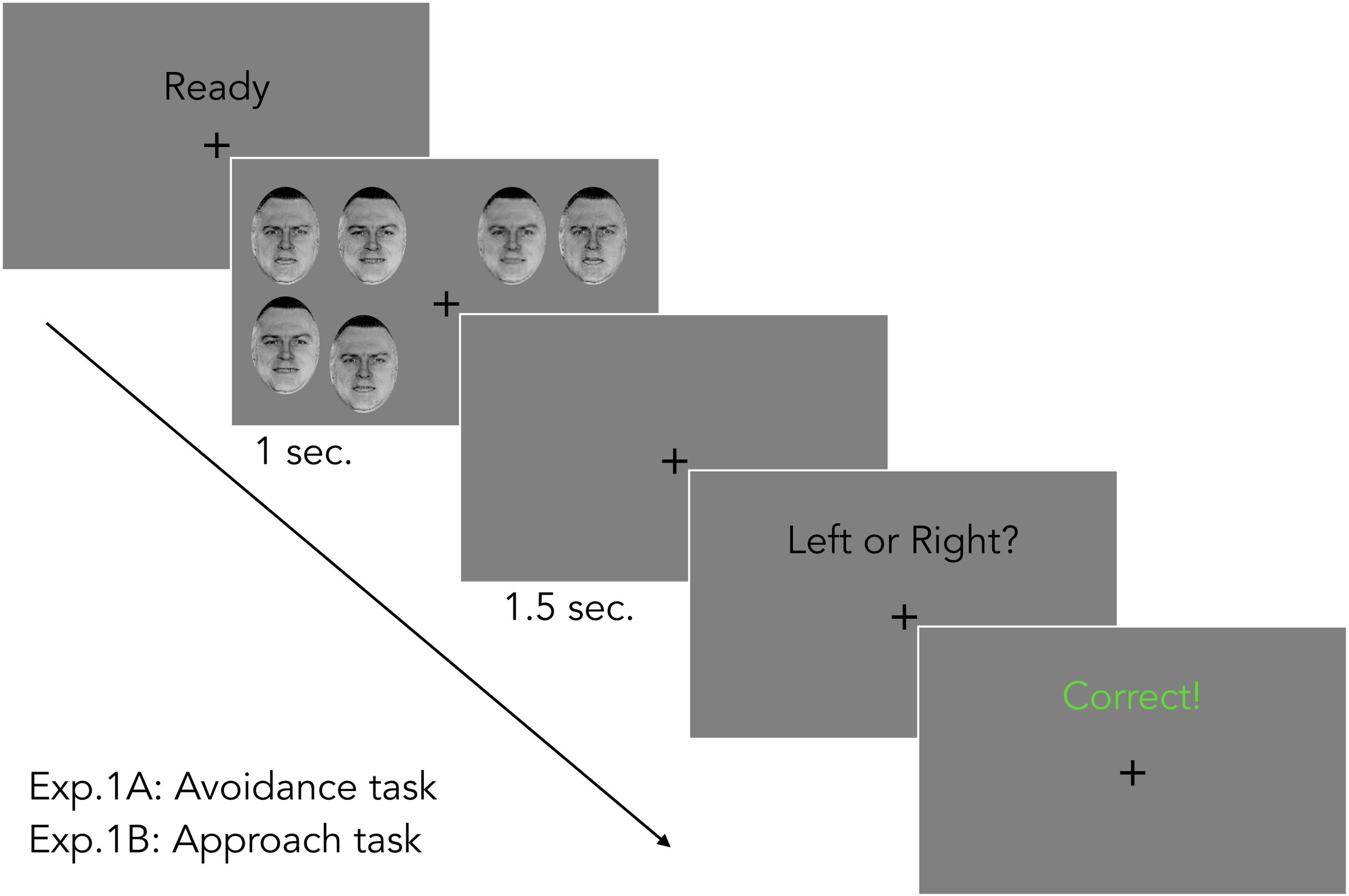
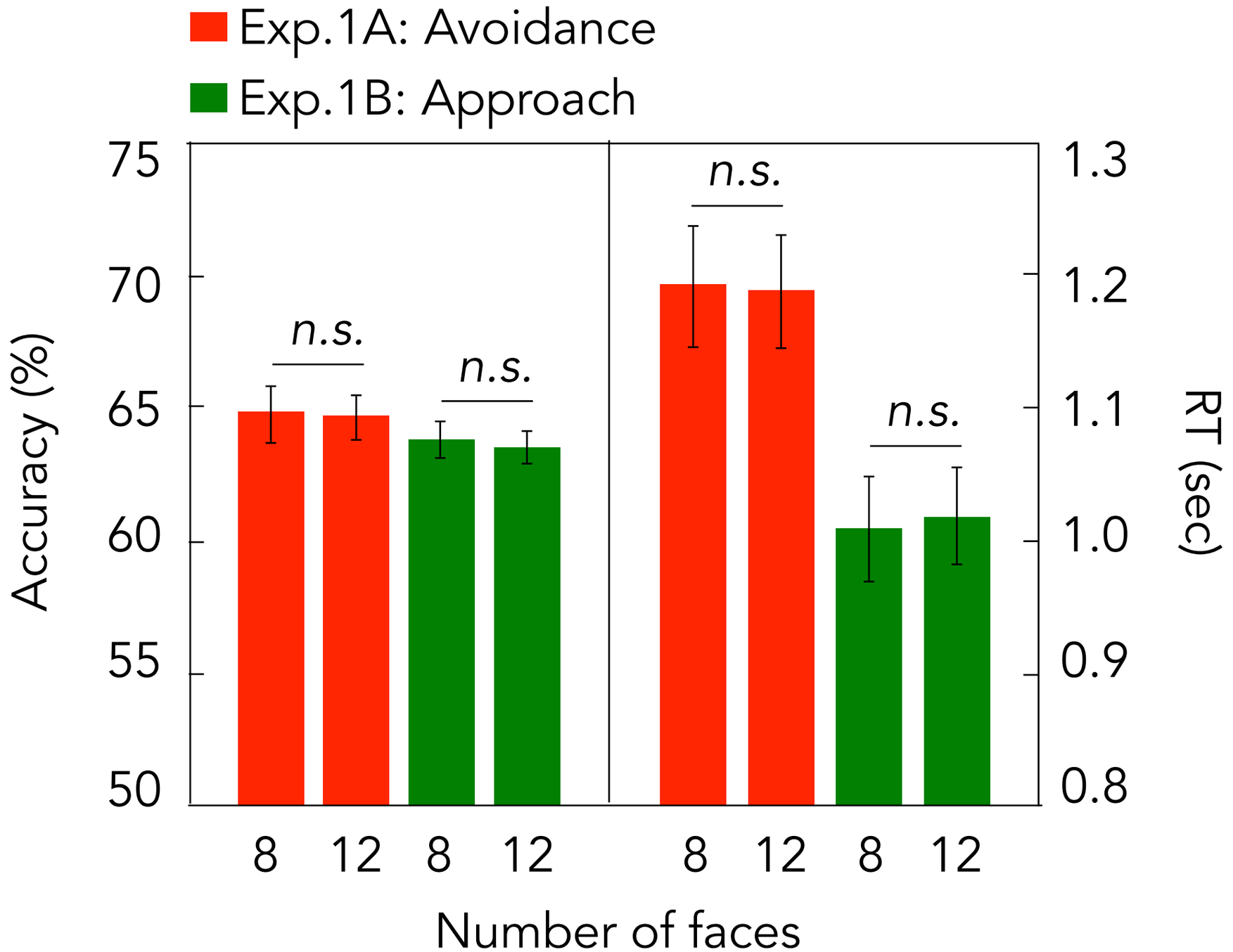
Crowd emotion task



Exp.1A: Avoidance task

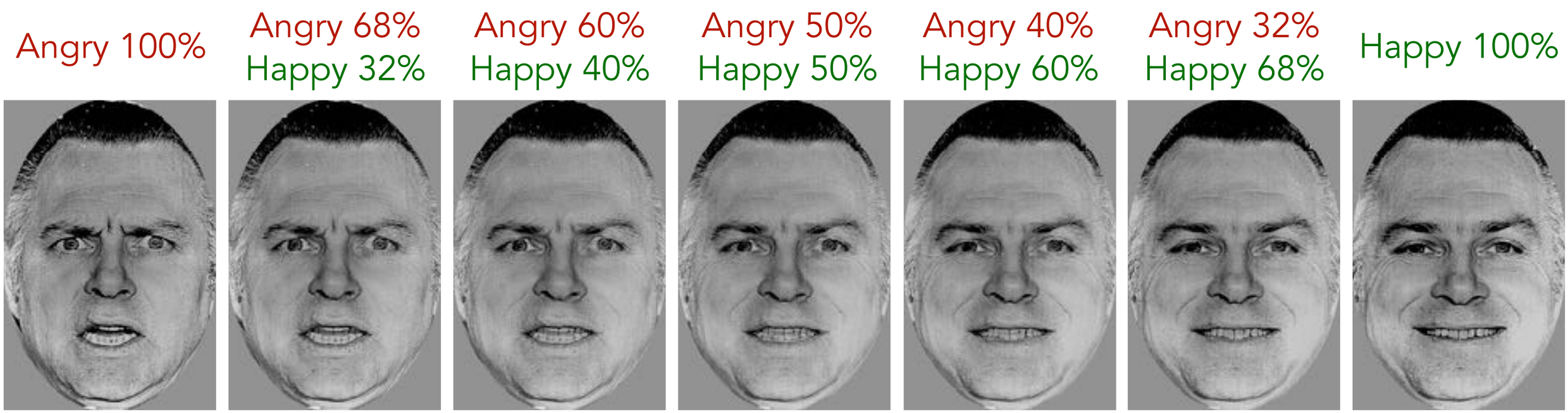
Exp.1B: Approach task

Parallel processing of faces

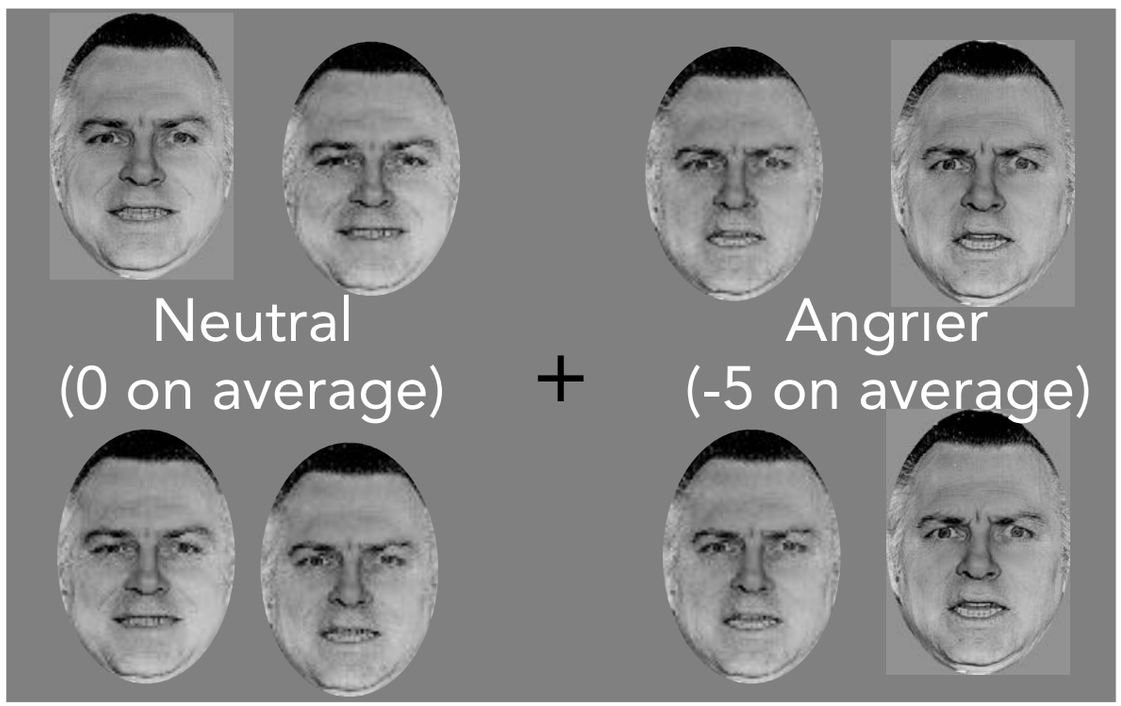


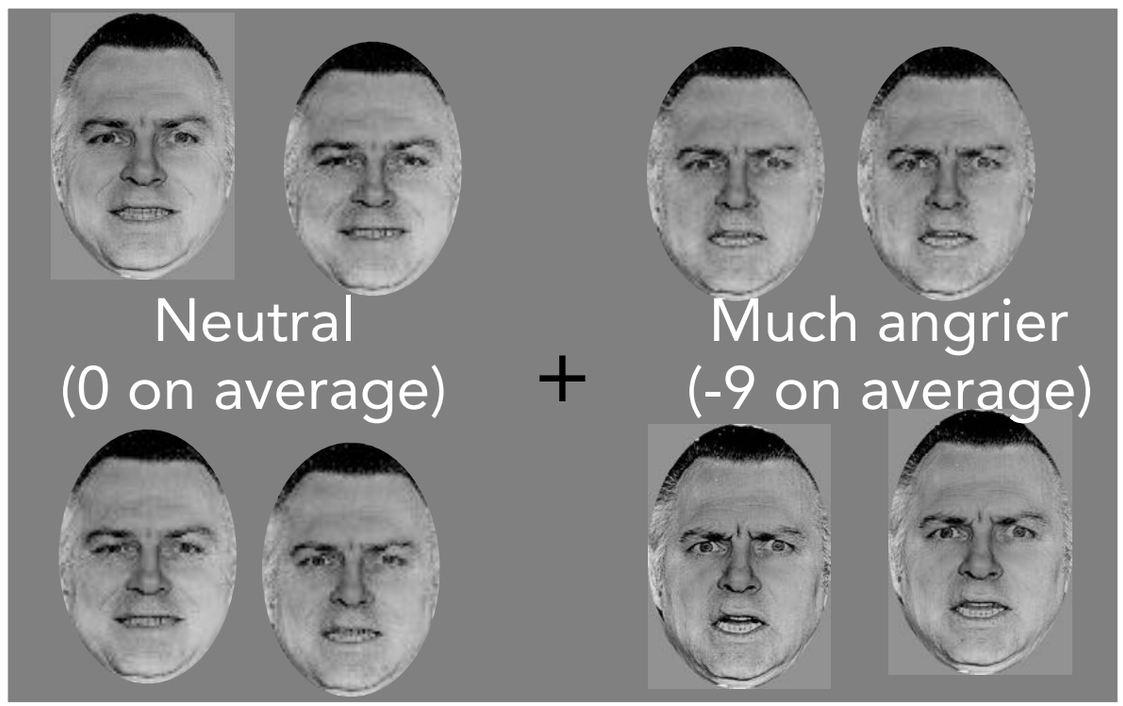
Im et al., *Nature Human Beh.* (2017)

