Source Modeling of the Error-Related Negativity in Criminal Psychopaths

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Purpose

To investigate the source localization of the ERN in criminal psychopaths and controls.

Background

Anterior Cingulate Cortex (ACC):

Involved in the processing of cognitive and emotional material.[1]

Considered the generator of the error-related negativity (ERN).[2]

Psychopathy:

Evidence suggests abnormal response monitoring under avoidance learning conditions.[3]

Evidence suggests abnormal ACC function during processing of affective stimuli[4,5]

Does increasing the affective component of an error monitoring task result in atypical response monitoring in psychopaths?

Methods

Eriksen Flanker Task

Emotion Flanker Task

HHHHH

SSSSS

HHSHH

SSHSS

Procedure: 480 5-letter arrays each presented for 190 ms.
Number of incongruent flanker trials = 320.
Number of congruent flanker trials = 160.
Instructions: Identify central letter by key-press.

Participants

• 7 forensic patients diagnosed with psychopathy (Mean age = 48.9 years, Mean PCL-R score = 31.1)
• 12 control participants (Mean age = 46.58 years)

ERPs

• 128 site Biosemi system
• 512 points per second
• offline filtered 1 to 30 Hz
• Locations of the major generators were modeled on grand average waveforms for each group using Brain Electrical Source Analysis software (BESA 5.0)[6]
• Site co-ordinates were digitized using a Polhemus FASTRAK digital tracker

Procedure: 480 3-face arrays each presented for 390 ms.
Number of incongruent flanker trials = 320.
Number of congruent flanker trials = 160.
Instructions: Identify emotion in central face by key-press.
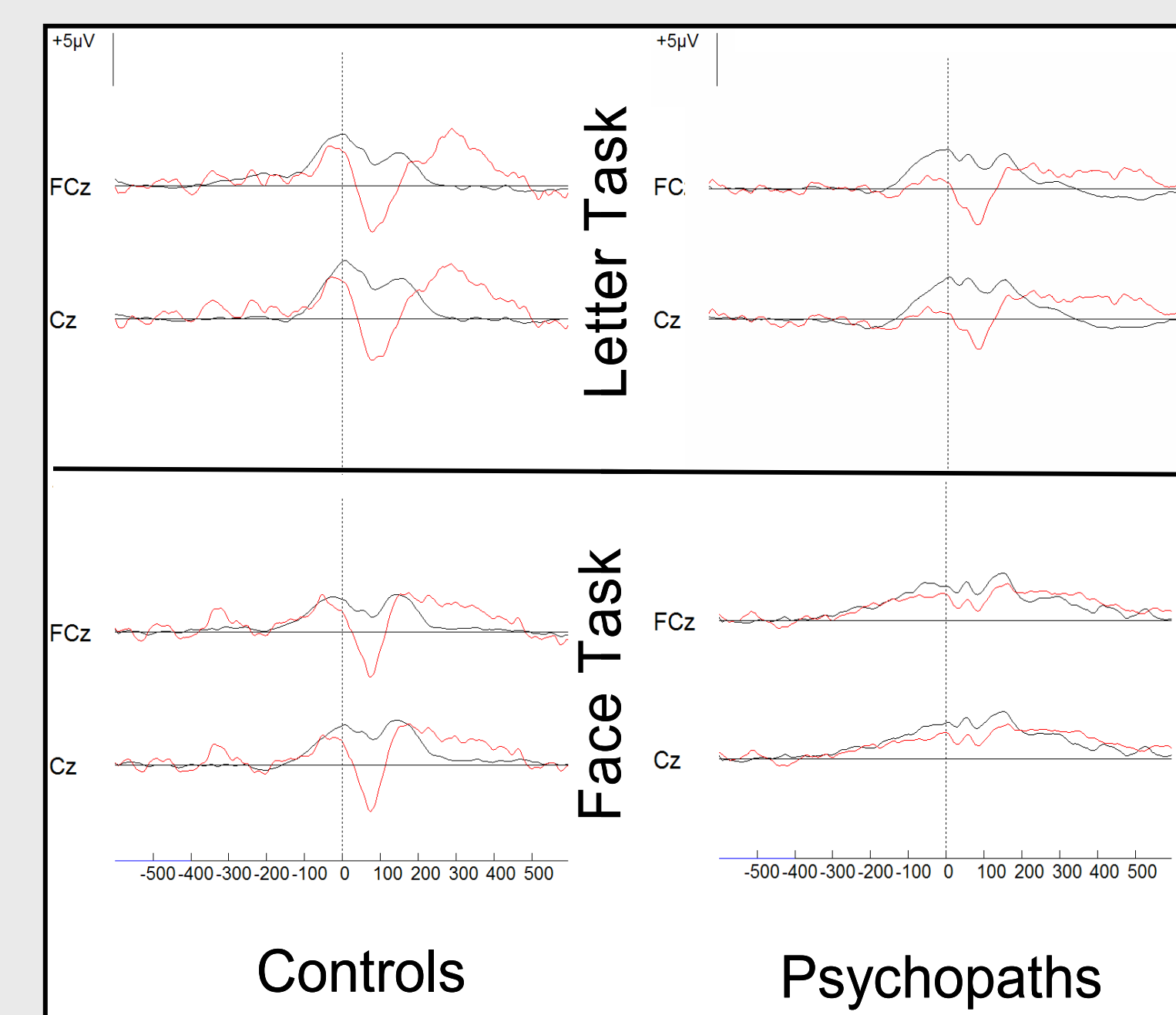
Results

