CIRCUMPLEX MODEL OF AFFECT OF VALENCE DOMAIN AMONG YOUNG ADULTS: AN ERP STUDY

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by

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LIST OF SYMBOLS

nA	Nanoampere
P	P-Value
%	Percentage
μv	Microvolt
1-β	Statistical Power
CI	Confidence Interval
df	Degree of Freedom
F	F-Statistic
Hz	Hertz
ms	Milisecond
N	Number

LIST OF ABBREVIATIONS

Ag/AgCl	Silver/Silver Chloride
BA	Broadmann Area
Cz	Central Midline
EEG	Electroencephalography
ERP	Event-related potential
Fz	Frontal Midline
HCGSN	HydroCel Geodesic Sensor Net
IAPS	International Affective Picture System
LPP	Late Positive Potential
MEG	Magnetoencephholography
Oz	Occipital Midline
Pz	Parietal Midline
SPSS	Statistical Package for the Social Sciences
USM	Universiti Sains Malaysia

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CIRCUMPLEX MODEL OF AFFECT OF VALENCE DOMAIN AMONG YOUNG ADULTS: AN ERP STUDY

ABSTRAK

Pengenalan: Fokus kajian ini adalah pada dimensi valensi dalam teori *Circumplex Model of Affect* yang merupakan sebuah model dimensi emosi. Dimensi valensi terdiri daripada emosi negative, neutral, dan positif. Emosi ini boleh dihasilkan menggunakan stimulus visual (gambar) daripada pangkalan data gambar *International Affective Picture System* (IAPS). Gambar IAPS merupakan stimulus visual standard yang digunakan dalam kajian ERP. Setiap gambar valensi negatif, neutral, dan positif mempunyai nilai purata tersendiri.

Objektif: Kajian ini bertujuan untuk membanding data ERP yang diperoleh daripada sampel belia di Malaysia dengan data IAPS. Data IAPS menyatakan gambar negatif lebih memberi kesan kepada emosi. Tindak balas otak terhadap ransangan emosi negatif dapat dilihat pada komponen ERP di mana amplitude yang dihasilkan adalah tinggi dan latensi (masa pendaman) yang pendek. Kajian ini juga ingin mengenal pasti bahagian otak yang terlibat apabila seseorang itu mengalami emosi yang berbeza menggunakan alat EEG yang akan merekod tindak balas otak ketika melihat gambar yang pada skrin komputer.

Metodologi: 35 peserta berusia antara 18-24 tahun melihat 15 gambar komponen valensi ketika menggunakan alat EEG dan tindak balak otak mereka direkod. Kaedah statistik Ujian Friedman telah digunakan untuk menganalis data yang diperoleh di elektrod tengah iaitu, Fz, Cz, Pz, dan Oz.

Keputusan: Statistik menunjukkan kesan utama (tindak balas otak terhadap ransangan emosi visual) pada komponen latensi P300 di elektrod Fz. Tetapi tindak balas itu tidak

sama seperti tindak balas pangkalan data gambar di mana kajian ini mendapati gambar neutral dan positif lebih memberi kesan pada emosi peserta berbanding IAPS (gambar negatif). Kedua-dua komponen ERP N200 dan P300 didapati terhasil di bahagian otak yang sama iaitu di lobus hadapan dan sisi (temporal) tetapi berbeza lokasi mengikut jenis emosi; negatif, positif dan neutral.

Penutup: Gambar neutral dan positif lebih memberi kesan terhadap emosi peserta. Ini menunjukkan bahawa perbezaan budaya dan latar belakang mempengaruhi emosi dan juga respon terhadap emosi tersebut.

CIRCUMPLEX MODEL OF AFFECT OF VALENCE DOMAIN AMONG YOUNG ADULTS: AN ERP STUDY

ABSTRACT

Introduction: This study is looking at the valence domain in the Circumplex Model of Affect. Valence domain in the model ranging from negative to positive emotion. Visual stimuli taken from the International Affective Picture System (IAPS) were used to evoke negative, neutral, and positive emotion (valence effect). IAPS is a standardised stimulus range that is regarded as the gold standard for affect ERP research and each pictures have its own normative value.

Objective: The aim of this research is to examine the correspondence of EEG-ERP valence data (P300, N200) with the normative valence from IAPS. This research also wants to identify the source of localization of P300 and N200 with regards to the different levels (high, moderate, low) of emotional valence processing

Methodology: 35 young adults aged 19-24 years old passively viewed 15 valence IAPS images and their brain's responses to the images were recorded using EEG Cap. Friedman Test was performed on the midline electrodes; Fz, Cz, Pz, and Oz for all components; N200 amplitude, N200 latency, P300 amplitude, and P300 latency.