Emotions distance between crowds

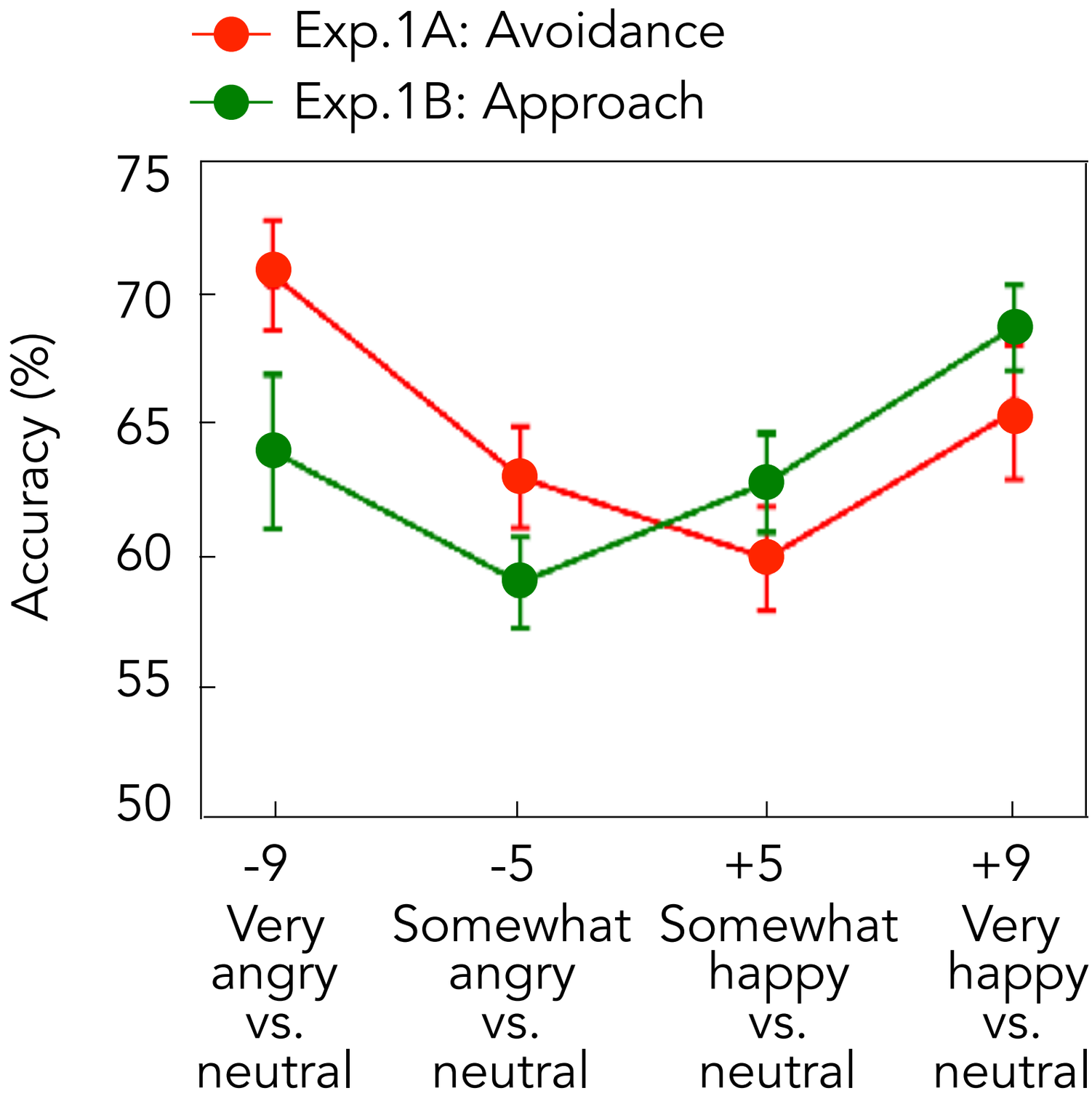


Emotional distance between crowds: -5, -9, +5, +9



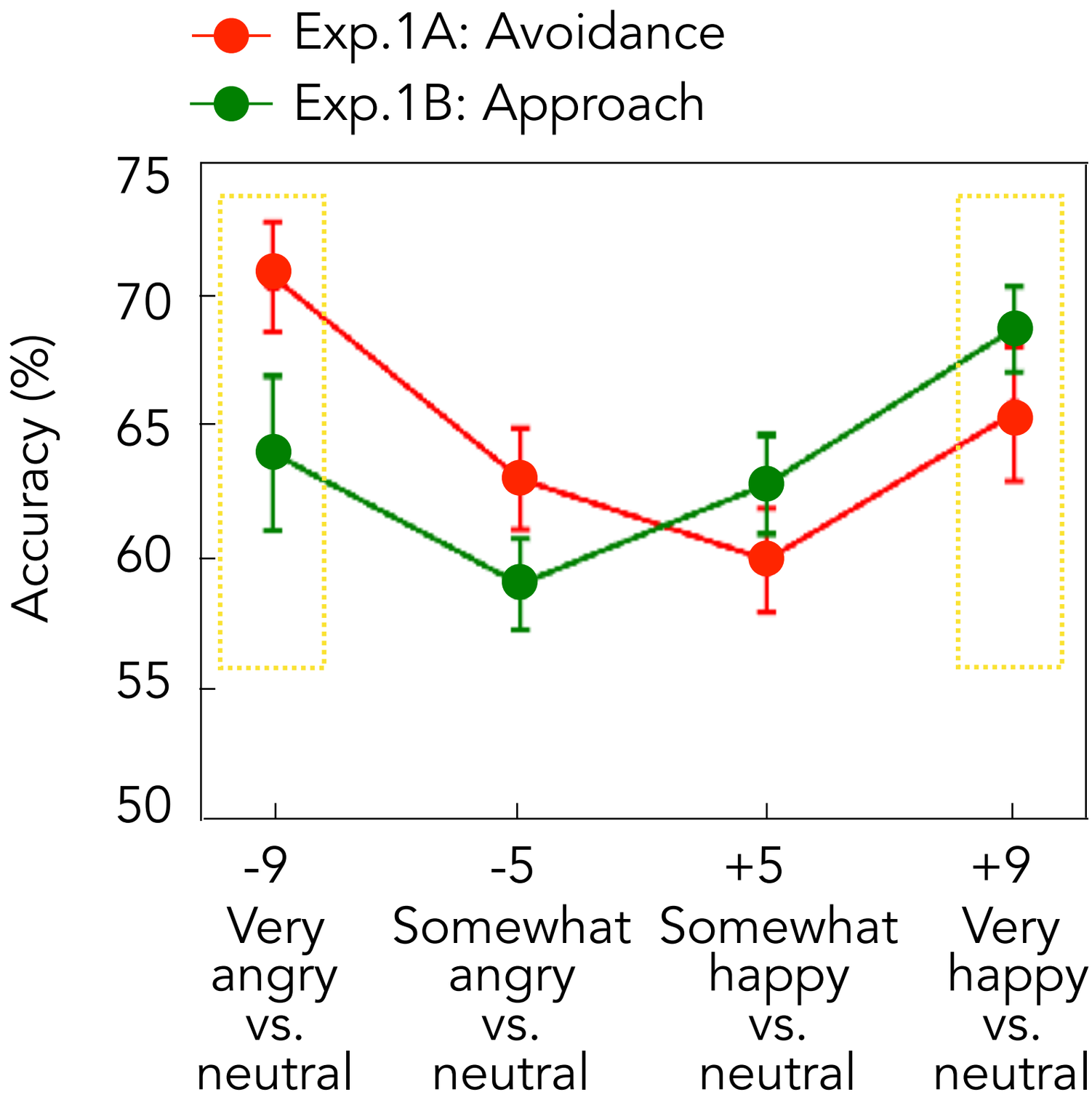


Goal-congruent crowd emotion



Im et al., *Nature Human Beh.* (2017)

Goal-congruent crowd emotion



Im et al., *Nature Human Beh.* (2017)

Gender of emotional crowd

Male faces

Female faces

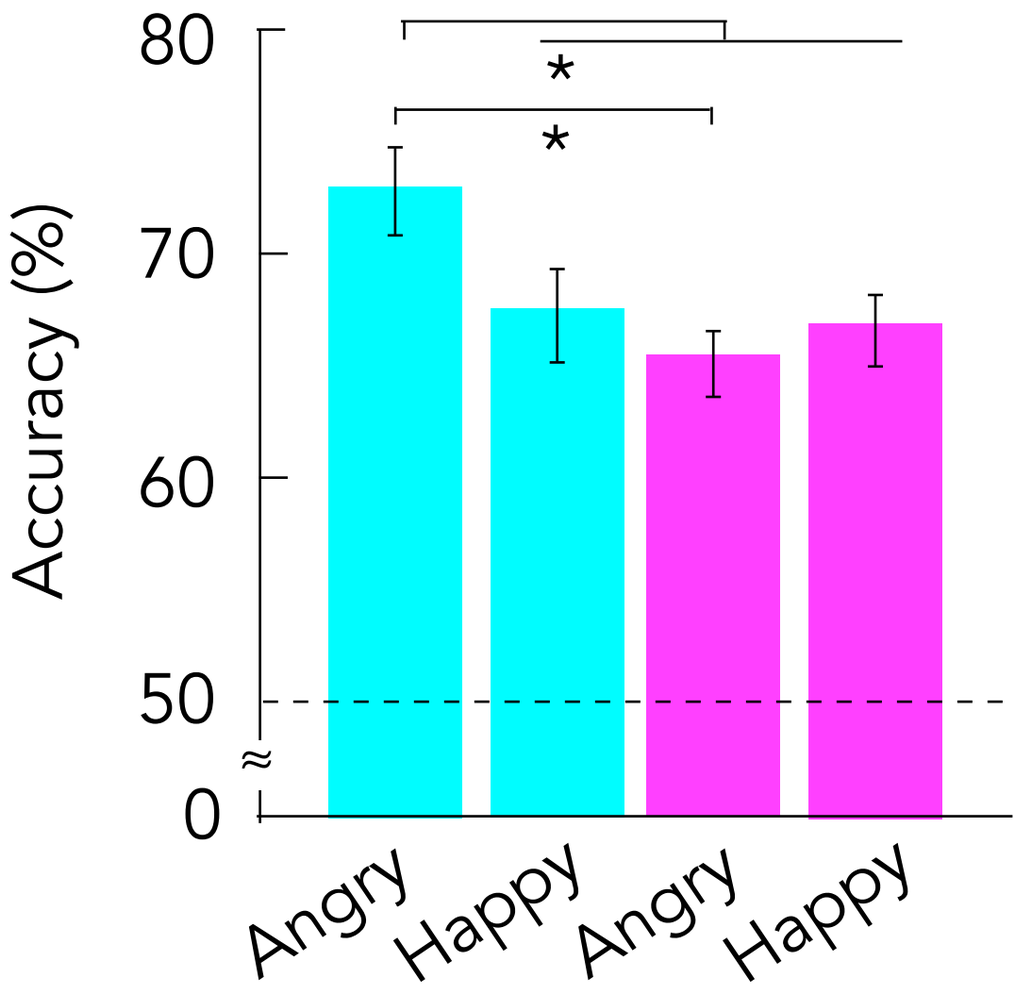
Im et al., *Nature Human Beh.* (2017)

Gender of emotional crowd

Male faces

Female faces

Exp.1A: Avoidance



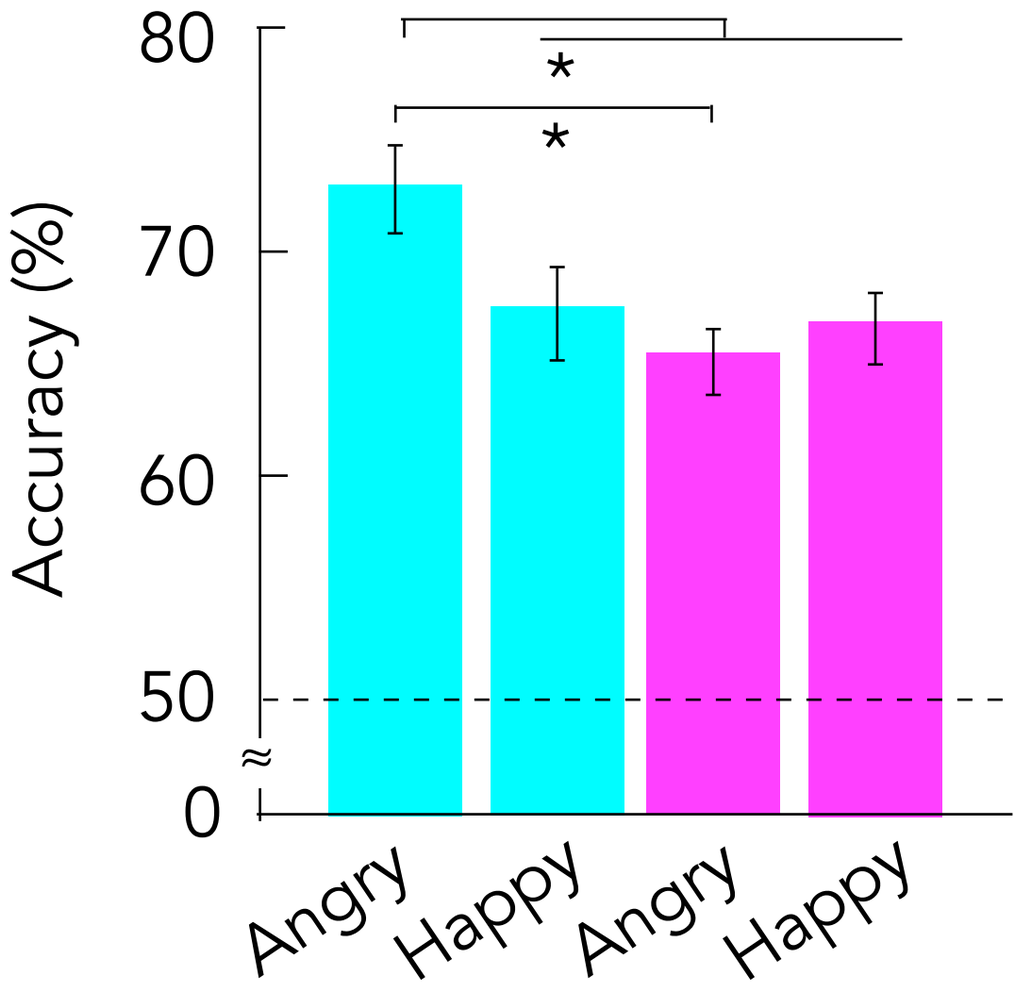
Im et al., *Nature Human Beh.* (2017)

Gender of emotional crowd

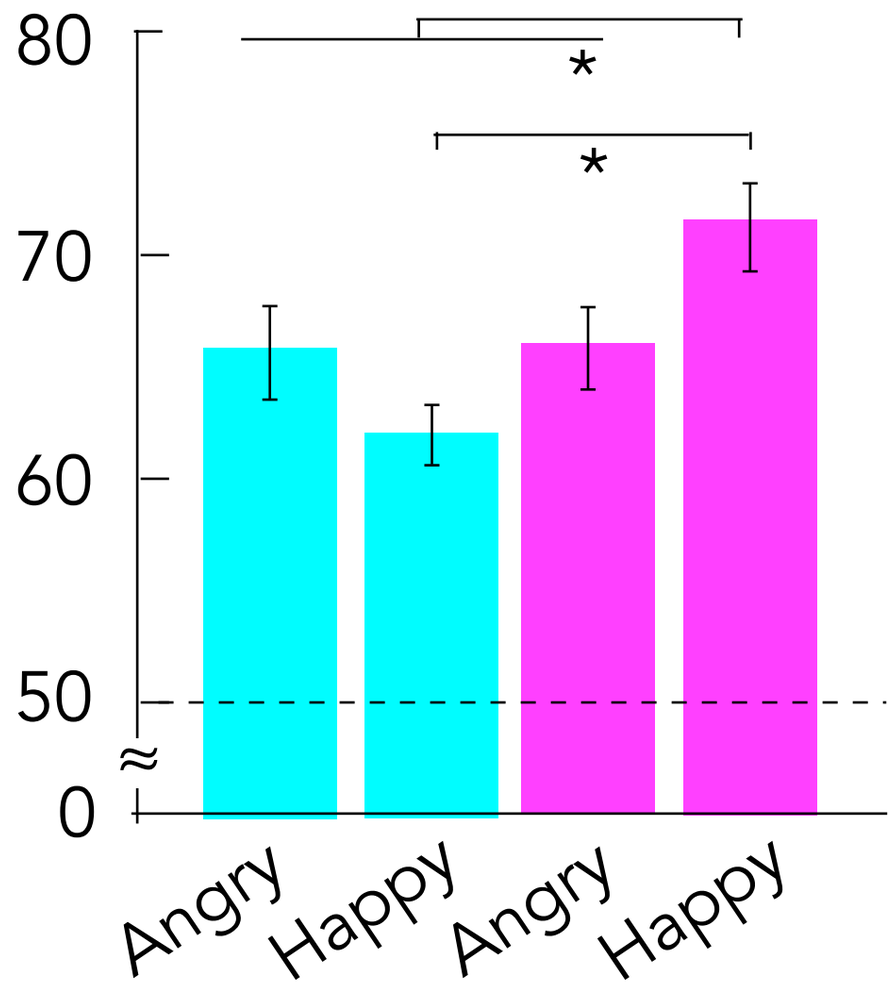
Male faces

Female faces

Exp.1A: Avoidance

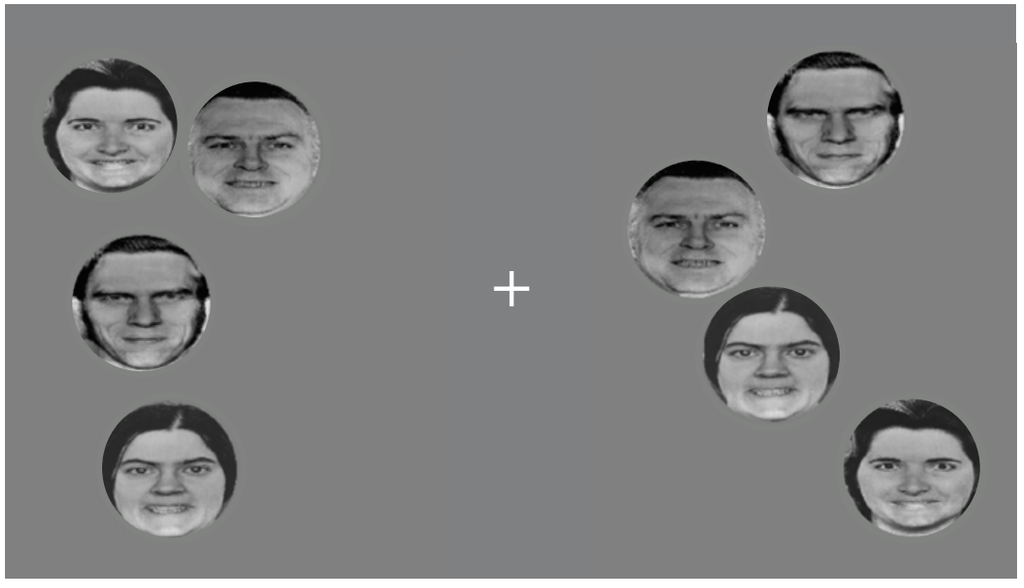


Exp.1B: Approach



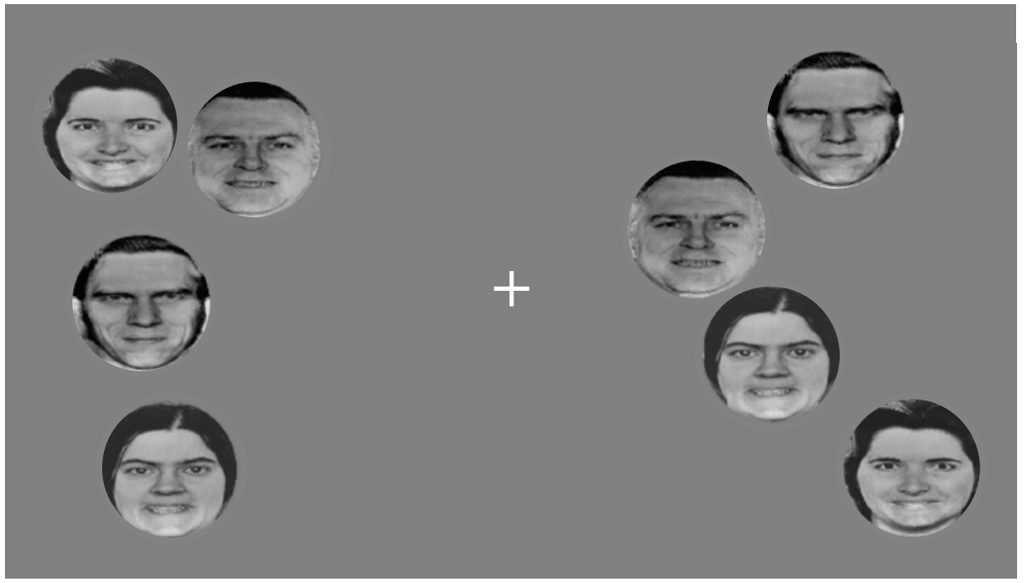
Im et al., *Nature Human Beh.* (2017)