Behaviour:

Group by Task interaction, $p < .01$, indicated that the groups did not differ on the Letter Flanker task but Psychopaths ($M = 15.17\%$) made more errors on the Emotion Flanker task than Controls ($M = 8.13\%$).
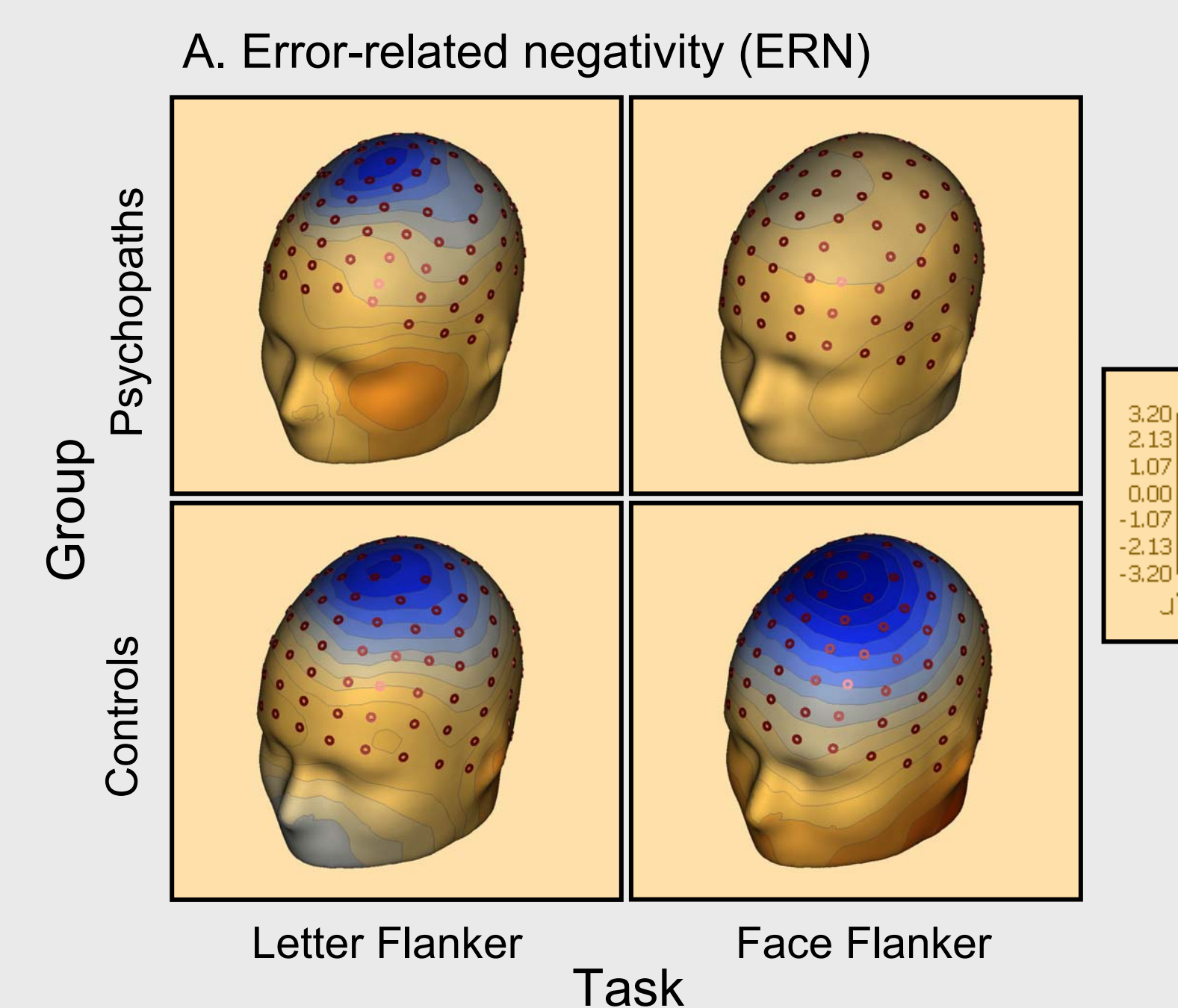
ERNs:

Group by Task interaction, $p = .015$, indicated that Controls produced ERNs of similar amplitude on the Letter and Emotion Flanker tasks. For Psychopaths, Emotion Flanker errors elicited a reduced ERN ($M = 0.46$ μV) compared to errors in the Letter Flanker task ($M = -4.53$ μV).

