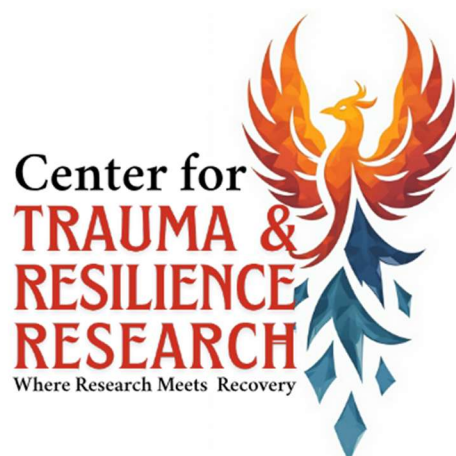


Neuroscience of Emotions and Physical Reactions

Dr. Meg Robertson

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600 1st Ave Ste 330
PMB 100974
Seattle, Washington 98104-2246 US
(541)630-3888; FAX: (360) 251-0821
Website: www.ctrinc.com
Nonsecure email: trauma.resilience.research@gmail.com
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Author Note

Dr. Meg Robertson, <https://orcid.org/0009-0008-0661-3461>

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Correspondence concerning this article should be addressed to

Margaret Robertson

Email: trauma.resilience.research@gmail.com

Abstract

Emotions are complex processes involving the brain and body. This paper explores the neural mechanisms behind emotional experiences and the corresponding physical reactions. Key brain regions such as the amygdala, hypothalamus, and prefrontal cortex interact to appraise stimuli and initiate physiological responses. Applications examined include consumer behavior (aromachology), defense mechanisms, architecture, emotion modeling through physiological data, emotion recognition using EEG and AI, mindfulness in adolescents, and stigma reduction in mental health. The conclusion emphasizes the interdisciplinary potential for improving human well-being through a deeper understanding of the emotion-body link.

Keywords: Emotion, neuroscience, physiological response, limbic system, aromachology, affective computing, mindfulness.

Introduction

Emotions are embodied phenomena that manifest through neural circuits and physical changes. Affective neuroscience has mapped how stimuli trigger responses in the amygdala and hypothalamus, which coordinate heart rate, hormone release, and behavioral shifts. These brain-body links serve adaptive purposes and inform applications in design, mental health, and technology.

Neurological Mechanisms of Emotion

The amygdala rapidly evaluates emotional stimuli, particularly threats, and activates the hypothalamus, which drives the fight-or-flight response via sympathetic arousal (Professional, 2024; Layton, 2024). Meanwhile, the prefrontal cortex interprets context and can dampen or reinforce emotional responses, crucial for emotion regulation (Kredlow et al., 2021). Other regions, such as the hippocampus and insula, contribute by linking memory and interoceptive awareness to emotion. These distributed networks create flexible, context-sensitive emotional states.

Physiological Responses

Emotions trigger involuntary bodily changes—sweating, accelerated heartbeat, pupil dilation—driven by hormones like adrenaline (Raisz-Abdullahi et al., 2023). These responses vary: fear can pale the skin, anger may cause flushing, and joy activates both sympathetic and parasympathetic systems. Facial expressions and posture reflect emotion automatically. Neural activity can outlast the stimulus, explaining why emotional arousal persists (Kennedy et al., 2020), which has implications for chronic stress and anxiety.

Applications

Aromachology and Consumer Experience Aromachology leverages the limbic system's olfactory-emotional link to influence consumer mood and behavior. Pleasant scents like lavender or vanilla can promote calm and increase dwell time in stores (Berčík et al., 2021). EEG and biometric tools measure these emotional responses, making scent a powerful tool in emotional branding.

Persistent Defensive States

Research on hypothalamic neurons shows that fear can persist after a threat, maintained by ongoing neural firing (Kennedy et al., 2020). This helps explain disorders like PTSD and anxiety, where emotional states linger. Interventions targeting these circuits could offer relief by disrupting pathological persistence (Malezieux et al., 2023). Neuroarchitecture Designing spaces with calming sensory cues—light, sound, color—can modulate emotional responses via the amygdala and prefrontal cortex (Otis & Edelstein, 2022). Integrating natural elements reduces stress and enhances well-being. Neuroarchitecture advocates for environments that support sensory integration and emotional regulation.

Emotion Intensity Modeling

Physiological signals—heart rate, skin conductance—can be used to model emotional intensity. Barradas et al. (2025) trained machine learning models using appraisal theory to estimate how strongly individuals felt emotions during different stimuli. Applications range from therapy monitoring to adaptive AI in vehicles or customer service bots.

Mental Health Stigma

Neuroscience can reframe mental illness, reducing stigma by showing its biological basis (Almeida & Sousa, 2022). Brain imaging studies of empathy reveal shared neural activity

between observer and sufferer, promoting compassion. Neuroscience-informed public education and clinical training may reduce bias and foster inclusive treatment environments.

Mindfulness and Adolescents Mindfulness training in teens enhances emotion regulation, improving emotional awareness and prefrontal activity (Özeke-Kocabaş & Koyuncu, 2023). Even brief programs show promise in increasing resilience and reducing stress in school settings. This supports incorporating neuroscience-based mindfulness into curricula for adolescent mental health.

EEG and AI in Emotion Recognition Emotion recognition through EEG has advanced with deep learning models that detect emotion states from brainwave patterns (Gkintoni et al., 2025). Combining EEG with other biometric data improves accuracy. Applications include mental health tracking, adaptive learning platforms, and affective robotics—though ethical concerns remain about privacy and data use.

Emotions in Rehabilitation

Coppola (2021) argues for using emotional rehabilitation in criminal justice, emphasizing emotional growth over punishment. Neuroscience shows that empathy, social connection, and emotional regulation deter antisocial behavior. Programs that teach these skills in humane environments reduce recidivism and support reintegration, shifting justice from retribution to restoration.

Conclusion

Emotions are not isolated brain events but dynamic, whole-body experiences that shape behavior and society. From the amygdala's rapid threat detection to the prefrontal cortex's nuanced regulation, emotional responses unfold across neural and physiological systems. Applied neuroscience is reshaping fields from retail and architecture to justice and education.

Future research will further unravel emotional circuits, quantify intensity, and tailor interventions for diverse populations. By embracing emotions as biopsychosocial phenomena, we can build more empathetic technologies, inclusive spaces, and compassionate societies.

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