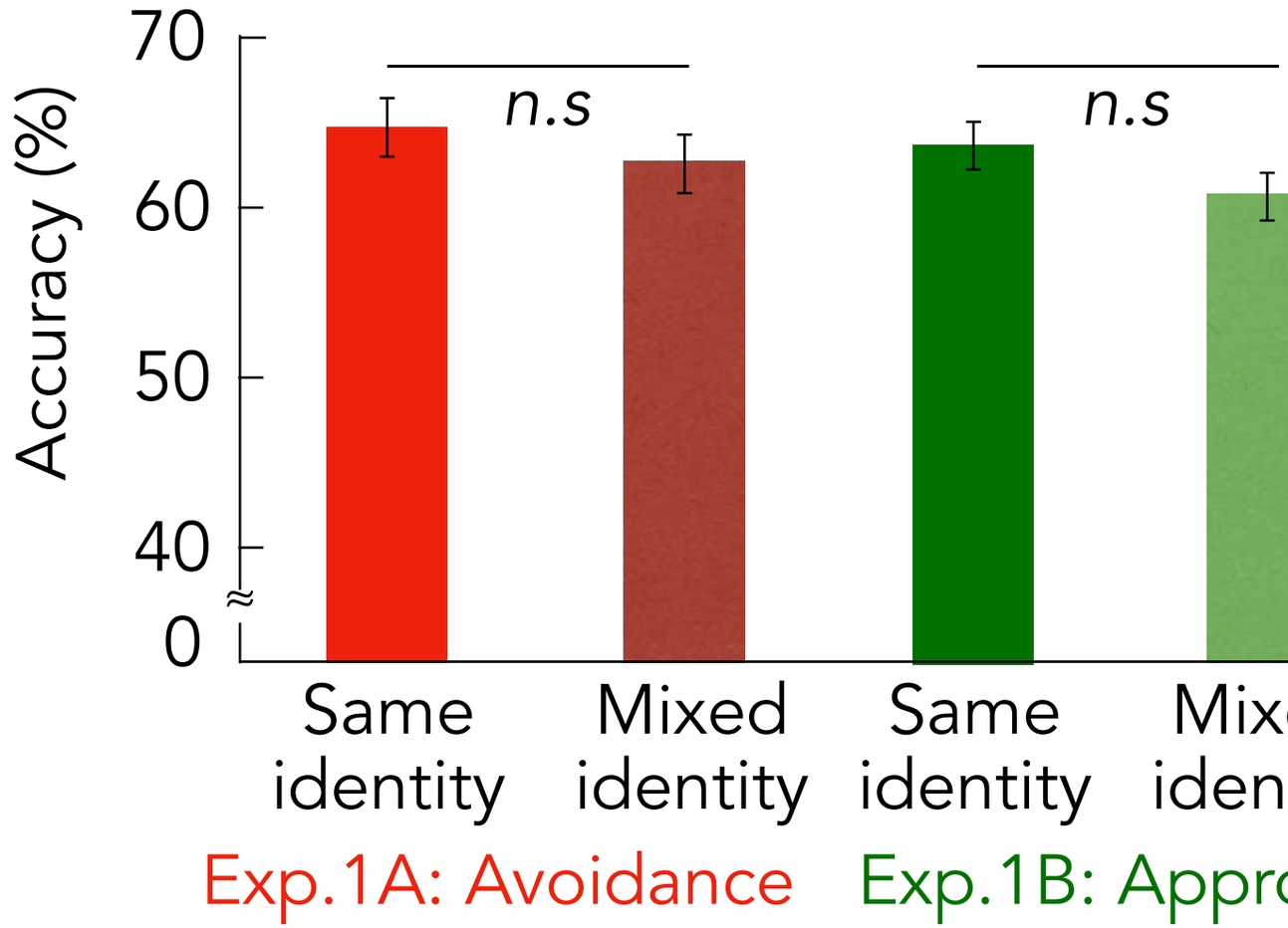
Intermixed identities



Im et al., *Nature Human Beh.* (2017)

Intermixed identities





Im et al., *Nature Human Beh.* (2017)

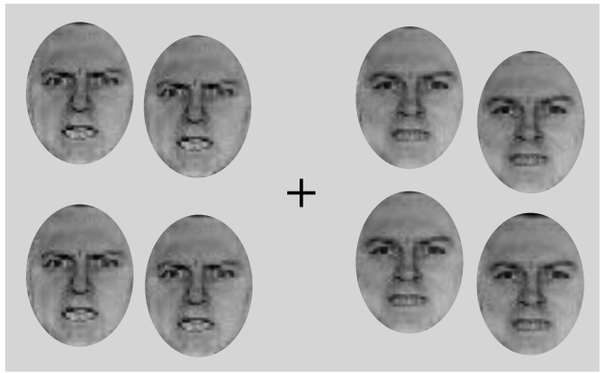
Task-dependent laterality effects

Exp.1A: Avoidance

Task-dependent laterality effects

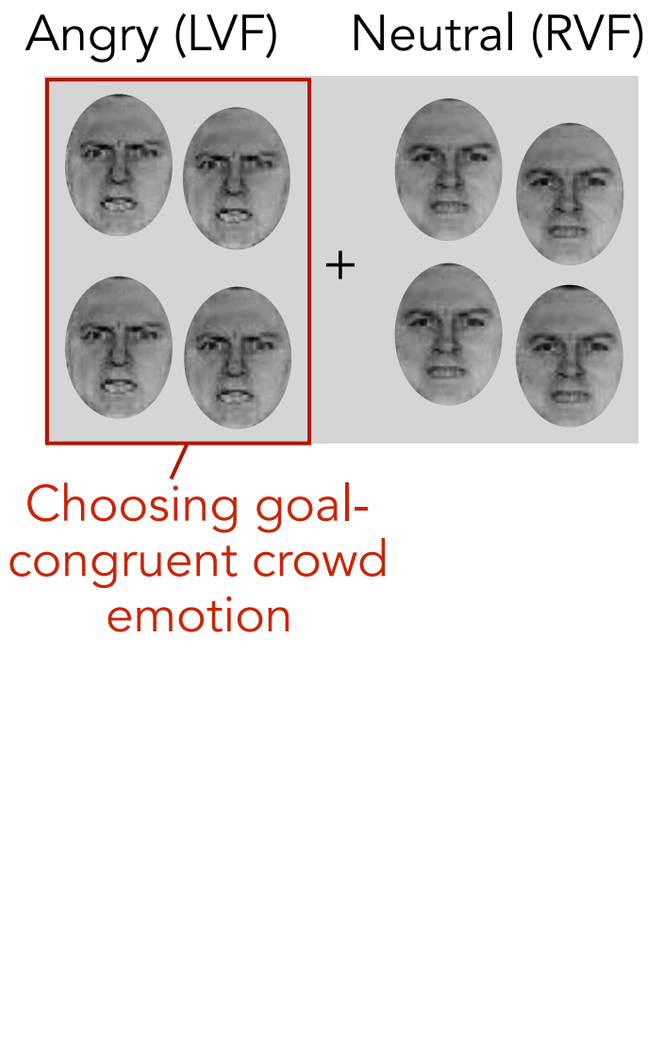
Exp.1A: Avoidance

Angry (LVF) Neutral (RVF)