Results: Statistic shows that valence effect (brain responses to the valence stimulus) is on ERP component P300 latency at Fz but the findings does not correspond with IAPS data. Different sources of localization were identified at Brodmann Areas 11, 17, and 38, with the frontal, temporal, and occipital lobes in different levels of emotional valence but similar in both ERP components; N200 and P300.

Conclusion: Findings does not correspond to IAPS findings because the valence effect in this study is found in neutral & positive images where IAPS' finding is on negative

images. Neutral and positive images evoke more valence effect in participant and it contradicts with IAPS. This shows that emotion and response to it is affected by factors such as culture and individual differences.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Emotions are essential for human life and have a significant influence on human behaviour. Our interactions are heavily affected by our feelings. Emotions are important in emotional processing. Gazzaniga and Mangun (2014) claimed that feelings influence everything from what we memorize to our attention and, ultimately, how we make decisions. In a nutshell, it influences our attitudes and actions.

1.2 Research Background

Over the decades, study on emotion has grown bigger and complex. According to Gazzaniga and Mangun (2014), scientists agreed that there are multiple neural circuits linked to emotion based on the situation, rather than a single neural circuit of emotion. This is due to the fact that empathy requires the convergence of other cognitive processes such as concentration, memory, and vision. Previously, structures such as the hypothalamus, amygdala, and insula were thought to be essential in emotion production. Latest research, however, has shown that the emotional brain system is actually interconnected to other brain regions, and the networks are more diffuse and complex (Pessoa and McMenamin, 2017).

Furthermore, it was demonstrated that emotion circuits change and unfold specific brain regions that are associated with the current behaviour at that time. Based on the stimuli, certain areas can be more involved in a network than others (Pessoa and McMenamin (2017).

Emotion processing research has mostly focused on neural connectivity between the brain's subcortical and cortical regions, Figure 1.1 (Pessoa and

McMenamin, 2017). The amplitudes (size) and latencies (timing) of ERP components can be used to investigate emotion processing (Olofsson *et al.,* 2008). Compared with other neuro- modalities, the event-related probability (ERP) approach has a significant benefit. The Circumplex Model of Affect offers novel theoretical and scientific approaches to researching the development of affective disorders, as well as genetic and cognitive factors that influence affective transmission in the central nervous system (Kring *et al*., 2003; Posner *et al*., 2005; Tseng *et al.*, 2014).

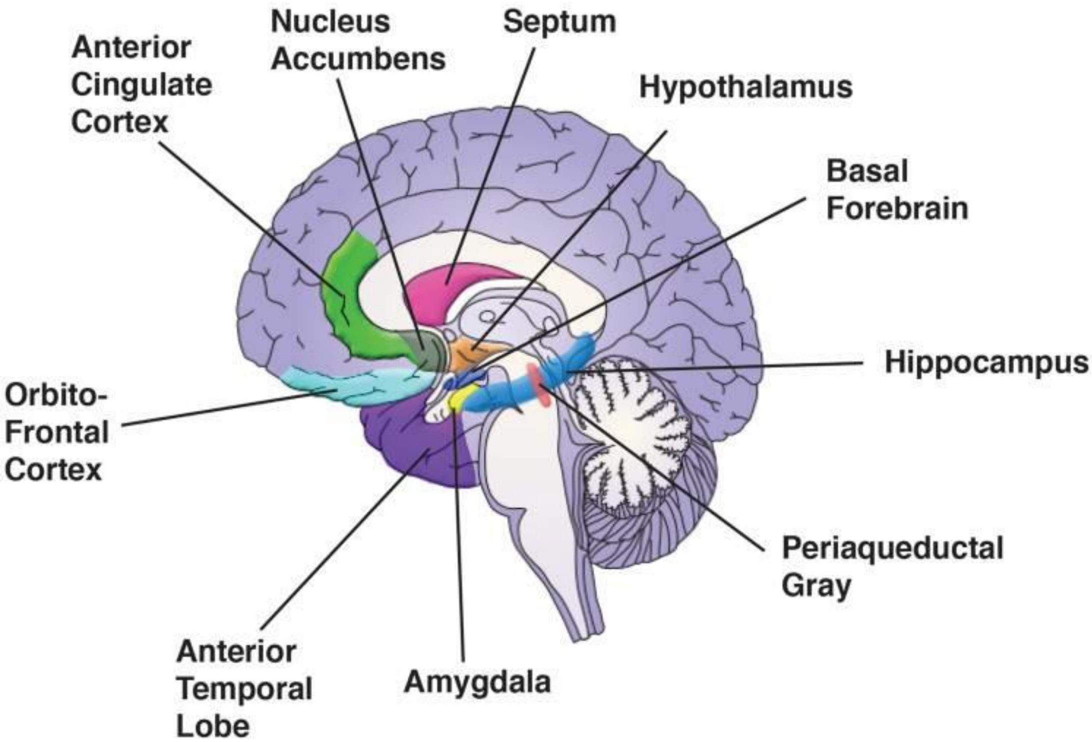

Figure 1.1 Brain structures that are often explored in emotion research (Pessoa and McMenamin, 2017).

