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ORIGINAL ARTICLE

Moral Internalisation Influences the Attentional Bias to Smoking and Non-Smoking Stimuli in Malaysian Youth

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ABSTRAK

Kelompok belia muda merupakan satu fasa pertumbuhan emosi dan kognitif yang kompleks serta dicabar dengan isu-isu moral dan tingkahlaku berisiko. Kajian ini bertujuan untuk mengemukakan bukti elektrofisiologi pada bahagian otak yang spesifik untuk menjelaskan tentang interaksi di antara bias perhatian terhadap imej tingkahlaku berisiko (merokok) dan tingkah laku bukan berisiko, yang boleh dipengaruhi oleh faktor kepelbagaian identiti moral. Seramai 78 subjek (Min umur 22 ± 2.1 tahun) terlibat dengan sesi Event Related Potential (ERP) yang dijalankan di Makmal Neurosains. Bias perhatian terhadap rangsangan visual ditentukan melalui gelombang otak N200 yang diukur semasa subjek memberi maklumbalas terhadap rangsangan imej target (iaitu tingkahlaku berisiko merokok dan tingkahlaku bukan berisiko) dan bukan target (neutral). Komponen N200 diekstrak dan dianalisis dengan analisa varians bercampur (imej target dan bukan target sebagai kesan dalaman subjek; manakala identiti moral sebagai kesan antara subjek). Bias perhatian terhadap rangsangan visual berinteraksi secara signifikan dengan kepelbagaian identiti moral terutama pada bahagian tengah otak. Ciri internalisasi yang tinggi dan simbolisasi yang rendah serta internalisasi dan simbolisasi yang tinggi, menunjukkan kependaman N200 yang pendek apabila memberi bertindak

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balas terhadap imej tingkahlaku berisiko (merokok) berbanding imej tingkahlaku bukan berisiko. Ciri internalisasi mempengaruhi bias perhatian terhadap tingkahlaku berisiko (merokok) yang ditunjukkan oleh pengaktifan neural N200 pada bahagian tengah otak. Kepentingan hubungkait aspek moral psikologi dengan tingkahlaku berisiko di kalangan belia muda perlu difokuskan dengan lebih terperinci dalam membangunkan program promosi kesihatan dan pendidikan pada masa hadapan.

Keywords: Bias perhatian; identiti moral; rangsangan potensi N200; tingkahlaku merokok

ABSTRACT

The youth age group is a phase of life associated with risk-taking behaviour and challenging moral issues. This study aimed to provide electrophysiological evidence that could explain the interaction between attentional bias towards the health-risk of smoking and non-health risk behaviour stimuli as influenced by various levels of moral identity. Seventy eight eligible subjects (mean age of 22 $\pm$ 2.1 years old) participated in the event-related potential session. Attentional bias towards the visual stimuli was determined by recording the N200 brain potential while participants emotionally reacted to the target (health-risk of smoking, non-health risk behaviour) and non-target (neutral) stimuli. N200 was extracted and analysed by using a mixed-design analysis of variance with target and non-target stimuli as within subject effects and types of moral identity as between subject effects. Attentional bias towards visual stimuli interacted significantly with the different levels of moral identity in the central part of the brain. High internalisation trait indicated shorter N200 latency when reacted to the health-risk of smoking stimuli than the non-health risk behaviour stimuli. An important insight regarding to moral psychology in relation to youth health risk behaviour was highlighted to focus for the development of the health promotion and education in future.

Keywords: Attentional bias; moral identity; N200 Evoke potentials; smoking behaviour

INTRODUCTION

Adolescents and youth are a transition period from childhood to maturity, characterised by profound biological and psychological adaptations in response to changes in hormone, mental process, and social life (Conger 1984). This stage of life is regarded as being particularly challenging because of the high prevalence of health risk behaviours such as smoking (Sanci et al. 2018). They possess a predilection for trying new things and taking risks, which exposes their health at serious risk. Other than smoking, health risk

behaviours such as cannabis and binge drinking were found to have higher impulsivity and sensation-seeking tendencies, as well as enhanced patterns of impulsivity during decision-making (Moreno et al. 2012).