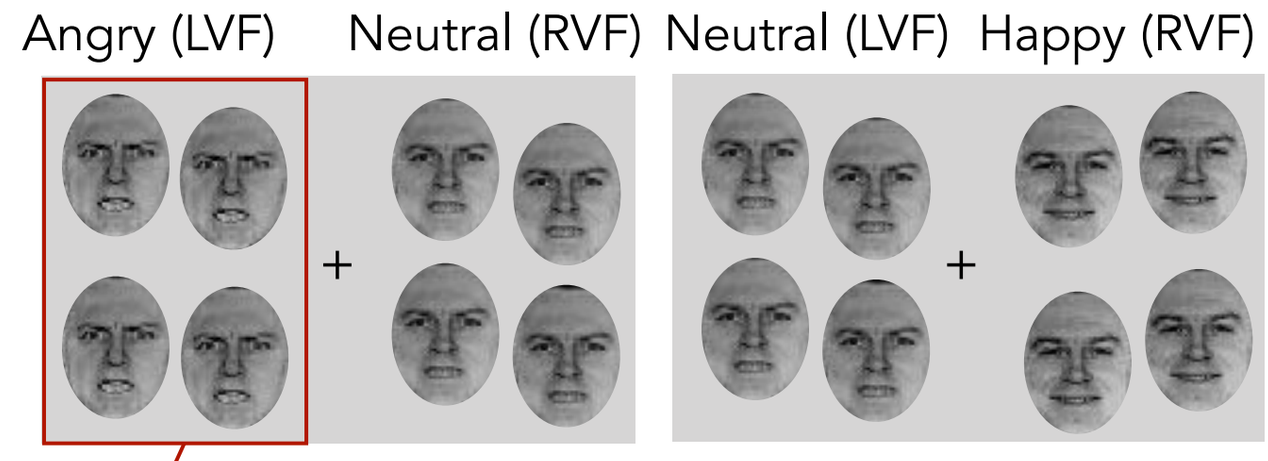
Task-dependent laterality effects

Exp.1A: Avoidance



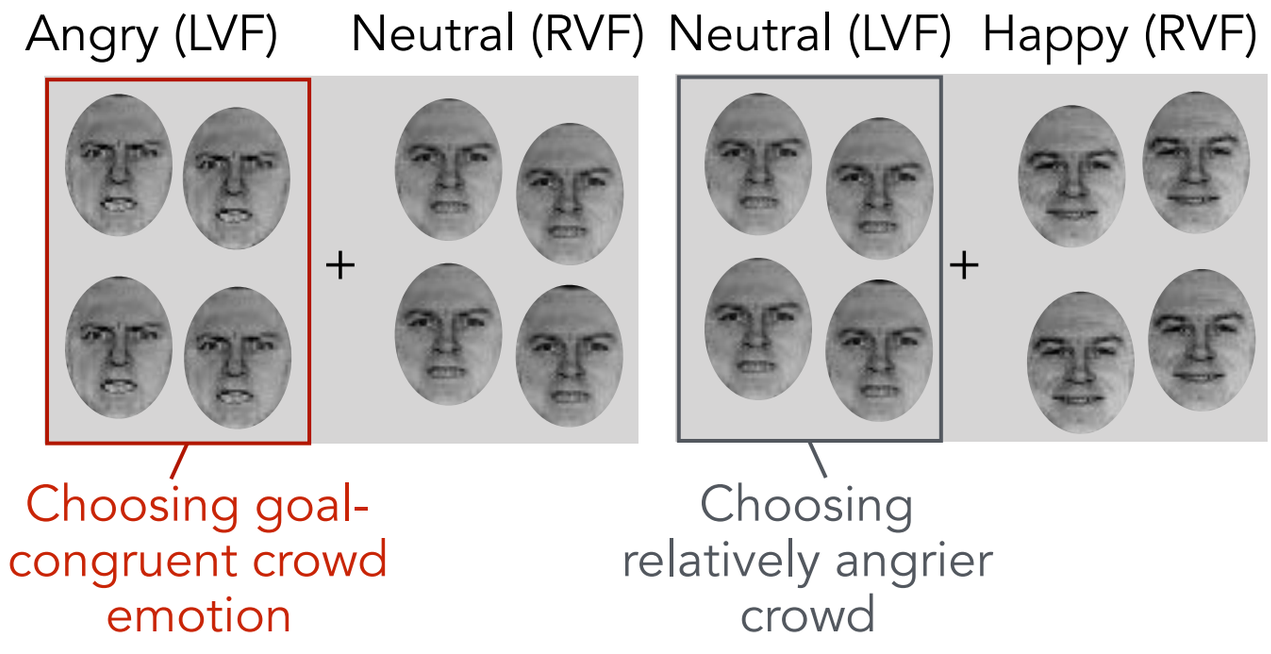
Task-dependent laterality effects

Exp.1A: Avoidance



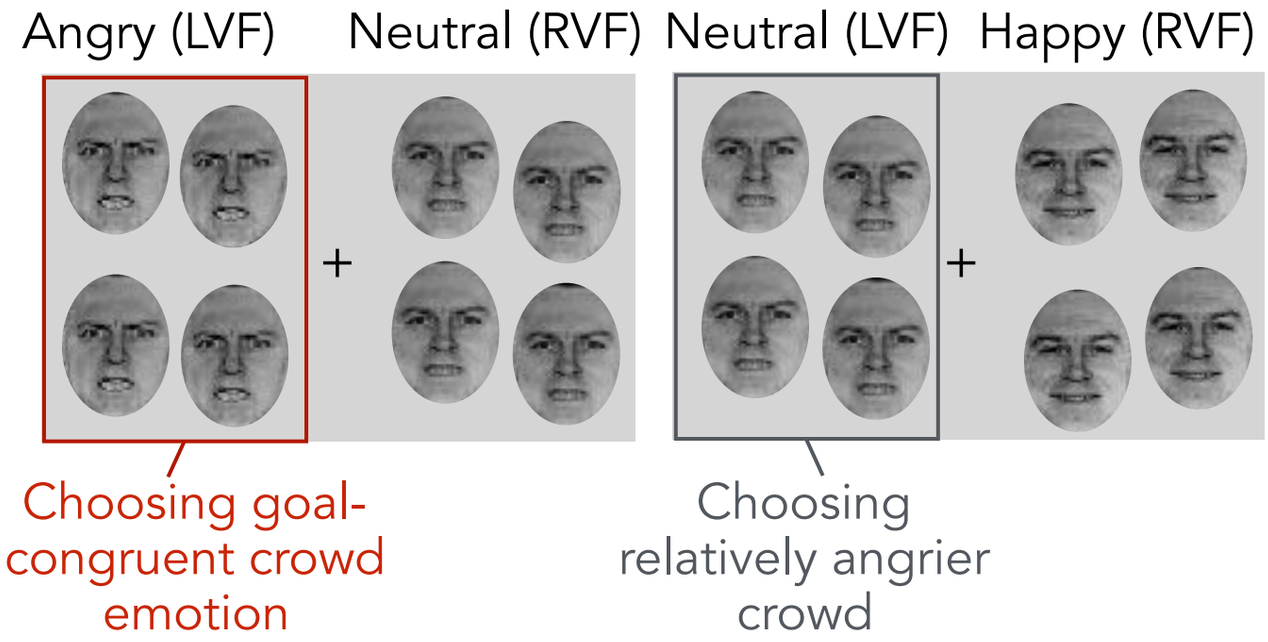
Task-dependent laterality effects

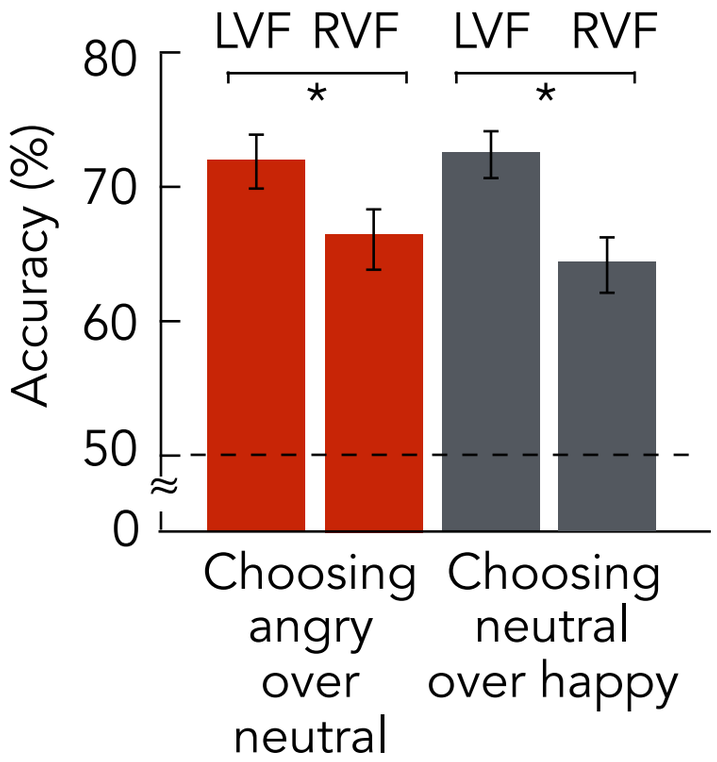
Exp.1A: Avoidance



Task-dependent laterality effects

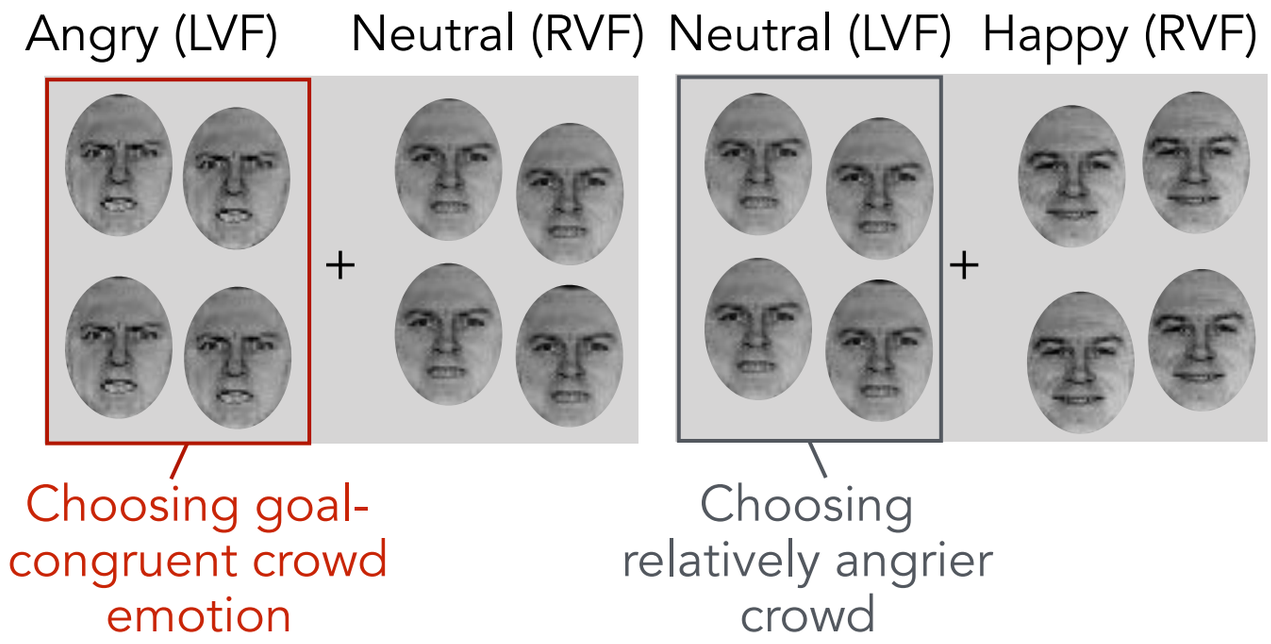
Exp.1A: Avoidance

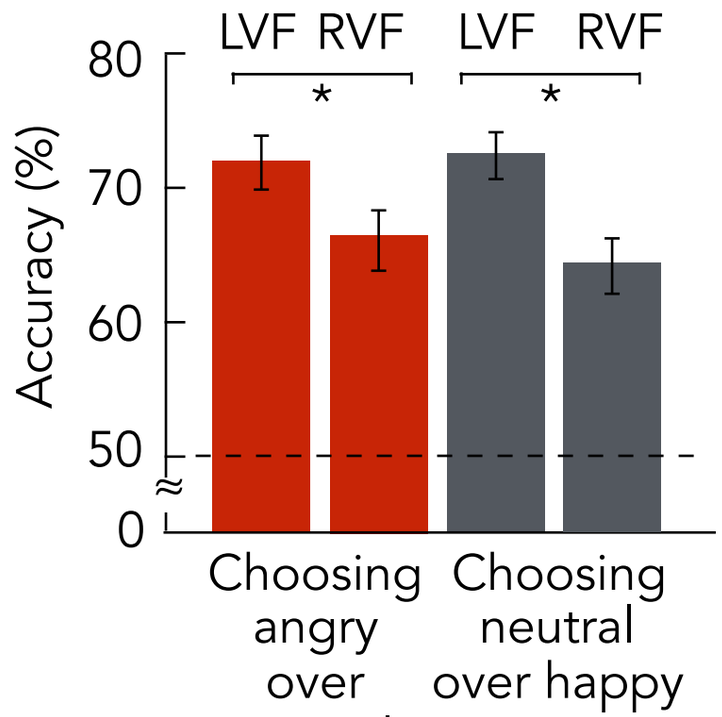




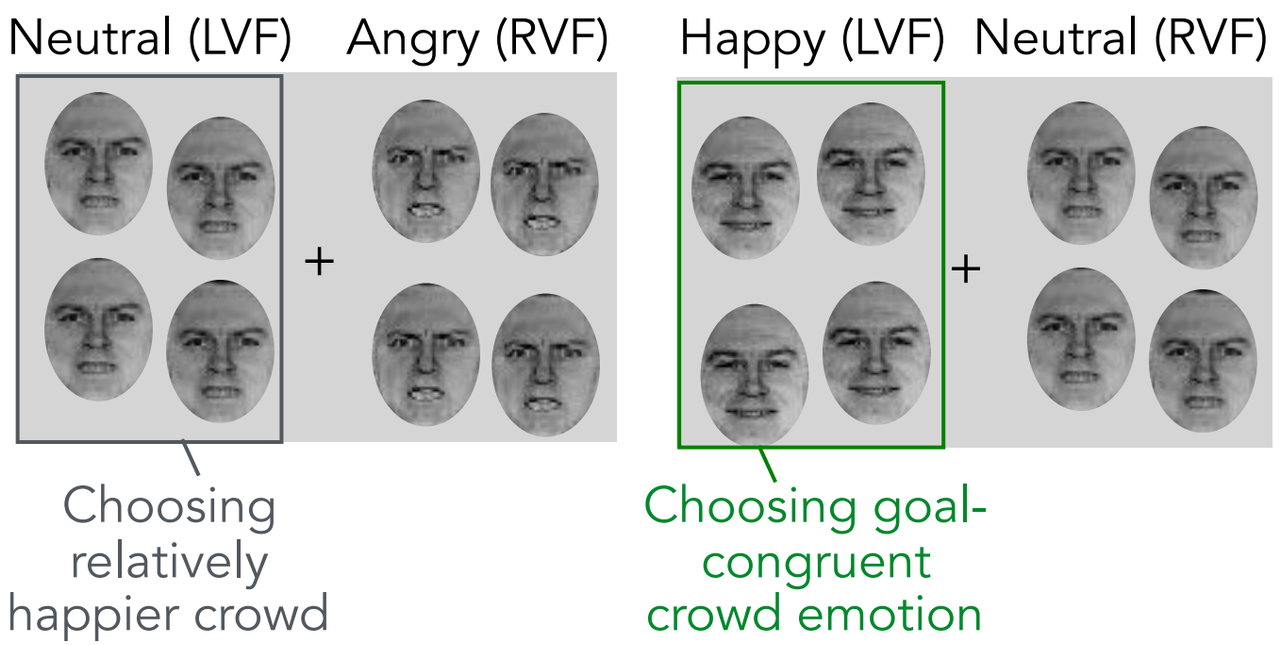
Task-dependent laterality effects

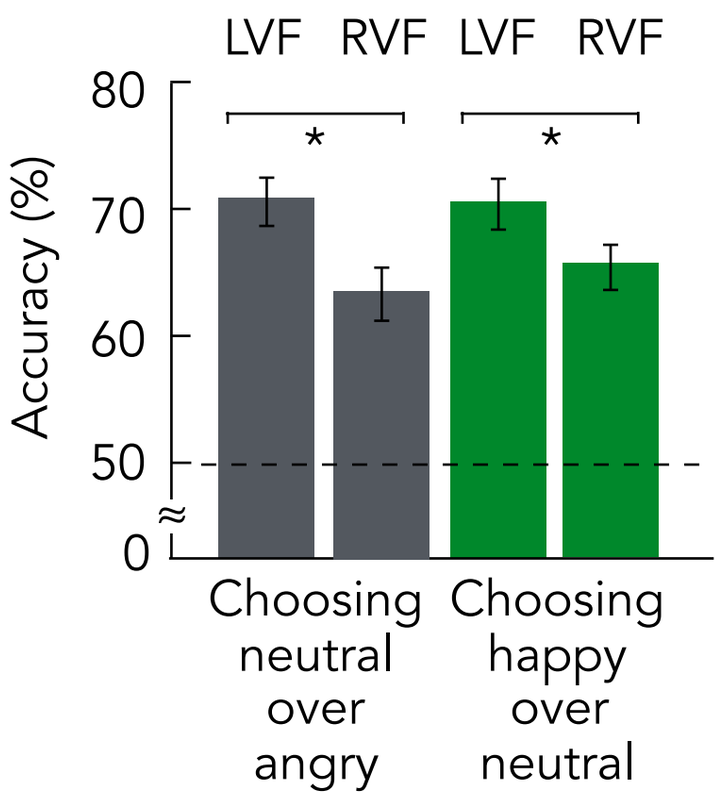
Exp.1A: Avoidance



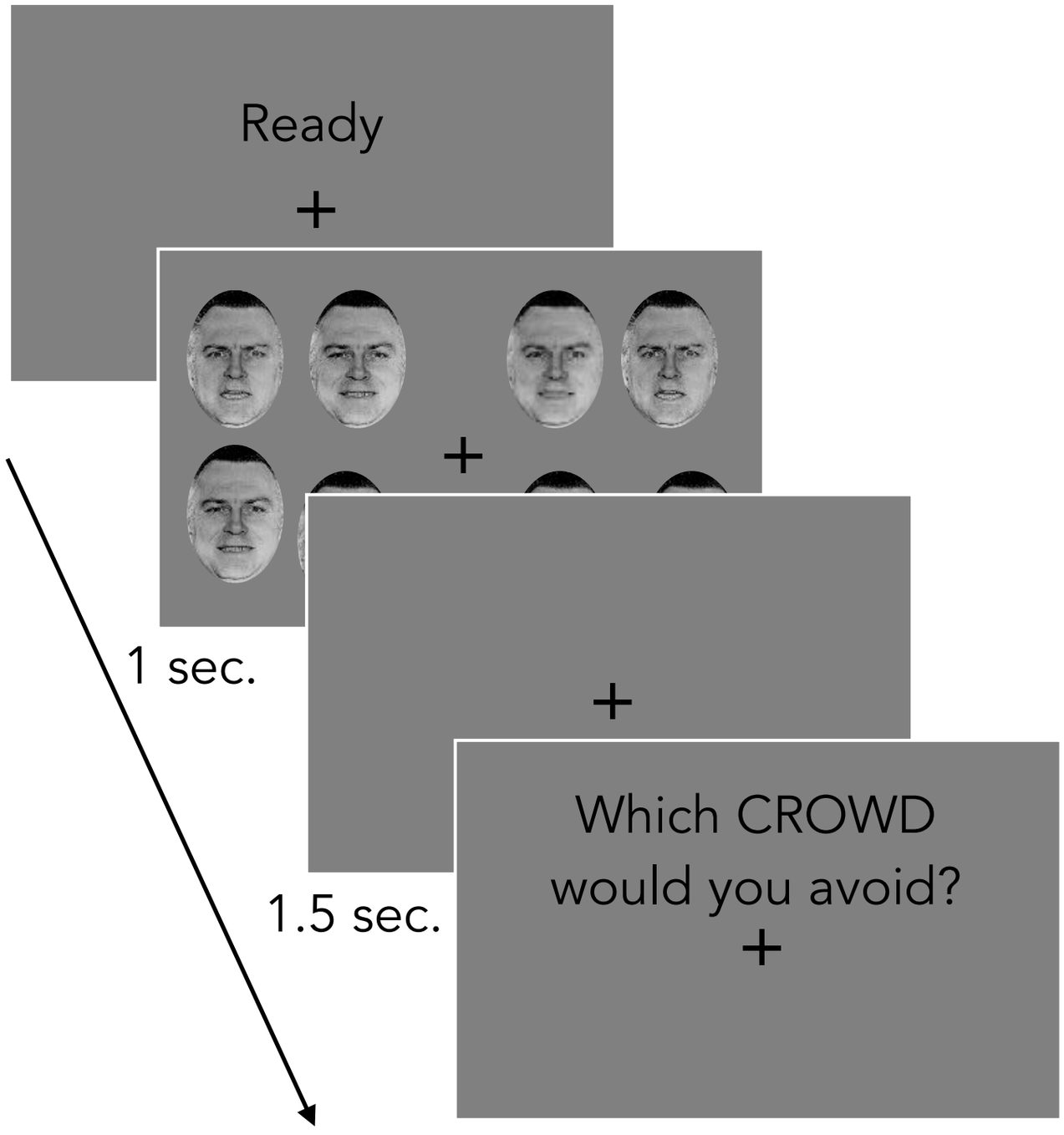


Exp.1B: Approach





Neural mechanism of crowd emotion perception: fMRI study



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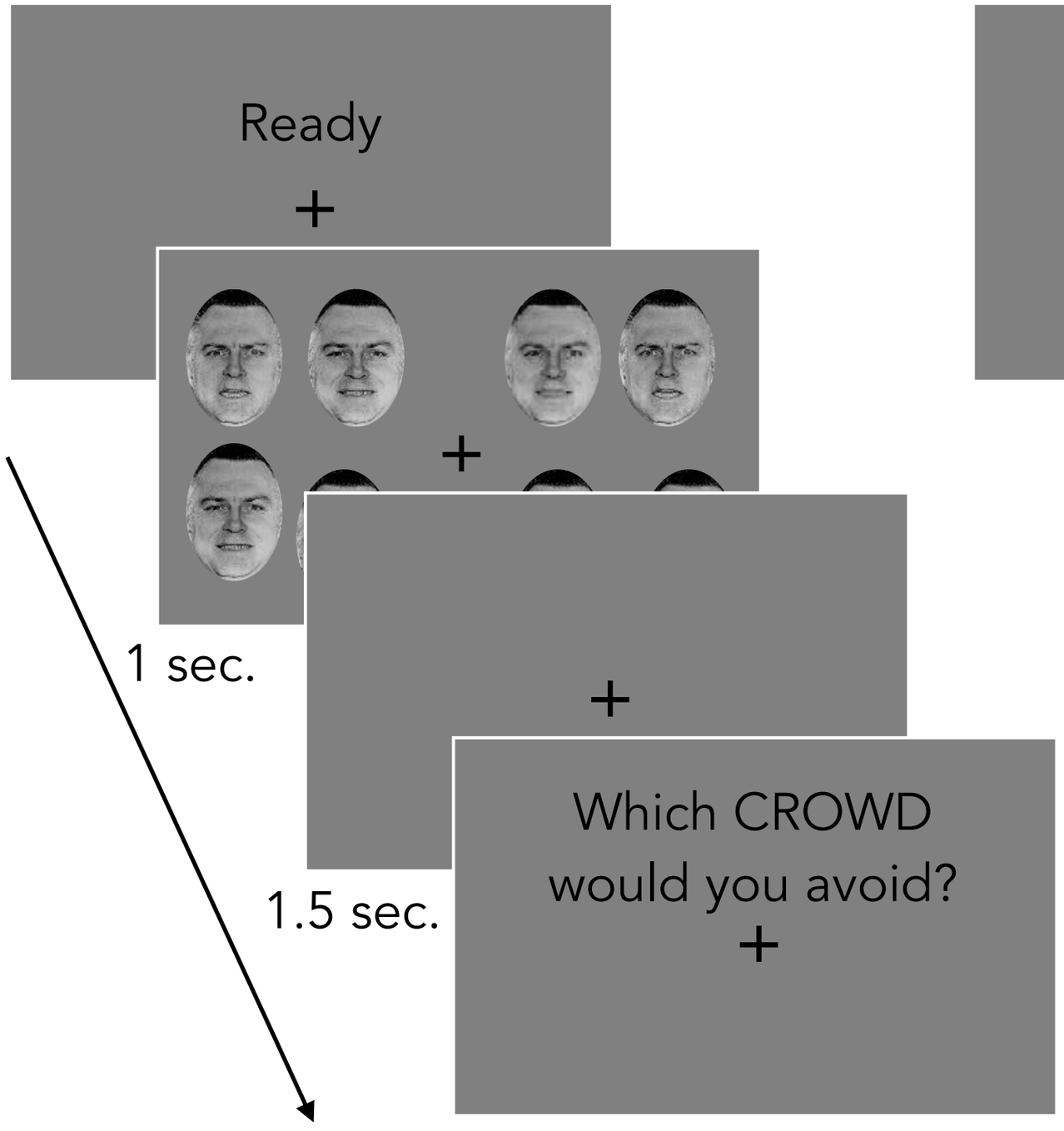
Neural mechanism of crowd emotion perception: fMRI study



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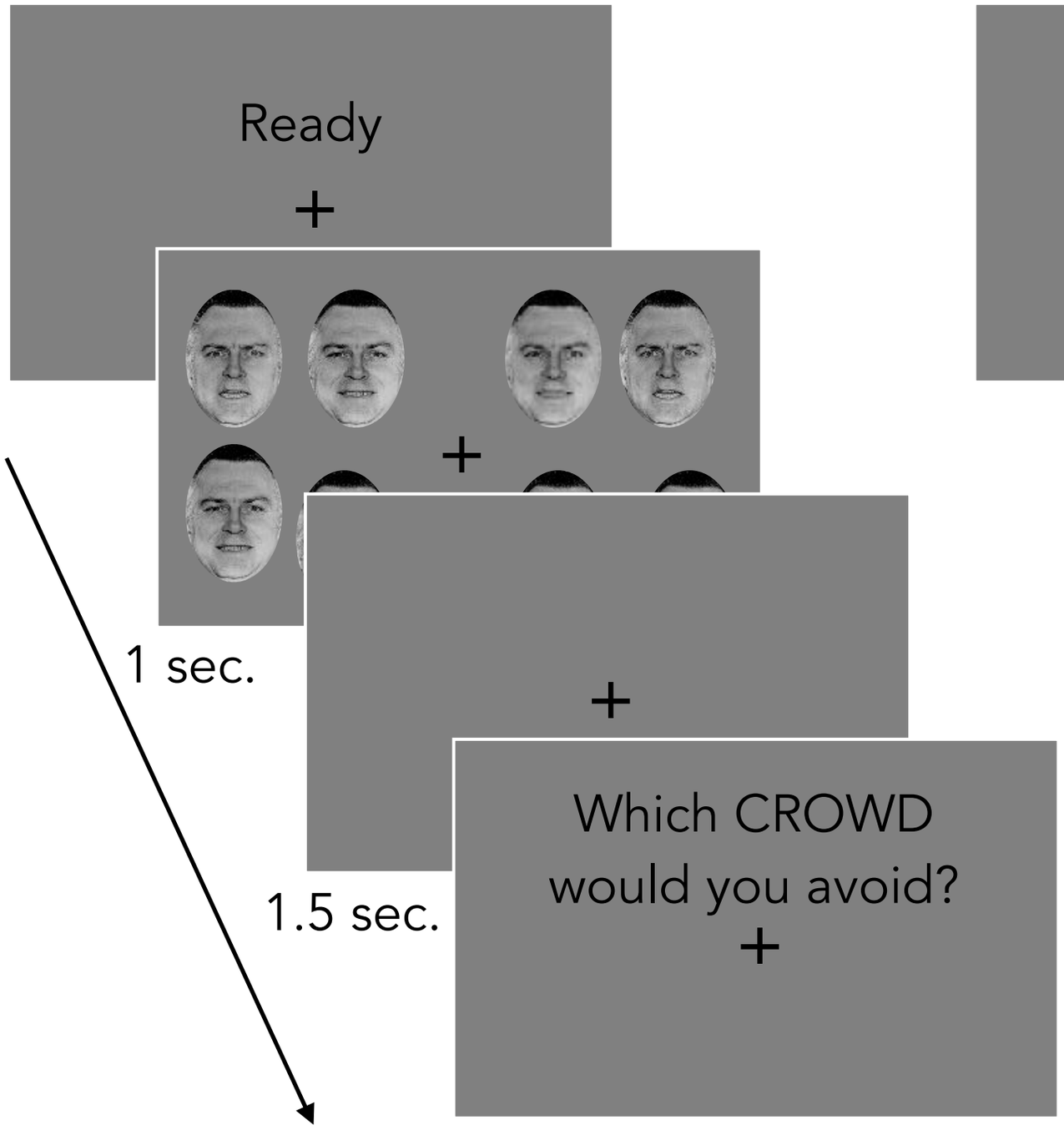
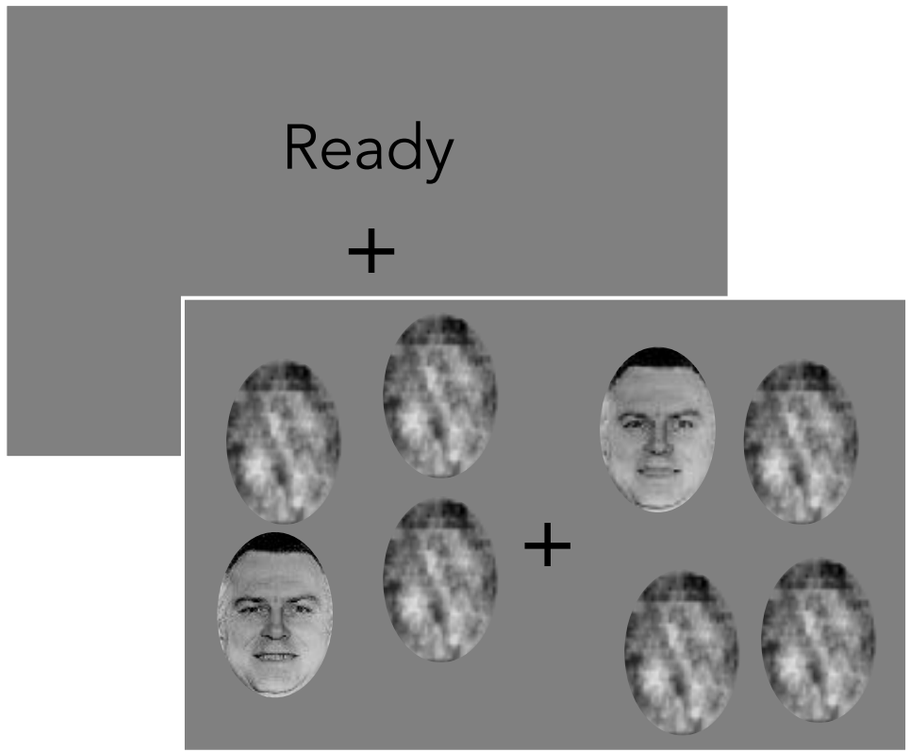
Neural mechanism of crowd emotion perception: fMRI study