The Circumplex Model of Affect is a model that shows how different emotions correspond to one another. The model is divided into four quadrants and a continuum. The model represents the visual interaction of different emotions (Gurtman, 2015; Posner *et al*., 2005; Tseng *et al*., 2014). James Russel developed the Circumplex Model of Affect, also known as the Circumplex Model of Emotion, in 1980. The horizontal axis (x-axis) of the model represents the valence spectrum, while the vertical axis (y-axis) represents the continuum of high and low arousal, also known as activation and deactivation. In contrast, the model's core reflects neutral valence and low arousal. This model is often applied to the analysis of emotional cues such as sentences, emotional facial expressions, and affective states (Hepach *et al.*, 2011; Tseng *et al.*, 2014). However, this study will only look at the model's Valence dimension.

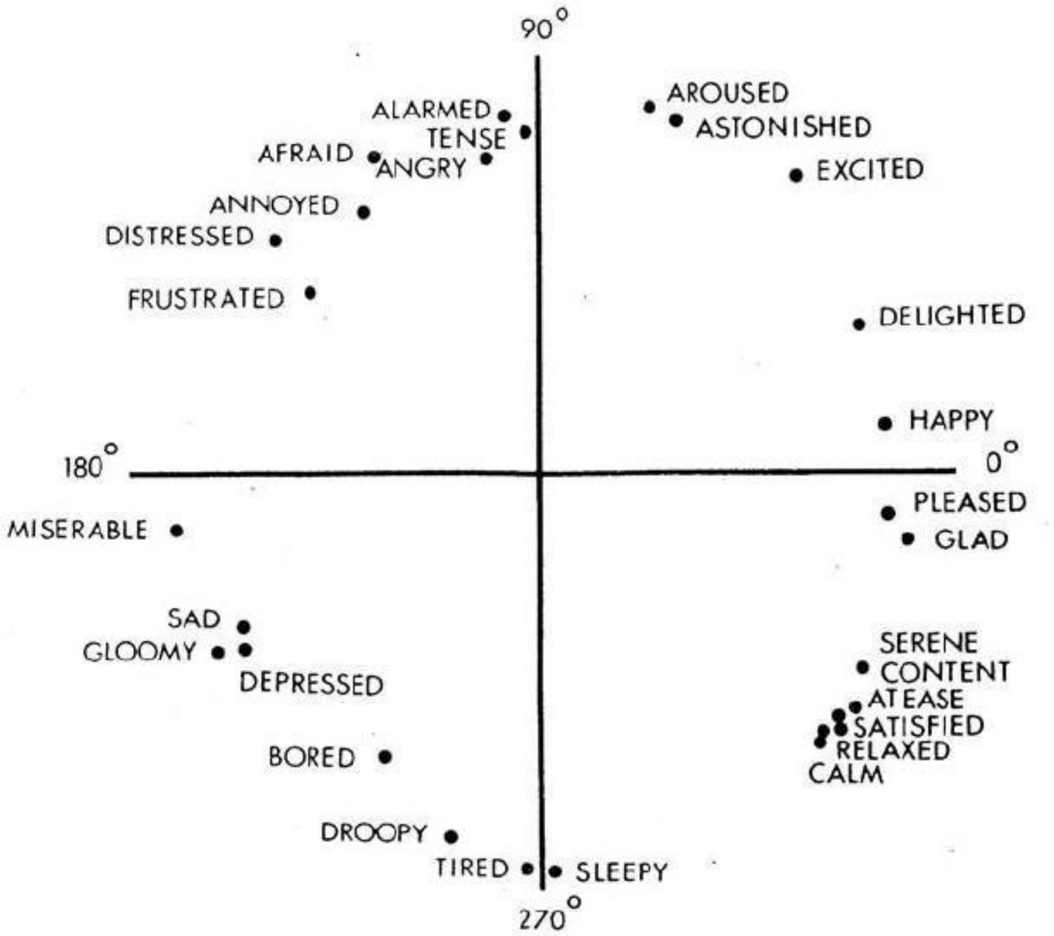

Figure 1.2 28 affect concepts in circular order (Posner et al., 2005)

According to Posner *et al.*, (2005), emotion processing in Circumplex Model of Affect consists of semantic representations of key neuronal impulses that are activated by two autonomous neurophysiological processes. This model differs from theories of basic emotions, which propose that each emotion is served by a single and autonomous neural system.

