

Neurocircuitry disruptions in torture survivors: a literature synthesis of the last quinquennium on threat, reward, cognitive control, and resting-state network connectivity

Evangelou K¹, Pavlidou L¹, Belimezakis N¹, Zervas V¹, Hadjiphilippou M², Louka C³

¹ Department of Medicine, National and Kapodistrian University of Athens, Athens, Greece

² Department of Nursing, National and Kapodistrian University of Athens, Athens, Greece

³ Department of Chemistry, University of Cyprus, Nicosia, Cyprus

INTRODUCTION

Torture is a prototypical “trauma of disconnection”, designed to destroy control, trust and social bonds and to induce enduring psychological disorganisation. Forensic psychiatrists frequently assess refugees and other survivors in whom torture-related posttraumatic stress, depression, dissociation and functional impairment persist long after exposure.

While volumetric changes and task-based abnormalities in emotion-related regions have been described, the last 5 years have seen a shift toward network-level fMRI approaches that examine how torture exposure alters large-scale systems underpinning threat appraisal, reward processing, cognitive control and intrinsic self-referential activity.

A synthesis of these findings can clarify whether torture is associated with a characteristic pattern of neurocircuitry disruption that is at least partly independent of current PTSD severity, with implications for forensic opinion and treatment planning.

AIM

To synthesise functional MRI evidence from the last five years on how torture exposure modulates: (1) threat and reward neurocircuitry; (2) intrinsic

resting-state network connectivity; and (3) cognitive control and attention networks, and to relate convergent neural findings to symptom dimensions and forensic-clinical implications.

METHODS

A structured literature search identified peer-reviewed fMRI studies published in the last quinquennium that: (a) compared adults with verified torture exposure to non-tortured but similarly trauma-exposed controls; and (b) reported whole-brain or network-based functional outcomes.

Three studies ultimately met criteria: interpersonal threat-reward face processing, resting-state intrinsic connectivity and Go/NoGo response inhibition. Across studies, torture survivors were mainly refugees with diverse country-of-origin and long intervals since exposure; non-torture survivors had comparable war and displacement histories.

Analyses controlled for age, non-torture potentially traumatic events, post-migration stress and PTSD severity, and used independent component or region-of-interest approaches to characterise activation and connectivity within canonical networks (default mode, central executive, attention, auditory-motor) and their links to symptom clusters (fear, avoidance, dysphoria).

RESULTS

During interpersonal face viewing, torture survivors showed blunted ventral striatal responses to happy faces relative to non-torture controls, with greater deactivation at higher PTSD severity, particularly avoidance. Simultaneously, the ventral striatum displayed stronger functional coupling with bilateral inferior frontal regions, suggesting increased prefrontal regulation of a hypo-responsive reward system.

Torture survivors also demonstrated reduced left anterior hippocampal engagement to both fear and happy faces, moderated by cumulative trauma load. Hippocampal activity during fear processing was more tightly coupled to lateral prefrontal, temporoparietal, posterior insula, precuneus, thalamic and supplementary motor regions, with connectivity strength predicted by avoidance and hyperarousal. Behavioural accuracy in labelling facial expressions remained intact, indicating covert neurocircuitry changes despite preserved task performance.

Resting-state analyses focused on the triple network model and prefrontal systems. Torture survivors exhibited reduced low-frequency spectral power in the left central executive network, consistent with attenuated long-range integration within lateral frontoparietal control circuits. Dynamic connectivity

analyses revealed stronger positive coupling between left central executive and anterior dorsomedial and ventromedial default mode subsystems, and stronger negative coupling between a lateral frontal network and both the central executive and anterior dorsomedial default networks. These patterns persisted after adjusting for PTSD symptoms, non-torture trauma load and dissociative severity, and were not explained by torture intensity. The profile suggests a re-tuning of interactions between top-down control and self-referential networks, with executive systems more tightly bound to internally oriented processing and lateral frontal regions more segregated, potentially underpinning over-controlled, rigid and withdrawn coping styles.

Go/NoGo network analyses showed that torture survivors had reduced within-network connectivity in the posterior default mode (left precuneus) and auditory-motor (right superior temporal gyrus) networks, and weaker coupling between a dorsomedial frontal control network and the dorsal attention network across the task. During successful response inhibition, the ventral attention network was more negatively engaged in torture survivors, suggesting under-recruitment of salience-guided reorienting despite preserved behavioural accuracy and reaction times. Secondary models indicated that more negative right superior

temporal and dorsomedial frontal-dorsal attention connectivity moderated the association between torture exposure and higher PTSD dysphoria, but not re-experiencing symptoms, highlighting a specific link between disrupted cognitive control networks and anhedonia, withdrawal and concentration difficulties.

CONCLUSION

Torture appears to reshape large-scale brain networks for threat, reward, self and control, producing blunted interpersonal reward, atypical hippocampal responses and abnormal default-executive coupling tied to avoidance and dysphoria. These persistent, biologically anchored changes inform assessments of capacity, vulnerability and treatment, and support medico-legal claims, disability decisions, custodial risk-management and specialised rehabilitation and human-rights monitoring.

CORRESPONDENCE

Kyriacos Evangelou; National and Kapodistrian University of Athens; NKUA
evangeloukyriacos@gmail.com

Lydia Pavlidou; National and Kapodistrian University of Athens; NKUA
lydiapav00@gmail.com