ERNs by Group and Task
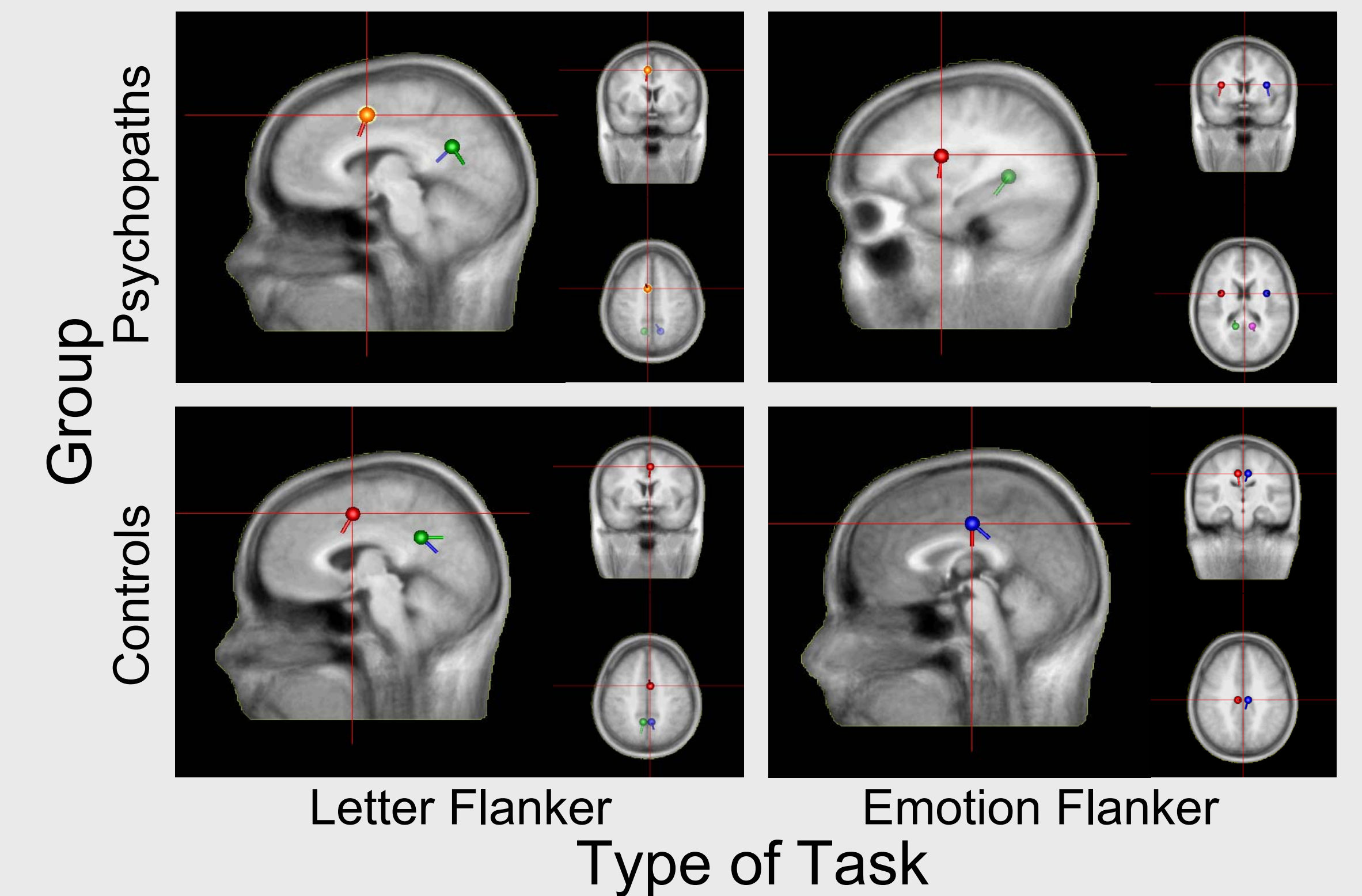

Topographical Maps of the ERN by Group and Task

A. Error-related negativity (ERN)

Source Modeling—Letter Flanker Task:

Both groups generated
• 2 symmetrical dipoles in the dorsal anterior cingulate cortex
• 1 minor dipole in the posterior cingulate cortex

Source Modeling—Emotion Flanker Task:

Controls generated two symmetrical dipoles in the ventral anterior cingulate cortex
Psychopaths generated two pairs of symmetrical dipoles:
• one major pair in the insula
• one minor pair in the parahippocampal gyrus

ERN Dipole Sources

Conclusions

Psychopathy is associated with an atypical error monitoring response when affectively-based discrimination is required

Psychopathy may be associated with functional limbic abnormalities during the processing of affective stimuli

This is consistent with the hypothesis that psychopaths use nonlimbic structures to process affective information[4,7]

References

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