Ministry of Health Malaysia lists smoking behaviour as one of the major delinquent behaviours alongside other health risk behaviours such as drug addiction, alcoholism, violence and unintentional injury, sexual risk behaviour and dietary behaviour (Institute of Public Health, Ministry of Health Malaysia 2021). Likewise, the adolescent Risk Behaviour Surveillance System's official report identified and recognised six areas of health risk behaviours among adolescent age groups that require attention, one of which being tobacco addiction (Kann et al. 2018). It has long been renowned that smoking poses a health risk with substantial social and economic consequences. Tobacco usage typically begins throughout adolescence, with approximately 46% of smokers starting between the ages of 18 and 20 (Nazary et al. 2010).

Youth morality and its relation to health risk behaviours such as smoking, is not an issue that has received little research for example by Schwartz et al. (2010). The psycho-moral perspective agrees that a developed sense of moral identity may lead to better mental health and less health risk behaviours (Hardy et al. 2013). In this context, influential moral theories, such as those proposed by Aquino and Reed (2002), proposed two fundamental moral qualities that humans possess which are internalisation and symbolisation. 'Internalisation' is linked to a core identity-defining internal value. In contrast, 'symbolisation' is an opposite trait linked to external value in the construction of identities. Individuals may have both traits at various levels (e.g., high internalisation, low symbolisation) or both at the same level. This theory was established decades ago on the notion that moral identity develops based on how important or central morality is to an individual's sense of self. To date, the social intuitionist model and the dual-processing theory, which place a focus on moral emotions that affect moral judgement, clearly conceptualise human moral component (Dellantonio & Job 2012; Haidt 2001; Jiang et al. 2020).

There has been a range of evidence from electrophysiological studies regarding how emotional cues are processed in the brain. Prior assessments to the neuroscience of morality mostly focused on the event-related potentials (ERPs) generated from an electroencephalogram (EEG) (Zhang et al. 2015), which showed how quickly the brain reacted to different stimuli, to identify which brain networks are responsible for hypothetical decision-making and abstract moral judgement. Likewise, neural mechanism becomes a critical evidence in understanding risk taking behaviour such as smoking behaviour (Rass et al. 2014). Neuroscientific data surrounding addictive behaviour points out the crucial role of inhibitory control among addicts. In Luijten et al. (2011), it has been argued that addicts with poor response inhibition

may have more difficulty to refrain from taking narcotics in the presence of drug cues. They discovered that smokers had lower N2 amplitudes than controls, implying that smokers have difficulty in inhibiting responses. Likewise, according to Li et al. (2021), impaired inhibitory control is more pronounced during substance-related cue exposure in addicts. This is because smokers' inhibitory control is negatively impacted by smoking-related background, although the revulsion that cigarettes specifically evoke in people is reduced by smoking warning visuals.

Neurocognitive assessment likes ERPs offer fundamental viewpoints on smoking behaviour associated with cognitive function. Luijten et al. (2016) found the relationship between smoking relapse and resumption through the explanation by underlying ERP component linked to inhibitory control (N2, P3). Potts et al. (2014) investigated the brain mechanisms underlying reward and punishment sensitivity in cigarette smokers, hypothesising that smokers are more susceptible to reward signals and less responsive to punishment, potentially predisposing individuals to risky behaviour. They discovered that non-smokers, but not smokers, had a larger error related negativity (ERN) on punishment-motivated trials, indicating that non-smokers are less punishment-sensitive than smokers and that smokers have a greater medial frontal negativity (MFN) response to unexpected rewards.

Several important researches have shown the relationship between morality and neuroscientific facts. In Pletti et al. (2022) that examined the impact of moral identity on the brain representation of moral content, a group of 10-year-old children were shown with images depicting both prosocial and antisocial behaviour, and electroencephalographic responses were recorded throughout. ERP analysis revealed that antisocial scenes elicited earlier posterior negativity (EPN) in participants with a strong moral identity than prosocial scenes. Thus, it was suggested that, at early processing stages, antisocial scenes grabbed more attentional resources than prosocial scenes for participants with a strong moral identity. Cowell and Decety (2015) investigated the neurological basis of moral sensitivity by recording continuous EEG and time-locked ERPs while participants observed characters engaging in prosocial and antisocial behaviours. When perceiving prosocial or antisocial actors, participants showed neuronal distinction in both spectrum EEG power density modulations and time-locked ERPs. In another study, Kunkel et al. (2018) who sought to understand the Task-dependent evaluative processing of moral and emotional content during comprehension, found that immoral compared to moral scenarios elicited a larger anterior negativity (500–700 milliseconds) and negative emotional scenarios elicited a larger posterior ERP positivity (LPP) about 200 milliseconds after the critical word onset.