Posner *et al.*, (2005) also mentioned that several EEG studies have shown that greater activity of the right frontal lobe is linked to the presence of negative valence emotions. Meanwhile, higher left frontal activation is associated with more positive (valence) emotions. According to the model, negative emotions result from a highly inter-correlated relationship within the valence system of the central nervous system. They are all located in the model's left half, reflecting low valence interactions. Variable arousal thresholds and mental appraisals dependent on previous experiences and the present environment further distinguish these unpleasant valence stimuli. (Posner *et al.*, 2005).

The Circumplex Model of Affect is useful in explaining the patterns of various typical psychological comorbidities such as attention-deficit/hyperactivity disorder (ADHD), bipolar disorder, and nervousness problems (Posner *et al.*, 2005). This point is backed by Hepach *et al*., (2011) who stressed that emotion sensitivity is needed in order to properly participate in social interaction and that certain psychological disorders stipulations share severe impairments in recognising emotion.

1.3 Problem Statement & Study Rationale (Justification)

Emotions play a vital role in the life of human beings as they produce different properties indicative of human behavior. Emotions affect humans physiologically, psychologically and cognition like decision making, perception, memory. Besides that, it also affects human interactions and intelligence. Emotion recognition is essential for effective social interaction, and a number of psychological disorders, including schizophrenia, bipolar disorder, borderline personality disorder, and depression, share significant impairments of emotion recognition, regulation, and cognitive function.

The amplitudes (size) and latencies (timing) of ERP components can be used to investigate emotion processing (Luck, 2014; Olofsson *et al.*, 2008). While various technologies exist for studying affective reactions, the event-related potential (ERP) approach remained a significant advantage over other modalities. The study of event-related potentials is a critical neuroscientific technique for determining how the human brain processes emotion (ERPs).

Emotion and cognition are intrinsically related, and evidence showed that brain regions (e.g., dlPFC, MCC) and prefrontal functions (e.g., working memory, cognitive control) associated with cognition play a critical role in emotion (Okon-Singer *et al.*, 2015). The study identified that emotional and cognitive regions communicate in similar ways that contribute to adaptive behaviour through a complex system of repetitive, often indirect anatomical networks (Okon-Singer *et al.*, 2015).

Posner *et al.*, (2005) stressed that the Circumplex Model of Affect is compatible with numerous previous developments in physiological, social neuroscience, neuroimaging, and developmental affect research. Despite being an old theory, the paradigm also provides novel and scientific approaches for studying the emergence of affective disorders, as well as genetic and cognitive mechanisms of affective processing within the central nervous system. There are mounting evidences that the Circumplex Model of Affect is a solid practical tool for explaining the affective properties of a wide range of stimuli (Evmenenko and Teixeira, 2020; Greco *et al*., 2016; Jaeger *et a*l., 2020; Marín-Morales *et al.*, 2018; Posner *et al*., 2005; Stanisławski *et al*., 2021; Tseng *et al*., 2014).

Kring *et al*., (2003) and Evmenenko and Teixeira, (2020) proofed that the Circumplex Model of Affect is nomothetic and applicable in various research design because of the universality of the emotion (Mohan et al., 2021). Not only the valence-and-arousal indicators can be used to describe key semantic features of affect in patient populations and citizens with similar social and demographic characteristics, but they can also be used to represent core semantic features of affect in patient populations and citizens with similar social and demographic characteristics.

The circumplex paradigm is a helpful framework for describing affective phenomena through diverse cultures, as shown by the data gathered from the models, which indicate preferred approaches in research. Research discovered that how emotion is seen, experienced, grasped, interpreted, and responded to is influenced by cultural values, norms, and beliefs (Cho *et al*., 2018; De Almeida and Uchida, 2018; Hareli *et al.*, 2015; Liberzon et al., 2018; Mohan *et al.*, 2021; Stanisławski *et al.*, 2021). Hence it is also important to look at the population's norms or participant's background as it will influence an emotion and response to it.

1.4 Research Questions

1. Is there a correspondence between IAPS valence and EEG-ERP valence data (P300, N200) in young adult samples?
2. Which part of the brain involved in different level of emotional valence processing?

1.5 Objectives

1.5.1 General

To examine the correspondence of ERP valence data (P300, N200) with valence from the International Affective Picture System (IAPS)

1.5.2 Specific

1. To examine the effect of visual stimulus with different level of emotional

valence on the pattern of ERP amplitude - P300 and N200 components

2. To examine the effect of visual stimulus with different level of emotional valence on the pattern of ERP latency - P300 and N200 components
3. To propose the source of localization of P300 and N200 with regards to the different levels (high, moderate, low) of emotional valence processing

1.6 Hypothesis

1. Different level of valence IAPS correspond to different level of amplitude and latency of P300 and N200 ERP component – i.e. Low IAPS valence corresponds to high amplitude and short latency of EEG-ERP component
2. There would be a difference in the source of localization in different levels of emotional processing of valence