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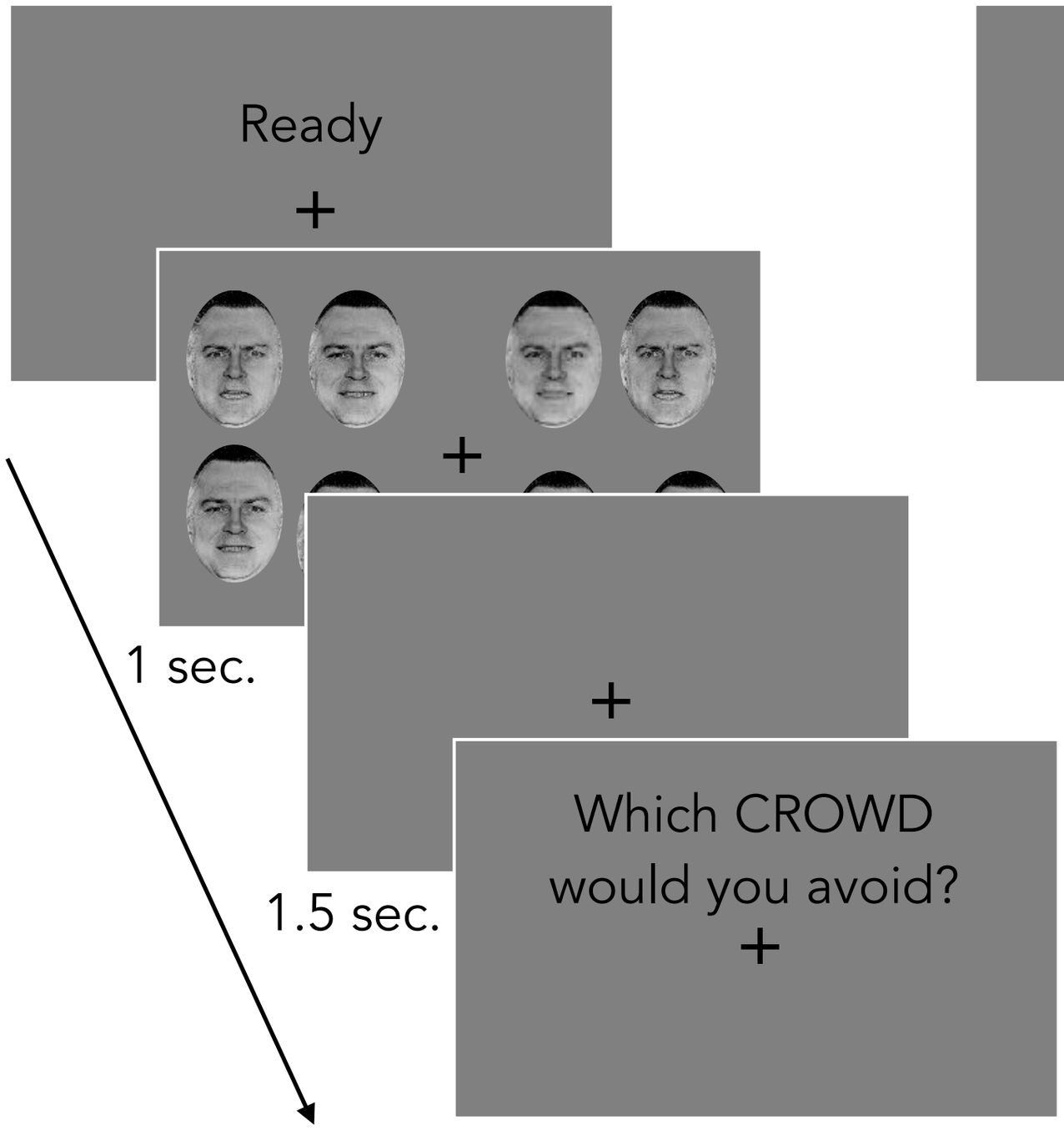

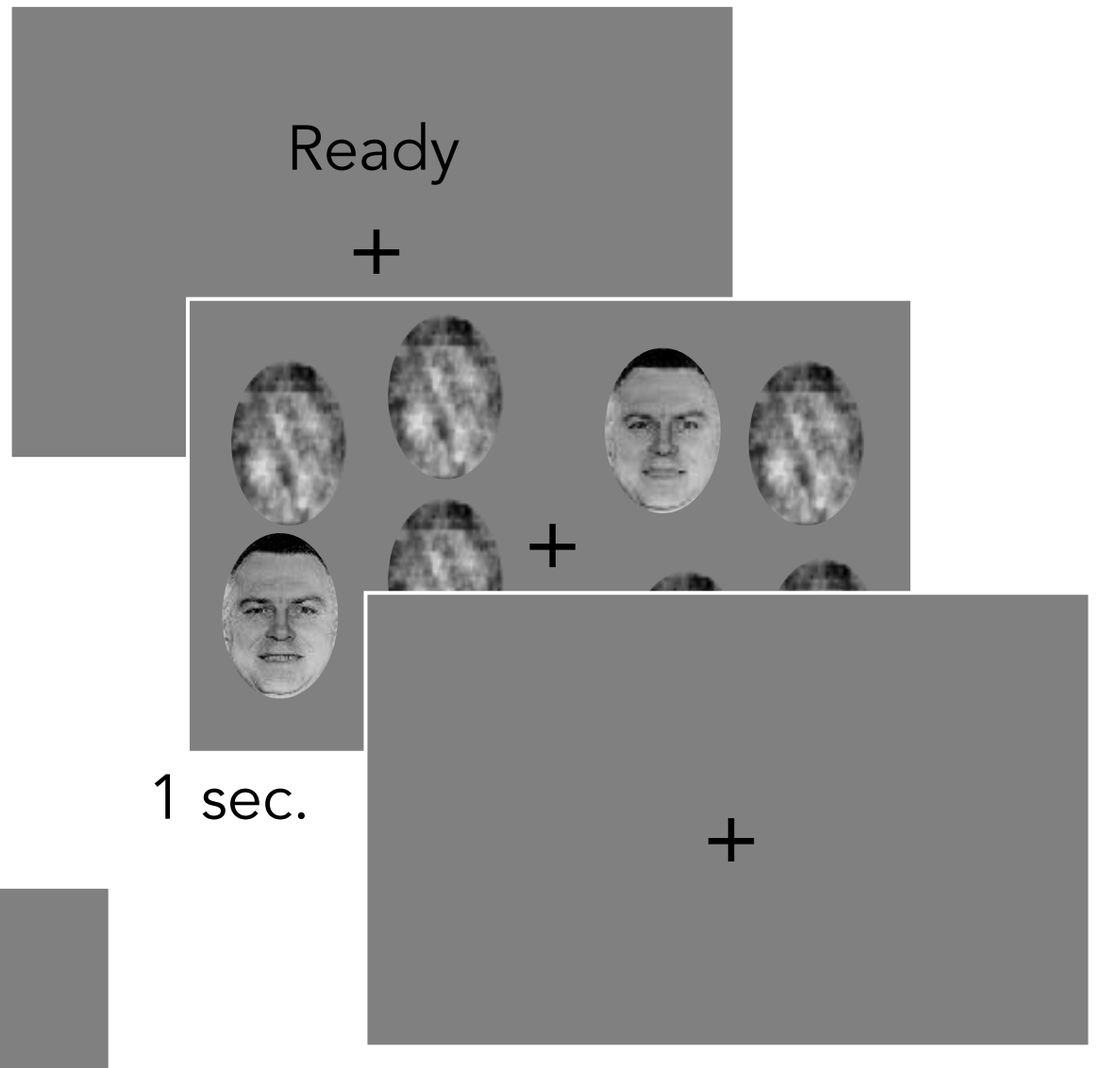

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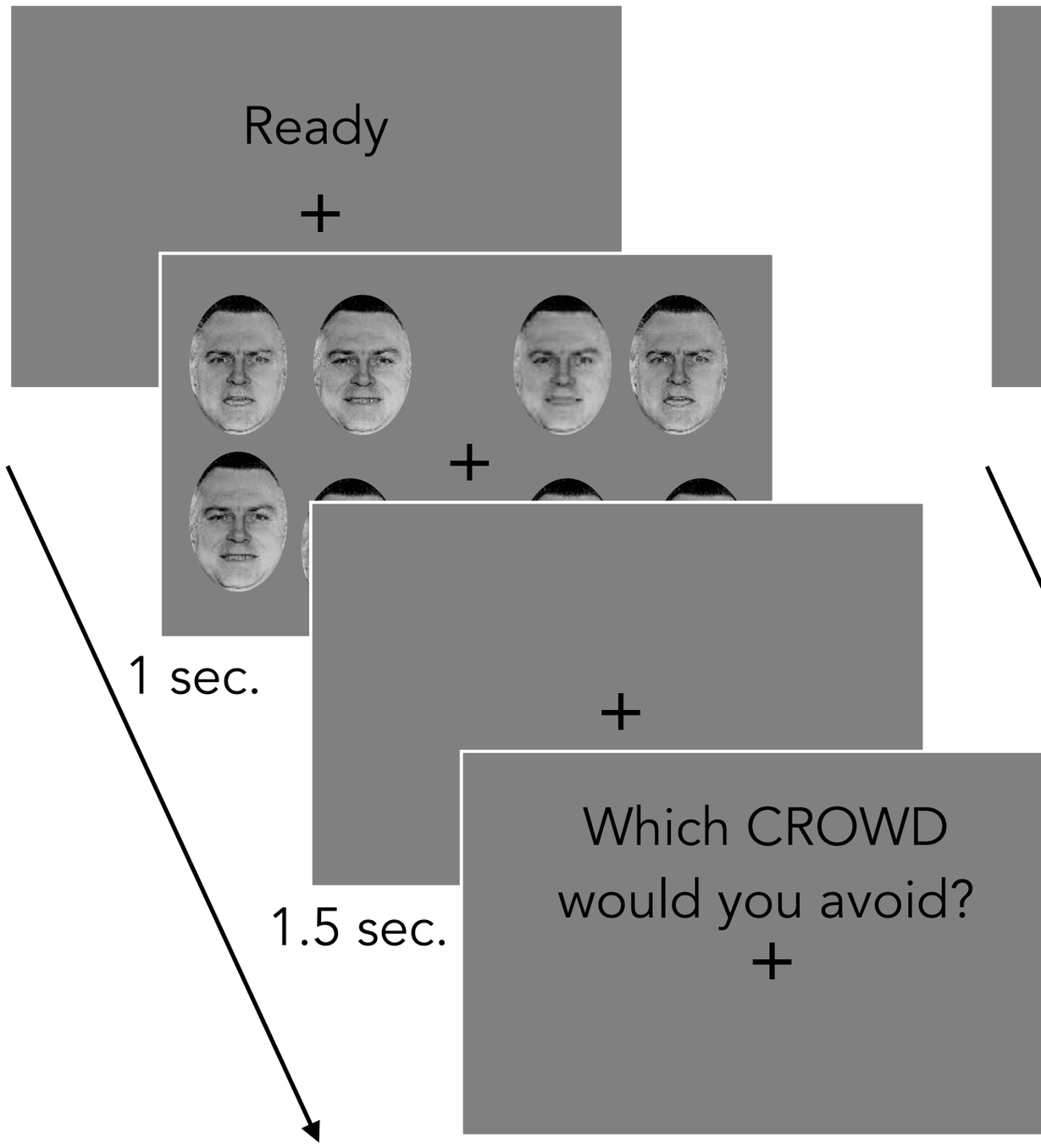
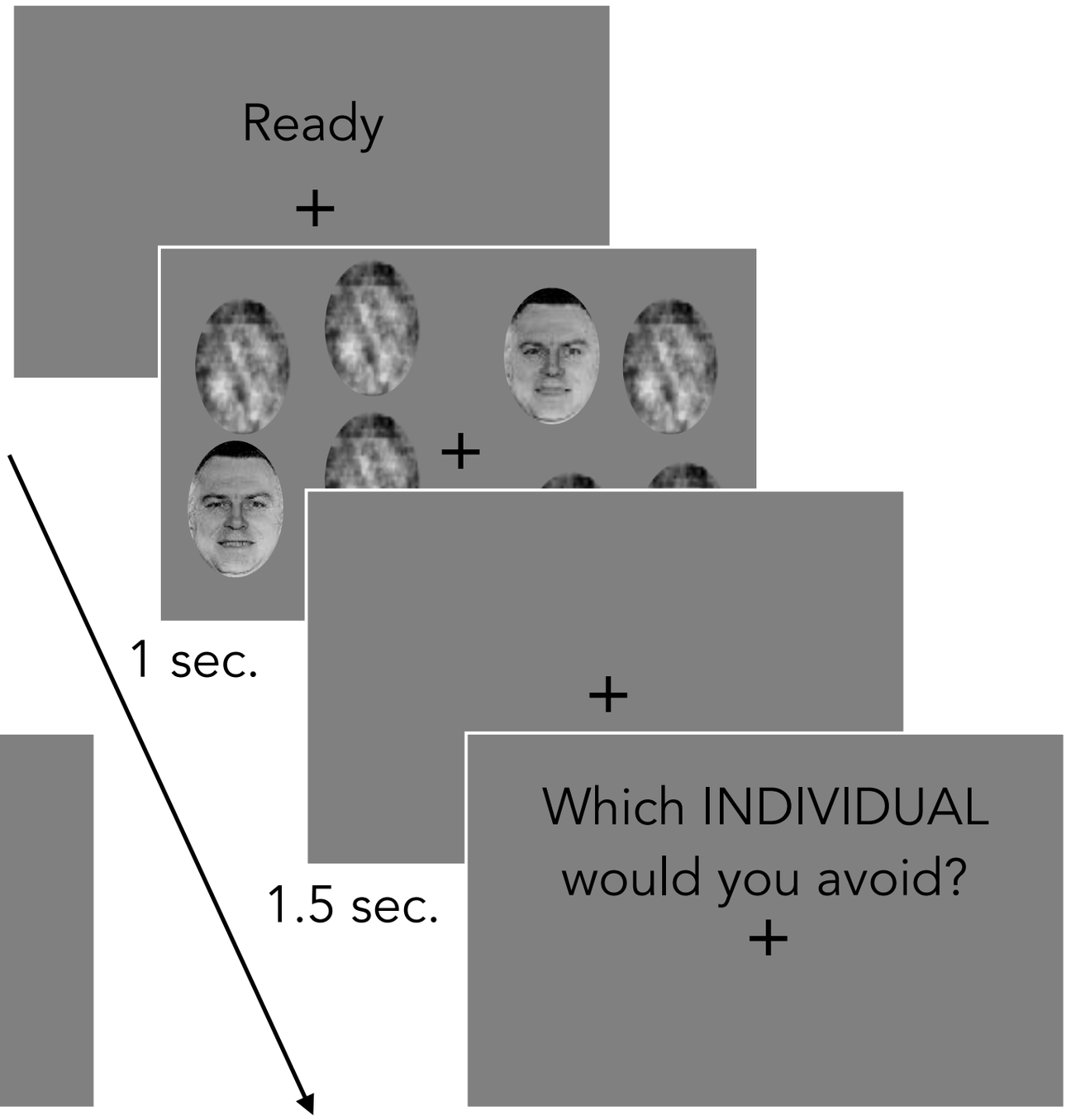
Neural mechanism of crowd emotion perception: fMRI study