The legacy of N200 as an early sensory stage of an ERP component related to perception and attention cannot be denied. It typically reaches

the peak 200-300 milliseconds after the stimulus begins. The ERP modulations induced by emotional content are frequently characterised by increased activation of primary sites, as measured by significant components such as N200 (Schindler & Straube 2020). For instance, research on moral disgust stimuli generated larger N200 and LPP amplitudes (Yang et al. 2014; Zhang et al. 2015). Meanwhile, P200 and other related components like P300 consistently shown more positive deflection in a negative condition compared to a neutral state in numerous experiments (Cao et al. 2020; Pegg et al. 2019; Tenssay & Wang 2019). In an experimental ERP study that compared emotional and neutral words in a version of the flanker task, Kanske and Kotz (2010) pointed out that emotion facilitated conflict processing, as evidenced by a conflict-related negativity at 200 milliseconds following stimulus start, indicating an early influence of emotion on conflict processing. N200 has also been indexed to assess cognitive decline in clinical populations such as Parkinson's disease (Xu et al. 2022). Xu et al. (2022) suggested that longer latency, especially at the Fz and Cz brain areas, can be an important biomarker of early cognitive decline. Other than that, several studies have found that a higher level of N200 is related to the perceptual novelty of aesthetic stimuli (Ding et al. 2017; Ma et al. 2015).

The field of neuroscience provides biological and physiological lens in order to comprehend the health risk behaviours. Watson et al. (2014) obtained the ERP data to explain the neurocognitive correlated of different patterns of risky alcohol use in college-aged adults. Although the N200 is not highlighted, the finding of greater P3a/b amplitudes in the odd-ball task linked to health risk behaviours is call for further investigation. Another study indicated the N200 component to play a role in determining whether reward and punishment sensitivity influenced young female drivers' attention to a series of positive and negative speeding advertising graphics.This study reported that the N200 mean amplitudes at the Cz electrode site on presentation of the negative images were substantially higher in subjects with a stronger sense of reward reactivity and impulsivity than in subjects with a weaker sense of reward reactivity and impulsivity (Kaye et al. 2018).

The relationship between moral identity and smoking tendencies is an area of ongoing research in psychology and behavioural studies. Moral identity refers to the extent to which an individual sees themselves as a moral person and how much their moral values and principles are central to their sense of self. Understanding the human value on health that might be ascertained from the moral identity element is one of the main research concerns in the smoking field. Individuals with a strong moral identity, who deeply value health and well-being, may be less likely to engage in behaviours that are widely perceived as harmful or unhealthy, such as smoking. This inclination might stem from their internalised moral values guiding them away from actions that contradict their moral principles.

However, this claim must be supported by scientific evidence. In addition, the neuroscience evidence will provide more insight to understand the dimension of emotion and cognition.

Based on the background above, we predicted that the attentional bias (or emotional cognition tendency) towards health-risk of smoking and non-health risk behaviour is influenced by moral identity (interplay of internalisation and symbolisation) that is processed in a specific brain region. In this scope, it is hypothesised that internalisation is more dominant than the symbolisation domain in youth's moral identity.

MATERIALS AND METHODS

Research Design and Participants

This was a laboratory observation study that was conducted in the Neuroscience Laboratory using the ERP technique. ERPs are small alterations in the EEG recorded on the scalp that are timed to the commencement of an event such as a sensory stimulus or a motor act. Electroencephalography offers a medium to comprehend neurobiological dysregulation, with the potential to explore neurotransmission. The youth age group (mean 22 ± 2.1 years old) was of particular interest. The participants, who were of varied racial (74% Malays, 19% Chinese, Indian 5%) and religious (73% were Muslims) backgrounds, live in Kota Bharu, Kelantan areas. Participants (38%) with visual impairments who wore glasses to improve their eyesight while responding to the visuals. The level of education among the participants varies – 82% were completing their first degree at health campus, USM and 12% were postgraduate. Small proportion had Malaysian high school certification and diploma. A total of 90% (N=68) from 78 participants were non-smokers and had never smoked in the past. The remaining were those who are currently smoking (6%) and non-smokers with a smoking history (4%).

Participants were chosen based on inclusion and exclusion criteria. Right-handed individuals without a history of neuropsychiatric or chronic medical conditions were chosen, as were those with normal or corrected-to-normal eyesight. All participants claimed they had never been involved in any serious health risk behaviours such as drug abuse, alcohol addiction, or unprotected sexual relationships.

