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Structural equation modelling to assess relationships between event-related potential components, heart rate and skin conductance in the context of emotional stimuli

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Abstract

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Background: Emotions are associated with central (CNS) and autonomic (ANS) nervous system arousal, which can be indexed through psychophysiological changes in event-related potentials (ERPs), heart rate and skin conductance to emotional compared to neutral stimuli. Relationships between these variables are complex and inadequately understood. ERP changes to emotional stimuli, for example, may reflect the activity of cortical regulation of limbic emotional areas or, conversely, increased attention to emotionally salient stimuli. The current study aimed to provide a stronger assessment of the relationship among these variables than is provided by analysing multiple levels of data separately or using traditional correlational approaches.
Method: We employed structural equation modelling to assess pathways between event-related potential component amplitudes and latencies, heart rate and skin conductance, and to statistically assess their relationship to a latent variable of emotional arousal. Twenty healthy volunteers responded to 500 trials of randomly mixed threat and neutral words with simple task requirements performed using a button press device. The psychophysiological data (ERP component amplitudes and latencies, heart rate and skin conductance) to threat and neutral stimuli were included in the analysis. An initial correlational analysis was performed, followed by structural equation modelling using AMOS software (Version 19) in order to clarify interactions among the variables. Fit indices for uni and multi-dimensional models of emotional arousal were compared.
Results: We present a schematic of the best-fitting parsimonious model to account for pathways between the variables. The model outlines both relationships and fractionation between these ANS and CNS psychophysiological measures and the hypothesised underlying concept of emotional arousal.
Discussion: The results suggest that the structural equation modelling and latent variable analysis is a useful approach to better understanding complex relationships amongst these different levels of CNS and ANS psychophysiological measurement.
Conclusion: Structural equation modelling helped to clarify relationships between multiple psychophysiological measures of ANS and CNS arousal in the current study. Structural equation modelling may be underutilised in the field of psychophysiology to date.