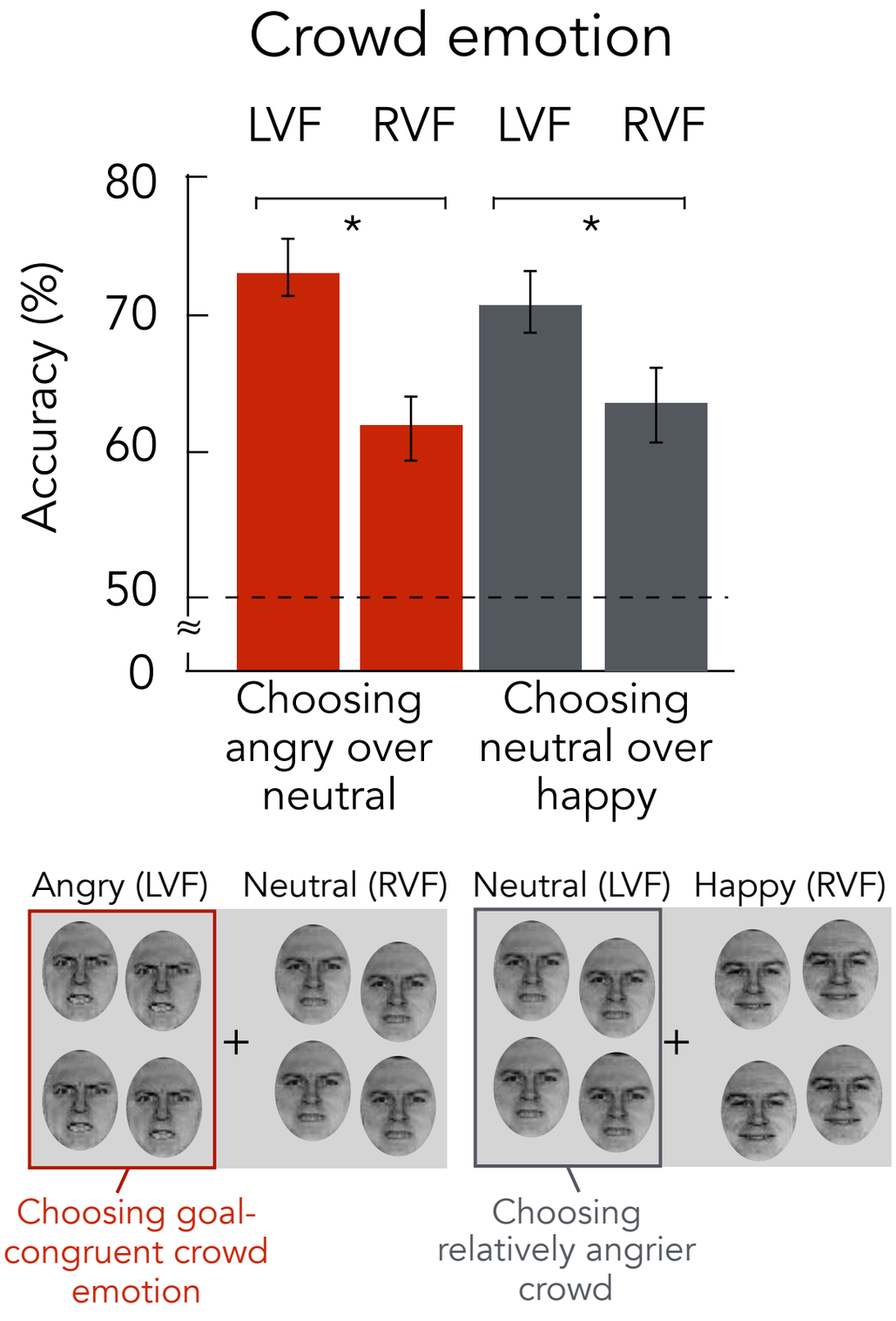


Im et al., *Nature Human Beh.* (2017)

Different laterality effects on crowd vs. individual emotion

Im et al., *Nature Human Beh.* (2017)

Different laterality effects on crowd vs. individual emotion



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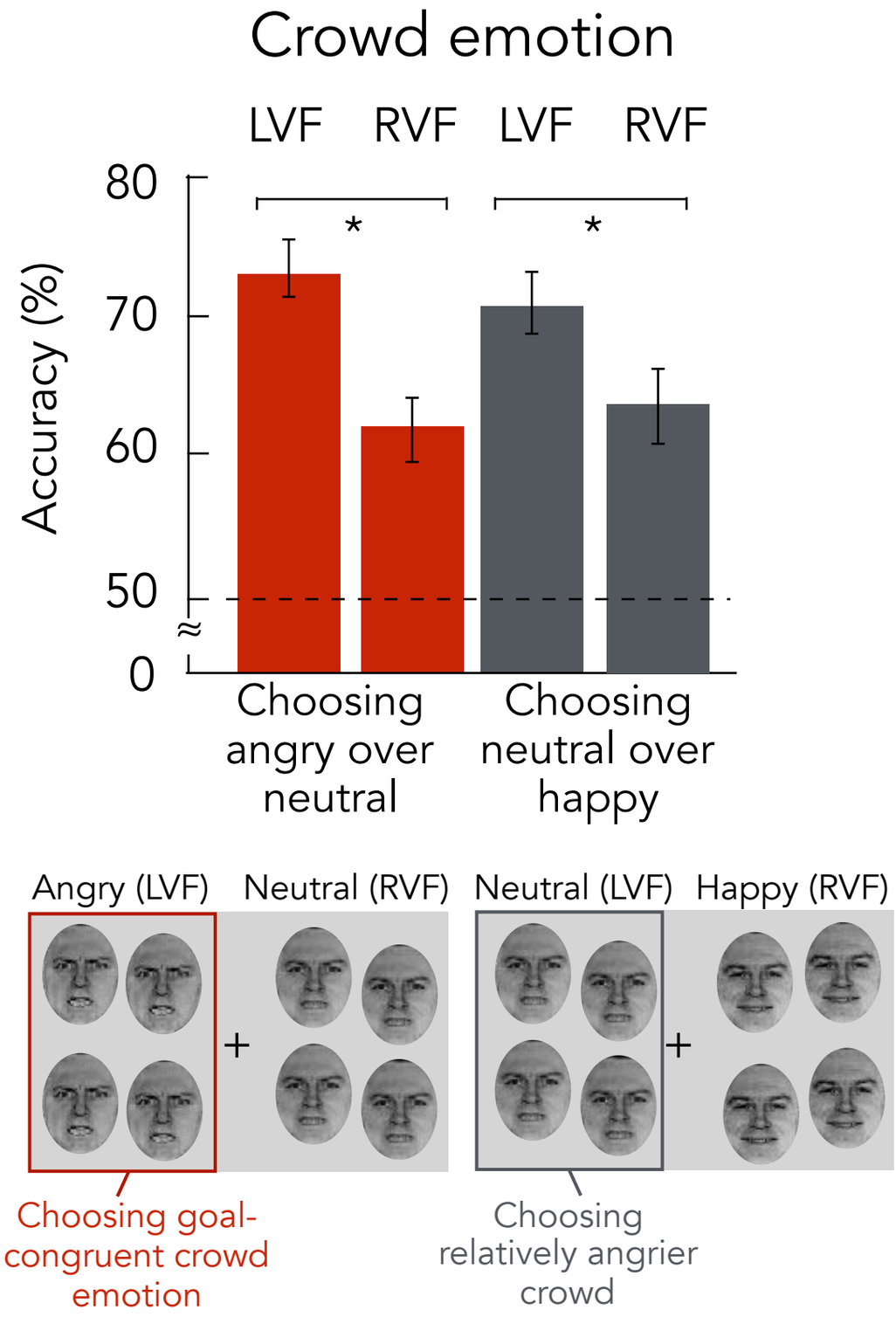
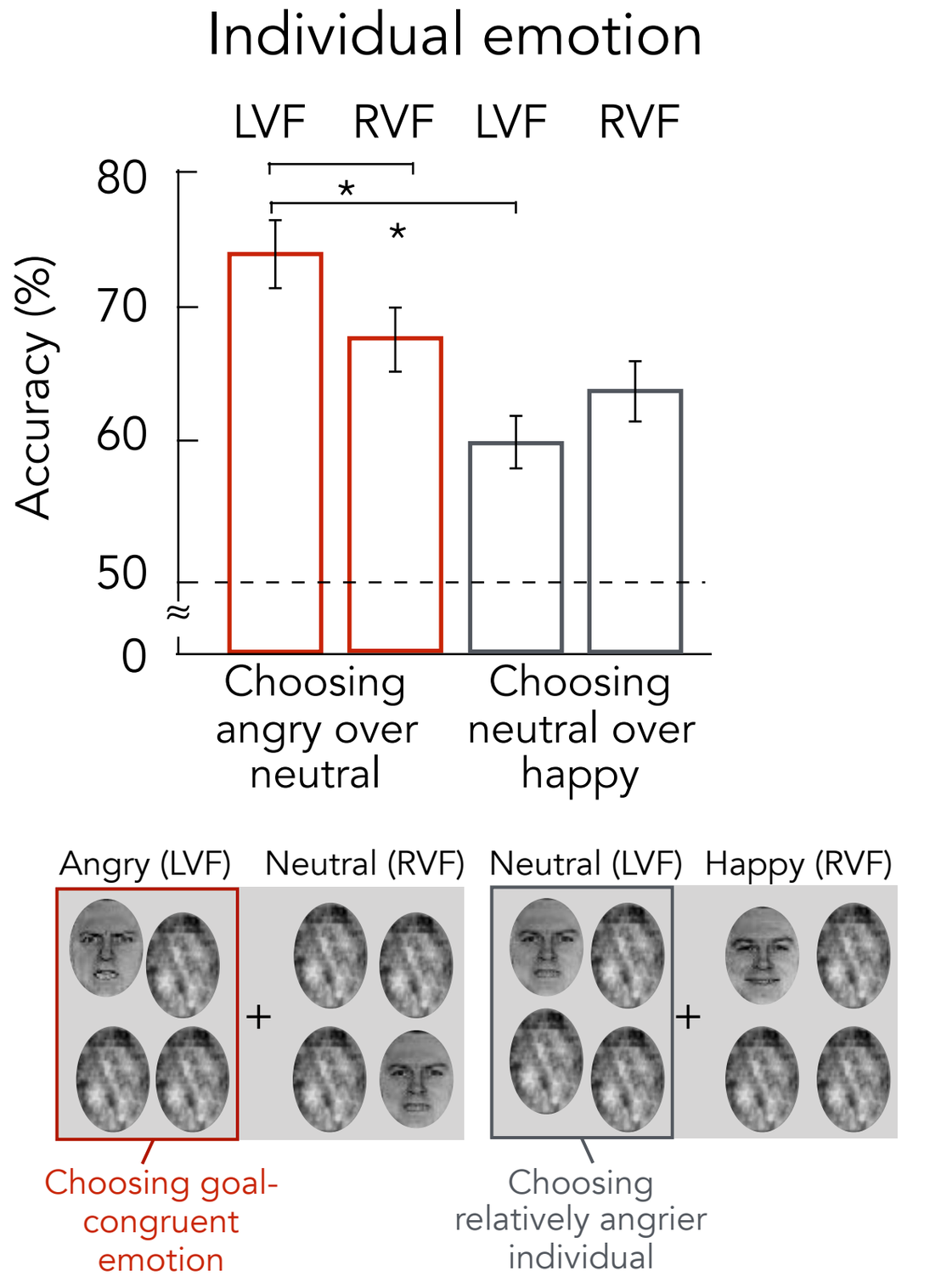
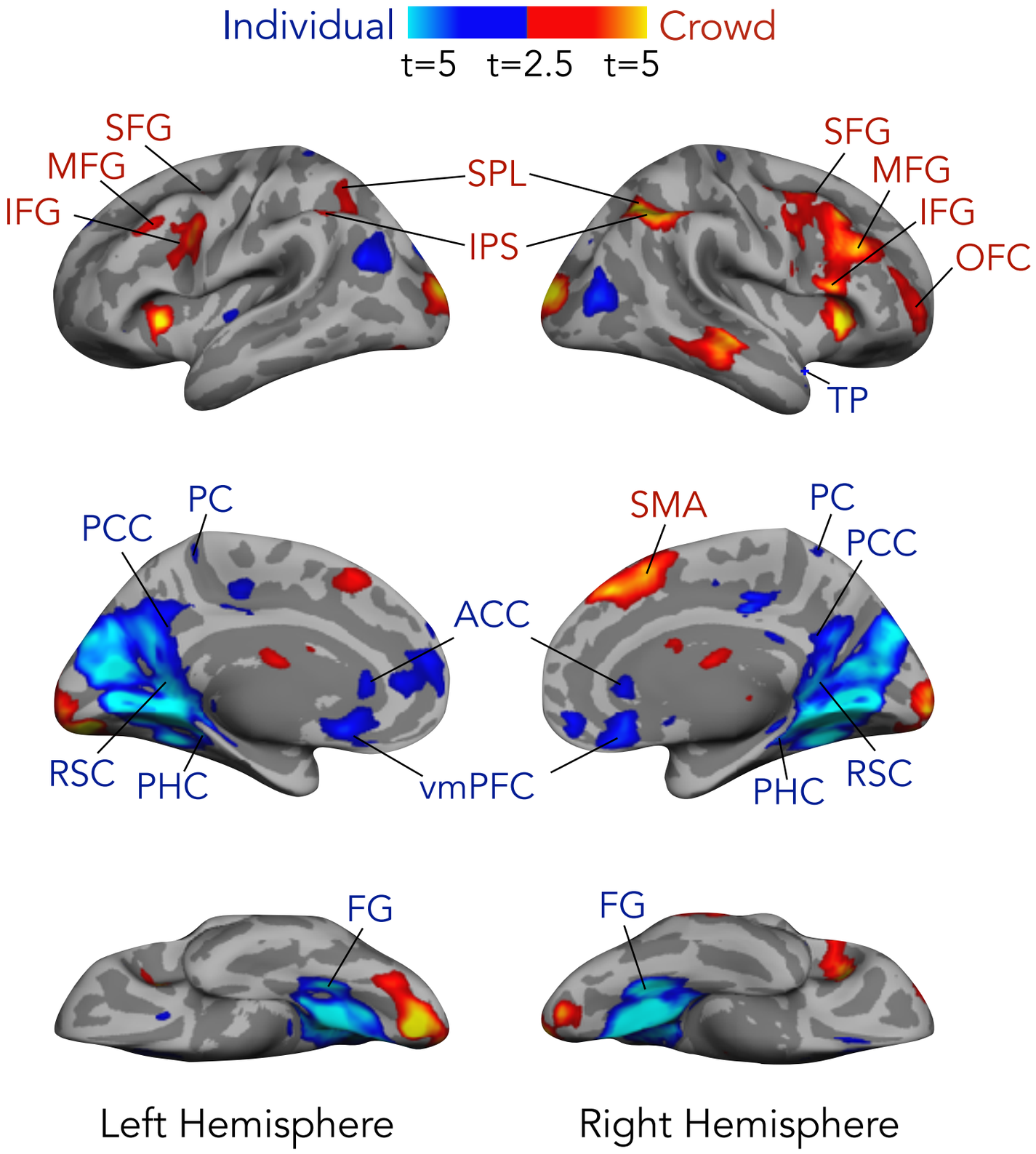
Different laterality effects on crowd vs. individual emotion





Im et al., *Nature Human Beh.* (2017)

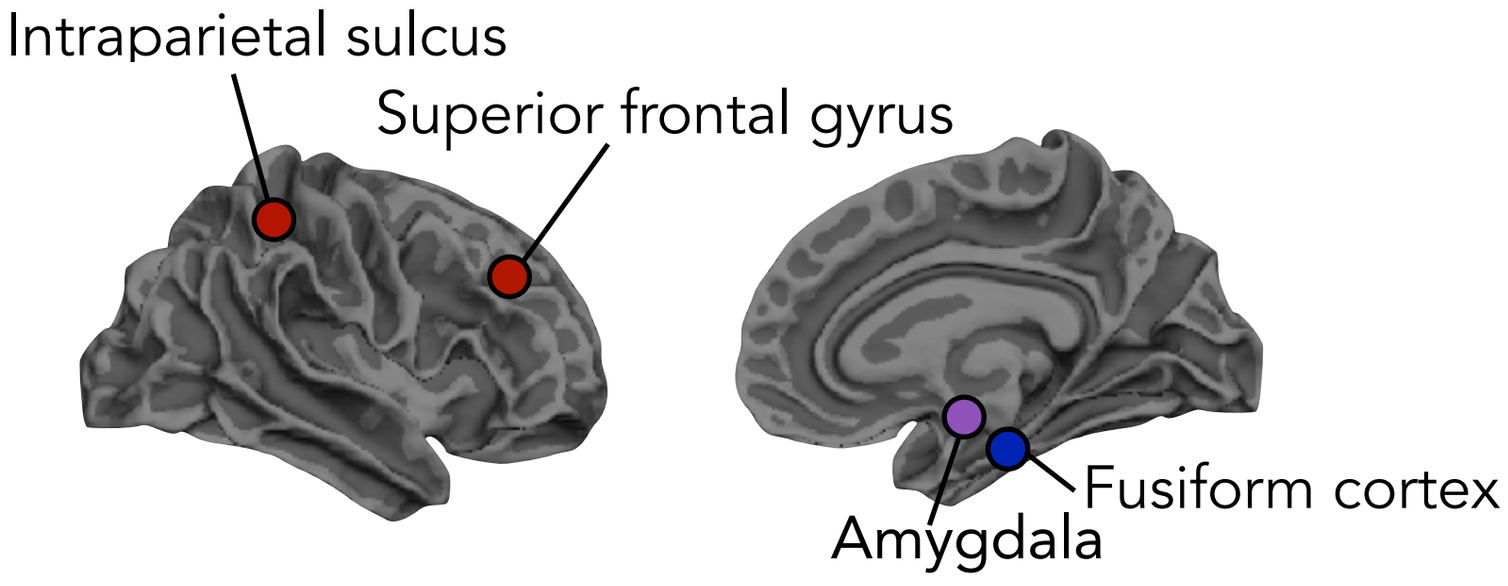
Reading emotion from crowds vs. individuals



The dorsal visual stream was preferentially activated in crowd emotion processing, whereas the ventral stream was preferentially activated in individual emotion processing.