Research Procedure

Social media was used to disseminate information about the study to potential participants. A convenient sampling method was implemented for the recruitment of participants. Interested participants who met the inclusion criteria were invited to participate in the study that was held in the Neuroscience Laboratory, Hospital Universiti Sains Malaysia. They were then provided with detailed information about the study's procedures before consent was taken from each participant. The protocol of the study had gone through critical evaluation by the human ethical board (protocol approval number: USM/JEPeM/20060297).

Moral Identity Screening

Prior to the commencement of the electroencephalography recordings in the laboratory, participants moral patterns (i.e. high internalisation low symbolisation, low internalisation high symbolisation, high internalisation high symbolisation) were screened by using the Malay Version Moral Identity Scale (psychometric properties of the scale have been published (Yusoff et al. 2022)), along with collecting the sociodemographic information.

The Moral Identity Scale (MIS) is an effective scale that is able to determine the level of internalisation and symbolisation traits that individuals hold. Aquino and Reed (2002) define internalisation as an intrinsic value that is central to the participant's self-concept. Meanwhile, symbolisation is an external value through displaying a social identity based on moral traits. The intrinsic value of the participants was determined through three items, for example "It would make me feel good to be a person who has these characteristics". Meanwhile, the other five items of the scale measured the external value of the participants, for example "I often wear clothes that identify me as having these characteristics". The MIS Malay version retained all the original items except two items from the symbolisation domain that indicated factor loading less than 0.5 (Hair et al. 2013) i.e. item number 4 – "I would be ashamed to be a person who had these characteristics" 0.15; and item number 7 "Having these characteristics is not really important to me" 0.23. Instruction for the scale required participants to visualise a series of positive words in their minds that might describe a person (i.e., caring, compassionate, fair, friendly, generous, helpful, hardworking, honest, and kind) by using a 7-point Likert scale ranging from completely disagree (scored as 1) to completely agree (scored as 7). Details of the psychometric properties of the MIS Malay version can be found in Yusoff et al. (2022).

In this study, the median split (DeCostera et al. 2011) was used to categorise moral identity scores. The median cut-off was 16 (scores ranged from 11 to 21) for internalisation. A score of 16 or higher indicated high internalisation. Meanwhile, a score of less than 16 indicated low internalisation. For symbolisation, the median cut-off score was 24 (scores ranged from 15 to 30). A score of 24 or higher was considered high symbolisation. Low symbolisation, on the other hand, was defined as a score of under 24. The analysis satisfied all necessary assumptions.

Event-related Potential session - ERP Recording

In the ERP session, participants viewed a series of health-risk smoking and non-health risk behaviour images as well as neutral images (geometries) projected from a computer screen that connected with a NetAmps 300 amplifier with a high input impedance to record the EEG brainwave. During the experiment, participants were equipped with the 128 HydroCel Geodesic Sensor Net applied to their

heads to capture their emotional cognition response.

The experiment procedure was illustrated in Figure 1. The trial initiated with the existing fixation mark (+) in the centre of the monitor screen for about 500 ms. The dark screen then displayed for 800 ms before the visual image appeared for 2000ms. The presentation of images was based on the odd-ball paradigm principle in which the presentation of sequences of repetitive stimuli was occasionally interrupted by a deviant stimulus. In this experiment, the non-target pictures (geometry) were presented more than the non-target pictures (70% non-target and 30% target), which equaled to a ratio of 1:1:3. Altogether, the presentation of images involved 200 trials that were distributed at random with three repetitions for each category. The following trial, again, began with the fixation cross, and so on until a total of 200 trials were completed, which took about an hour entirely.

Validity of Visual Affective Stimulus

Two categories of images depicting health-risk of smoking and non-health risk behaviour (target images: presenting 30% of total images) and neutral images (non-target: presenting 70% of total images) were used as visual stimuli in the experiment, with the aim of determining the neural basis underlying the attentional bias towards health-risk smoking and non-health risk behaviour. All photographs (images) were free from copyright and were collected from the internet (Figure 2).

The validity of the images' content was evaluated by three psychologists. They evaluated a series of health-risk of smoking and non-health risk images using the options as follows: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant (given as X), 4 = highly relevant (given as X) (Davis 1992). The Individual Content Validity Index (I-CVI) demonstrated the content validity of each image by taking into account the scores of 3 and 4 as rated by each evaluator. Thus, the value of I-CVI was obtained by the calculation as follows: Amount of X (score of 3 or

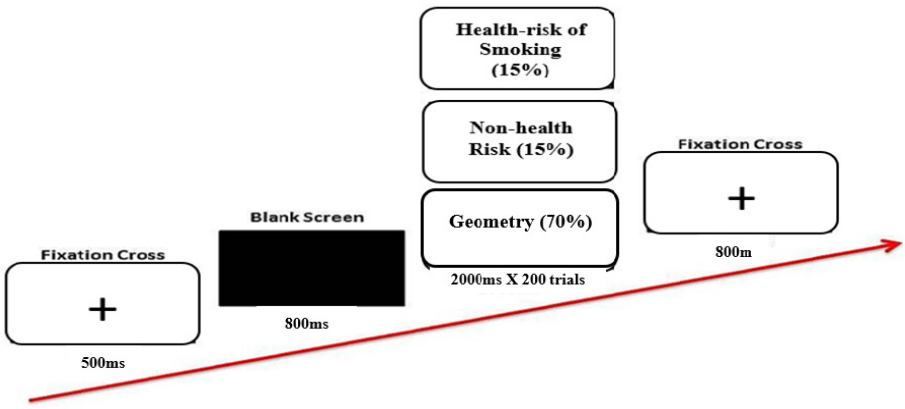

FIGURE 1: Experimental procedure

A: Health Risk Behaviour (Smoking) – 15% Presentation

B: Non-health Risk Behaviour – 15% Presentation

C: Geometry – 70% Presentation

FIGURE 2: Different categories of visual presentation in odd-ball paradigm

4)/Number of Evaluators.

In the final analysis, 20 pictures (10 smoking and 10 non-smoking) that indicated an I-CVI score of one were selected. An I-CVI score of one indicated an acceptable value in determining content validity. To minimise technical bias, images' brightness and size were standardised.

Data Extraction and Analysis

ERP data that was recorded with Ag/AgCl electrode- plated carbon pellet surrounded by a sponge and connected by a 1-meter-long insulated lead wire to a Hypertronics-compatible, gold-plated pin, as according to the international 10/20 system, the scalp sites in the following five brain regions: fronto-parietal (Fp1, Fp2), frontal (F3, F4, F7, F8, Fz), central (C3, C4, Cz), temporal (T3, T4, T5, T6), and occipital (O1, O2) were selected for data analysis.

Prior to statistical analysis, raw ERP data were extracted into the specific components by using several standardised steps. The 0.3-30Hz noise reducer was used to filter the raw EEG brain waves in order to eliminate noise from electrical systems or muscular action. Segmentation was accomplished by locking it to 200 milliseconds before stimulus onset and 1000 milliseconds after initiation, with a 45-millisecond offset. Following that, artefact detection was performed along with the elimination of ocular artefacts such blinking and eye movement. Channels that were bad (about 20% of the recordings across all segments) must be interpolated using the signal provided by surrounding good electrodes. The wave was then averaged independently to improve the signal-to-noise ratio. The captured wave was transformed into a 10-20 EEG montage and corrected for baseline. Data were then combined and averaged. Finally, the wave was converted to numerical data for SPSS analysis.

Because of its importance in information and visual cognitive processing, the ERP component of N200 was the focus of the current study. An analysis of variance for the repeated measure design was carried out to determine the variations in N200 amplitude and latency at selected brain regions as stimulated by visual affective

pictures (within subjects effect: (i) Smoking behaviour; (ii) Non-smoking behaviour; (iii) Neutral – geometrical images). In the case of spherical assumption violation, adjustment of degree of freedom (df) was performed. The Epsilon Huynh-Feldt result was reported as a new degree in this case. All analysis was done by using IBM Statistical Package for Social Sciences (SPSS) Statistics version 27.

RESULTS

N200 Latency

A significant interaction effect of attentional bias towards different types of visual stimulus (i.e., health risk of smoking behaviour; non-health risk behaviour; neutral images) across four categories of moral identities was observed in the central region of the brain – F (5.9,144.5) = 2.5; p=0.03. Based on the estimated marginal means (Figure 3), two moral domains associated with high internalisation (i.e., high internalisation low symbolisation (HiLs); high internalisation high symbolisation, (HiHs)) indicated shorter latency for the health-risk of smoking stimuli than the non-health risk behaviour stimuli. Meanwhile, moral domains associated with low internalisation, regardless of symbolisation level (i.e., low internalisation high symbolisation (LiHs), low internalisation low symbolisation (LiLs)) indicated no difference for both stimuli i.e., health risk of smoking and non-health risk behaviour. The EEG patterns of HiLs and HiHs that were captured around 200–300 ms were also illustrated in Figures 4 and 5, respectively.