Im et al., *Nature Human Beh.* (2017)

Regions of Interest analysis



- Magnocellular pathway

  Intraparietal sulcus

  Superior frontal gyrus

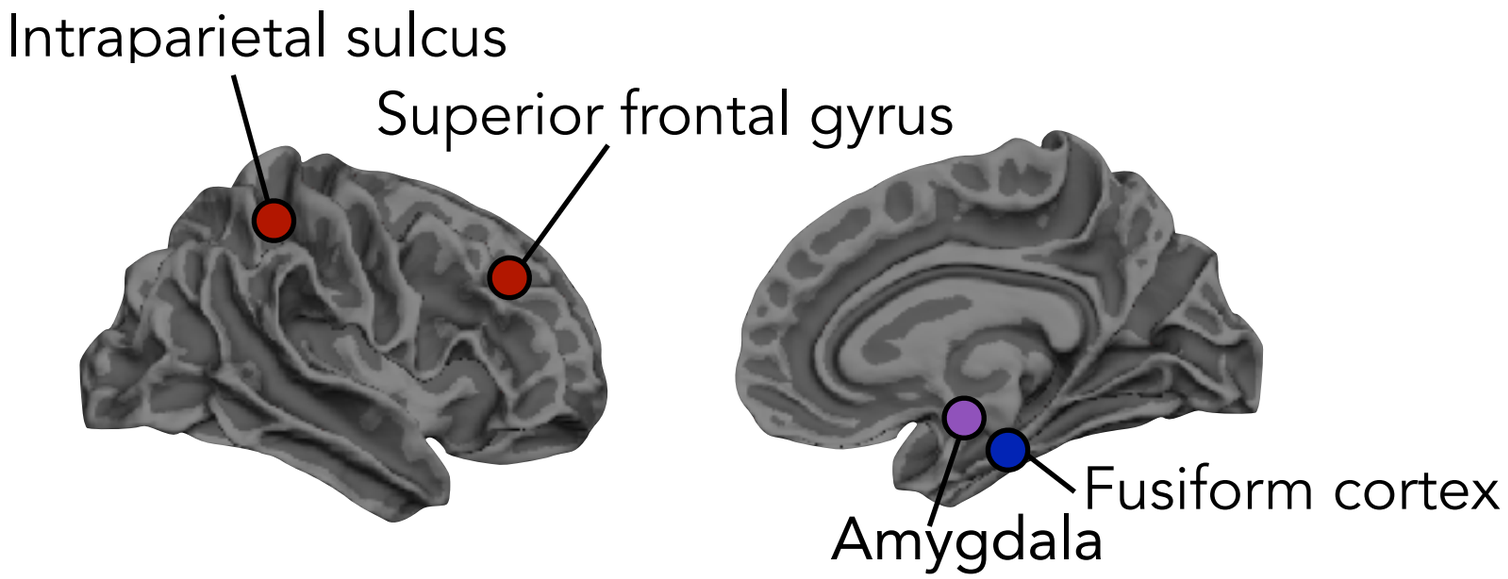
- Parvocellular pathway

  Fusiform gyrus

- Amygdala

Im et al., *Nature Human Beh.* (2017)

Regions of Interest analysis



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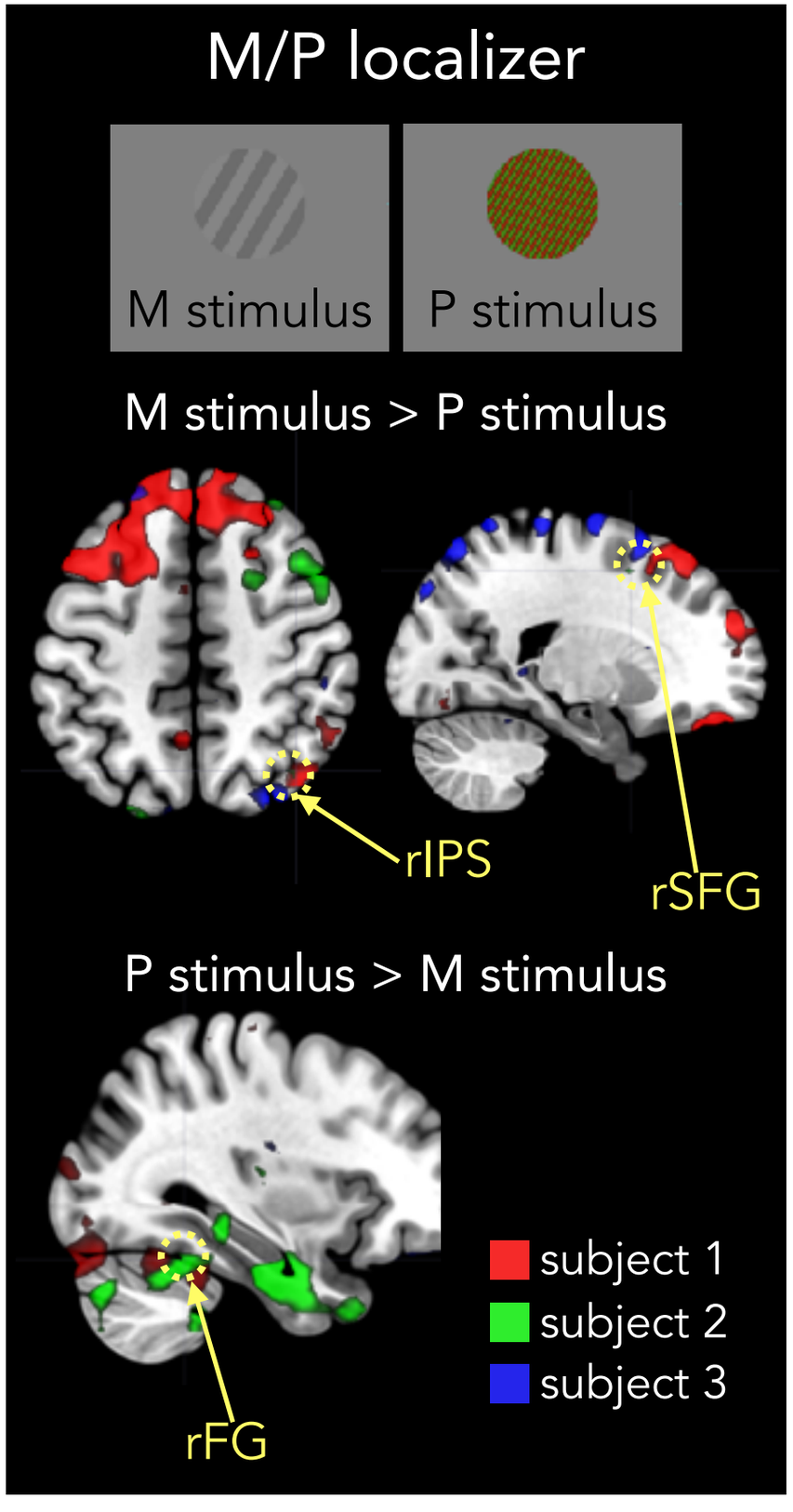
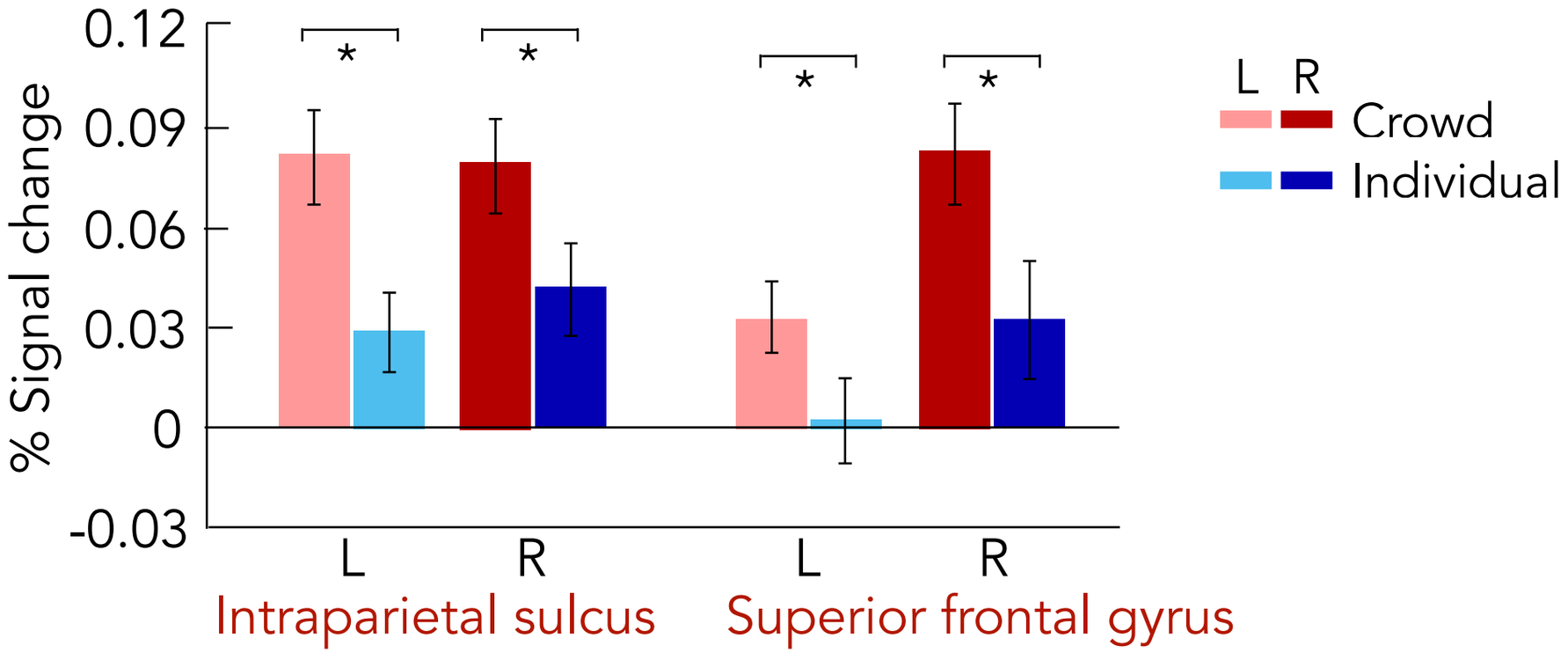


Im et al., *Nature Human Beh.* (2017)

M- and P-pathways for crowd and individual emotion

Im et al., *Nature Human Beh.* (2017)

M- and P-pathways for crowd and individual emotion



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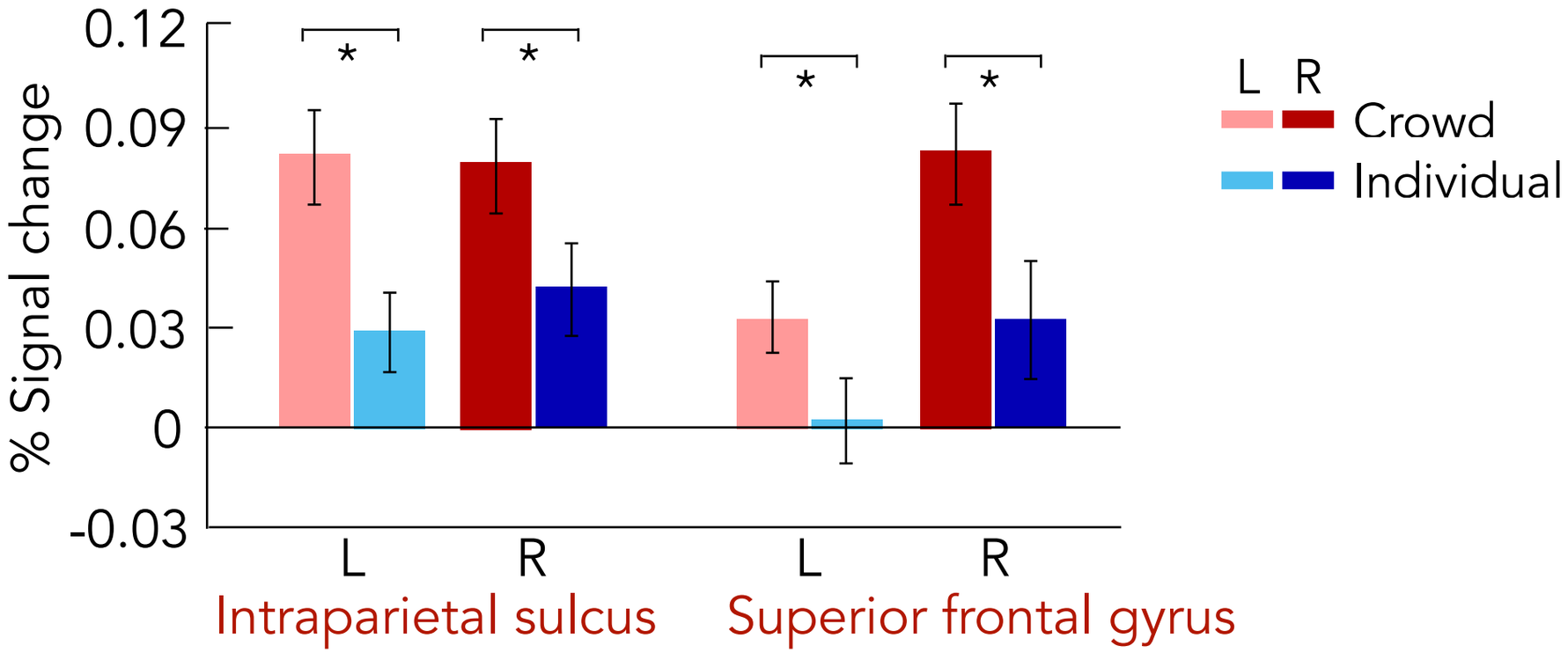
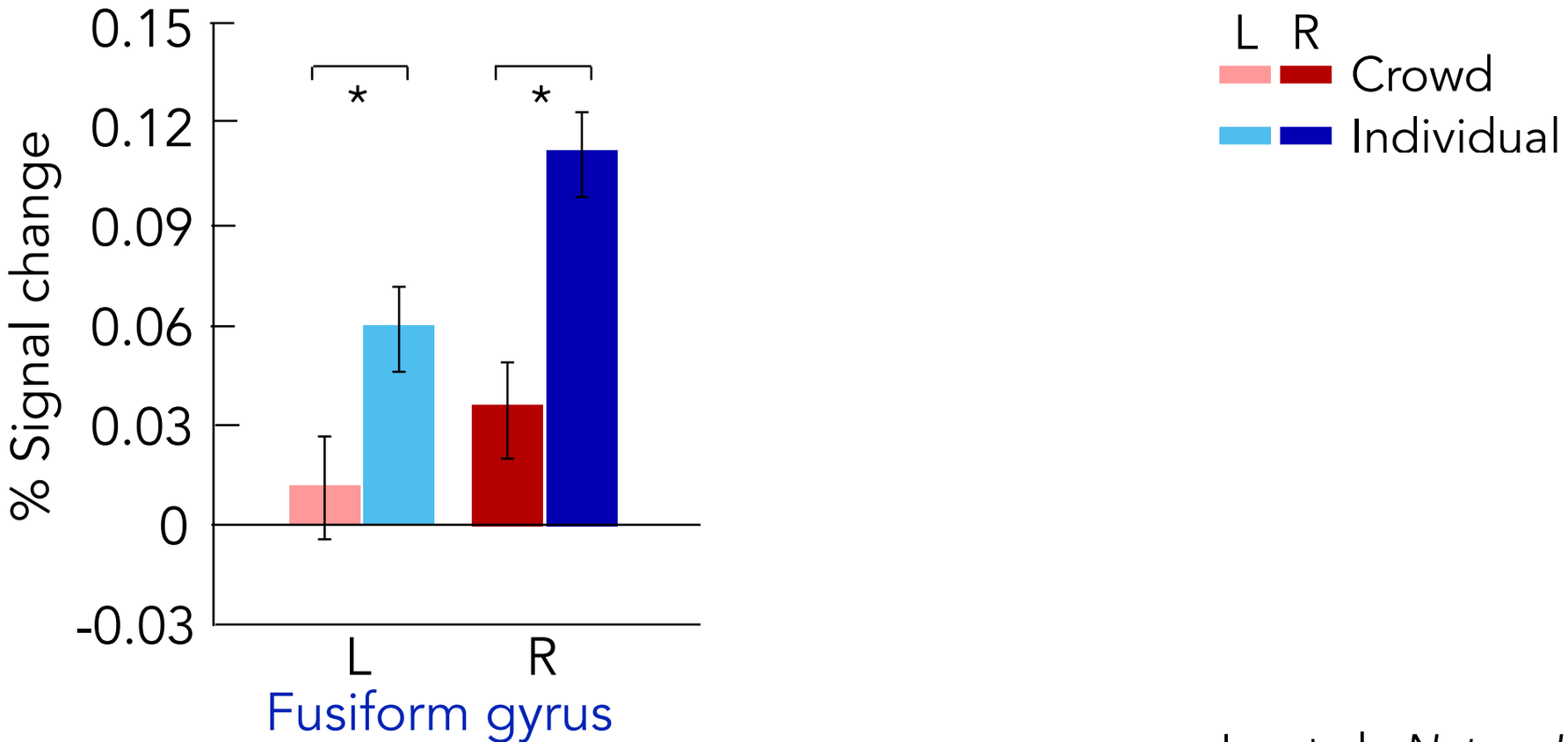
M- and P-pathways for crowd and individual emotion





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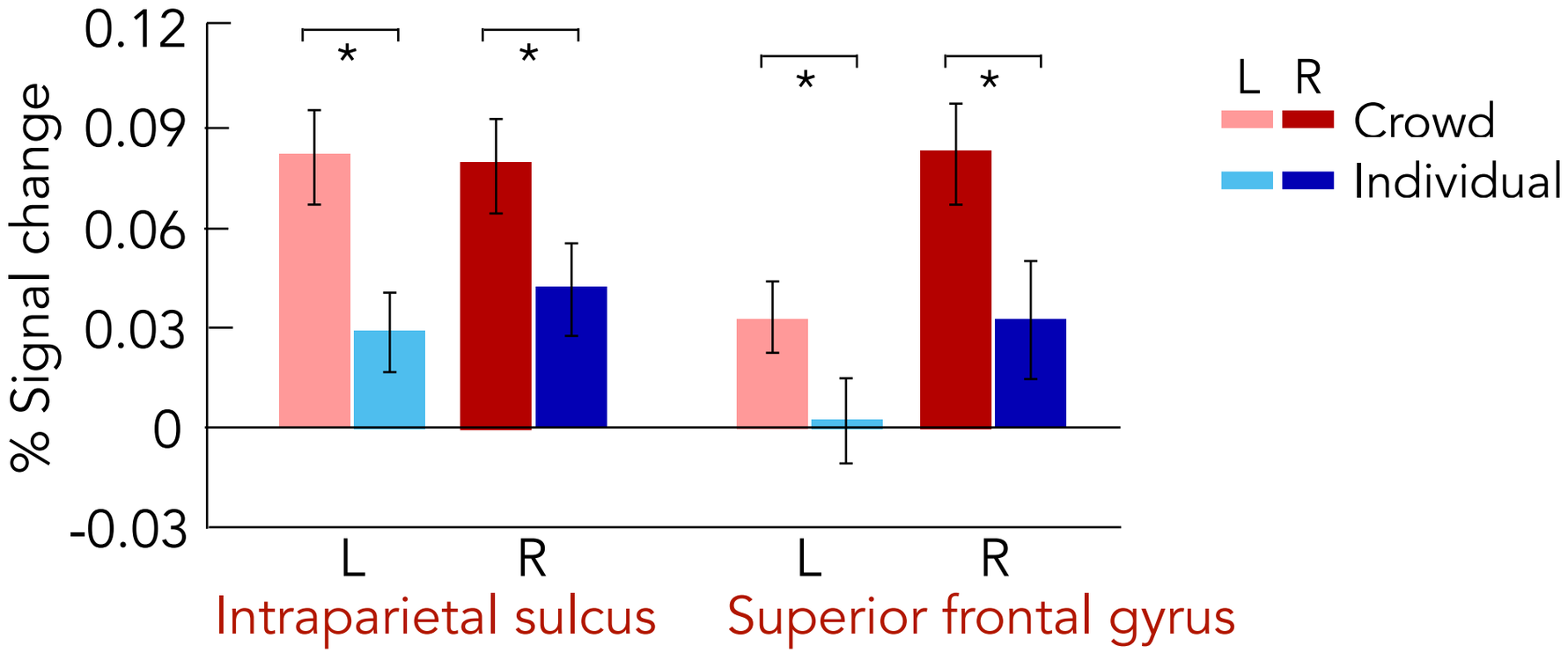

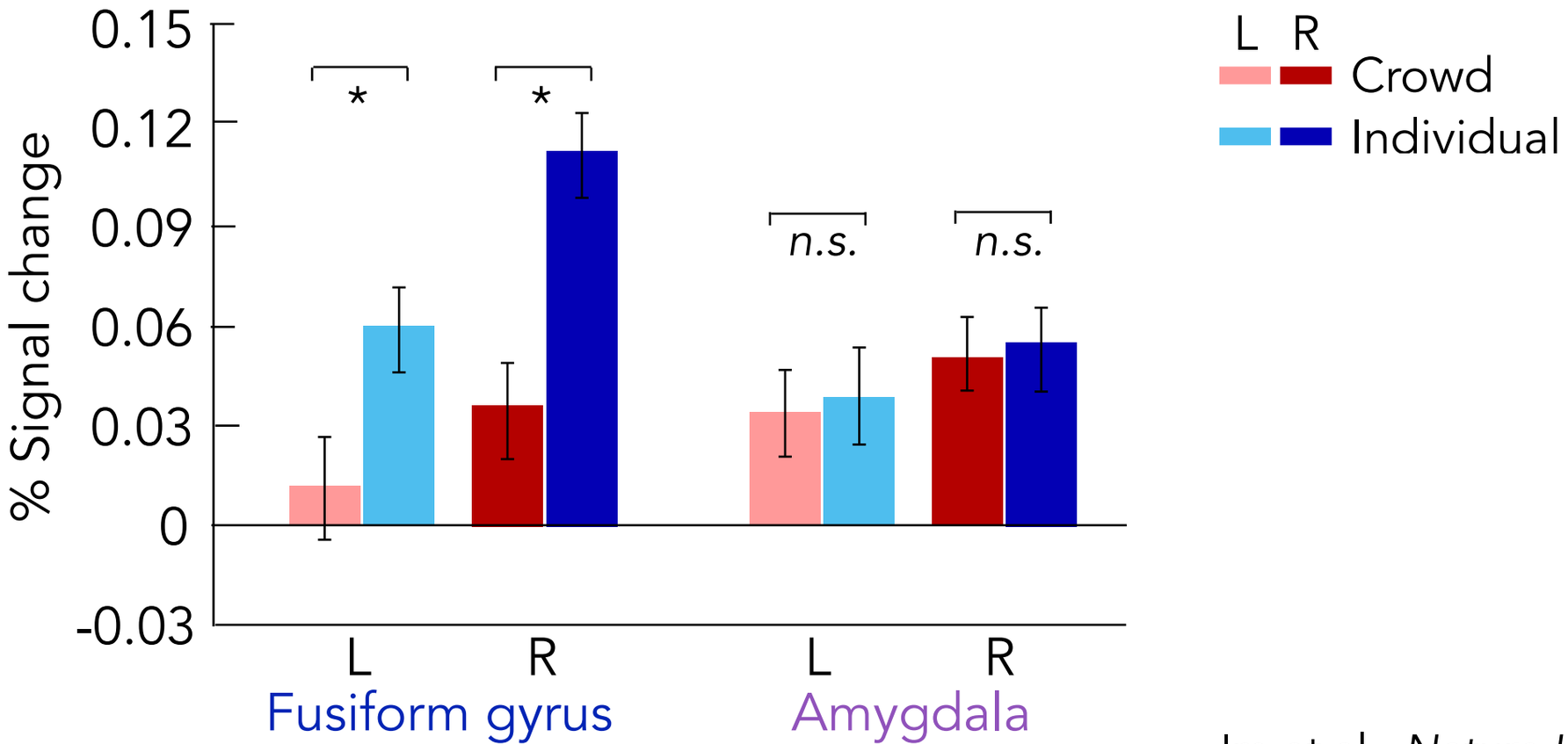

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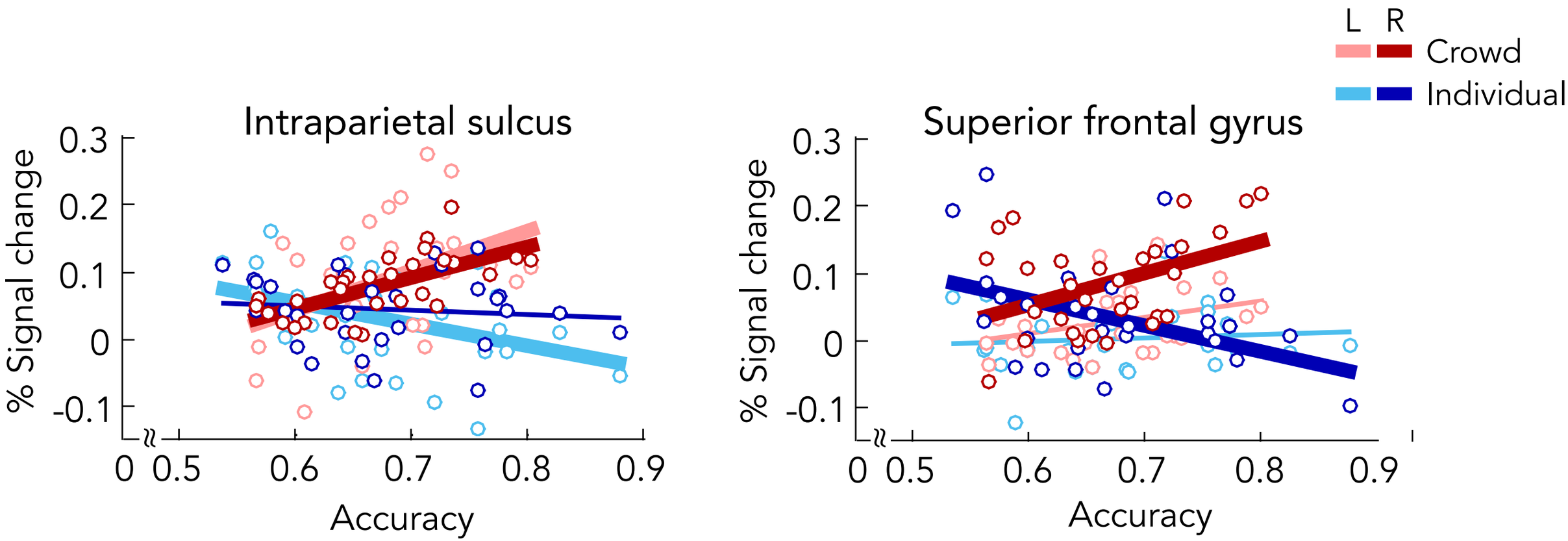
Brain areas predicting accuracy for crowds and individuals



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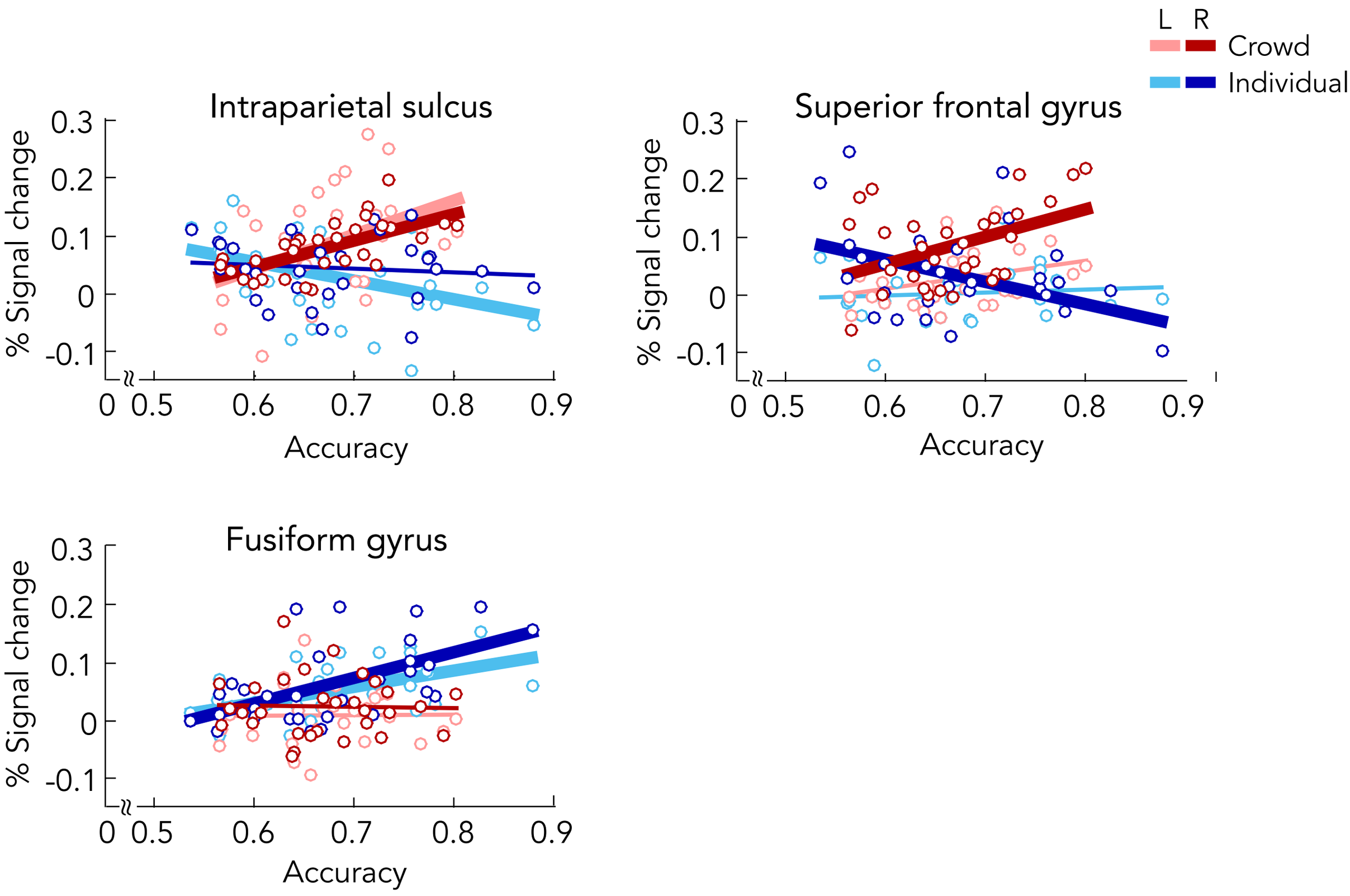

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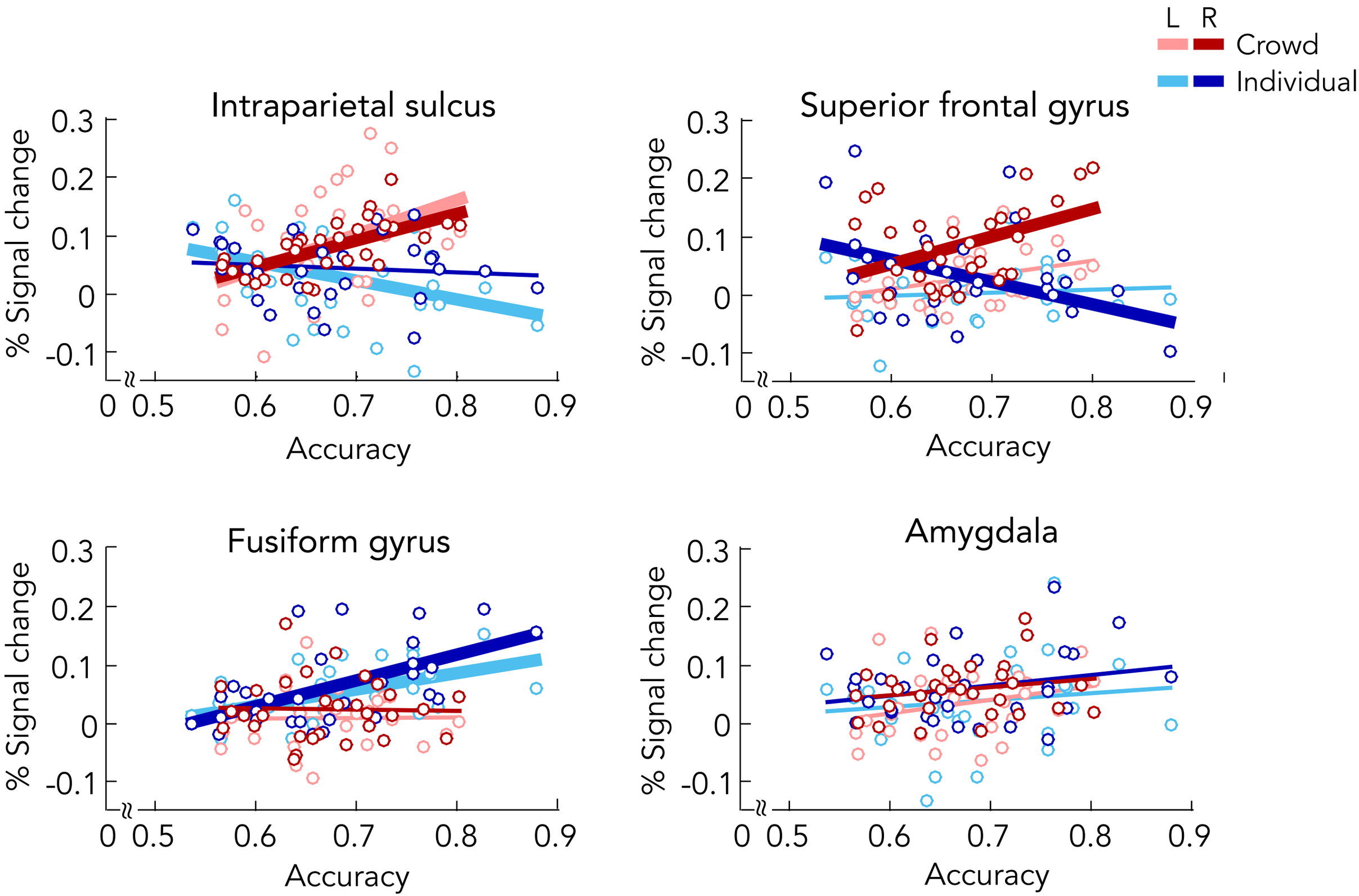

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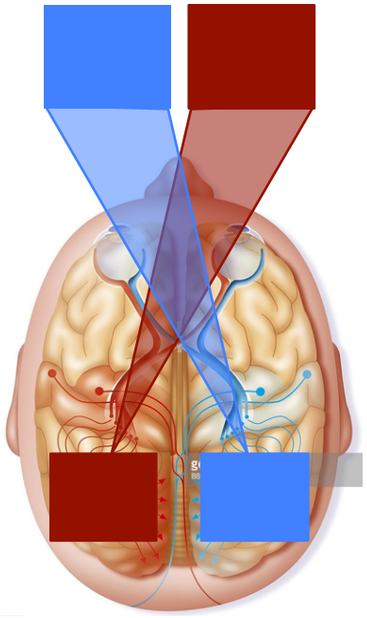
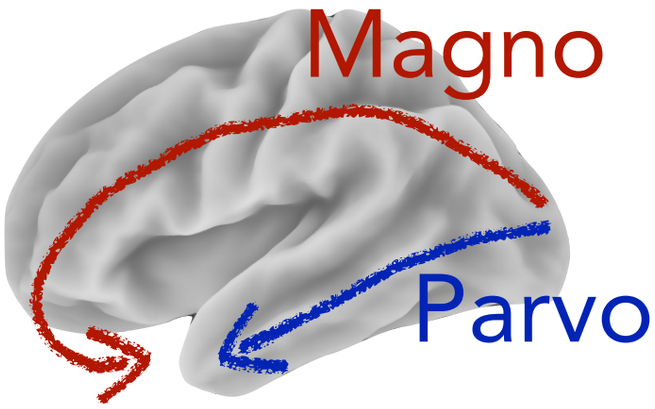
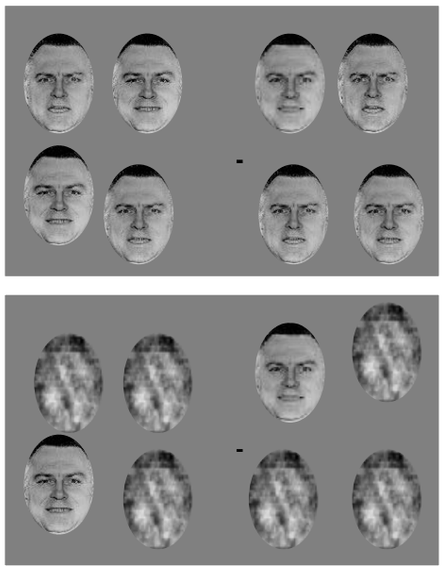
Summary



(1) Different and complementary functions of the two hemispheres



(2) Differential contributions of the two visual pathways (M and P)



(3) Distinct mechanisms of reading emotion from crowds and individuals

Acknowledgement

Funding: NIH 5R01MH101194-02

Kestas Kveraga

Reginald Adams

Cody Cushing

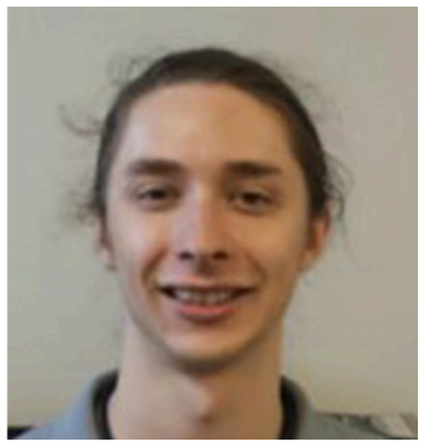
Dan Albohn

Troy Steiner

Jasmine Boshyan

Noreen Ward

Nouchine Hadjikhani



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