The brain central area also indicated a significant main effect, with a longer latency in responding to non-health risk behaviour images (193.5 ± 19.0 ms) than health-risk of smoking behaviour images (189.2 ± 19.0 ms) and neutral images (188.3 ± 23 ms) - [F (2, 144.5) = 3.7; p=0.03]. No significant interaction effects and main effects were observed in other brain areas (Table 1).

N200 Amplitude

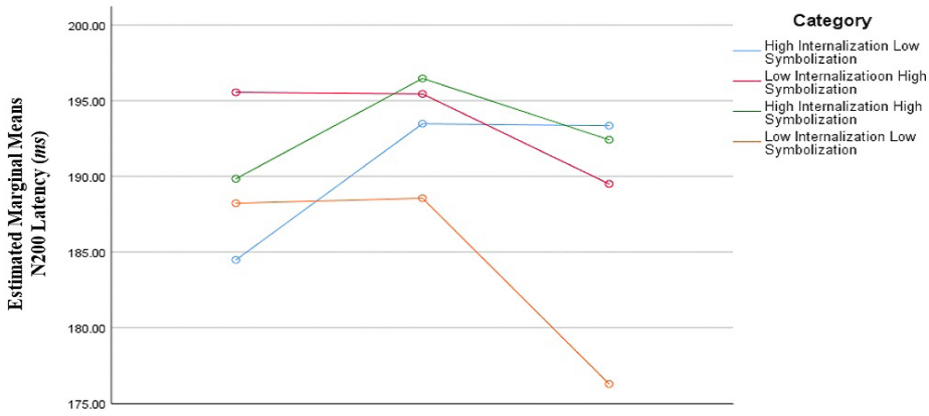

FIGURE 3: Influence of different moral domains on attentional bias towards visual stimuli

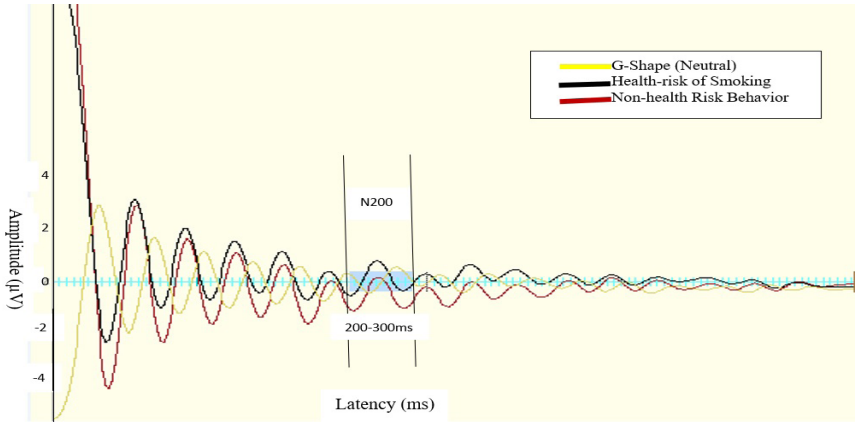

FIGURE 4: N200 Central brain wave in moral HiLs

For the N200 amplitude, there was no significant interaction effect of attentional bias towards different types of visual stimulus (i.e., health-risk of smoking behaviour; non-health risk behaviour; neutral images) across four categories of moral identities in all regions of the brain. However, significant main effects were observed in all brain areas – frontoparietal [F (1.9,139) = 19.7; *p*=0.00], frontal [F (2, 73) = 7.1; *p*=0.00], central [F (2, 73) = 15.6; *p*=0.00], temporal [F (1.6, 116.9 = 70.1; *p*=0.00], parietal [F (2.0, 146.9 = 3.9; *p*=0.02] and occipital [F (2, 73 = 66.0; p=0.00). Emotional attention to neutral stimuli was lowest as compared to health-risk of smoking behaviour images and non-health-risk behaviour images in most brain regions, especially the frontoparietal, frontal, temporal, and occipital. Some brain regions indicated higher amplitude for health-risk of smoking behaviour images than non-health risk behaviours. This can be seen in frontoparietal, central, and parietal areas (Table 2)

DISCUSSION

Our main finding was that there was an interaction between attentional bias towards different types of visual stimuli (i.e., visual health-risk of smoking

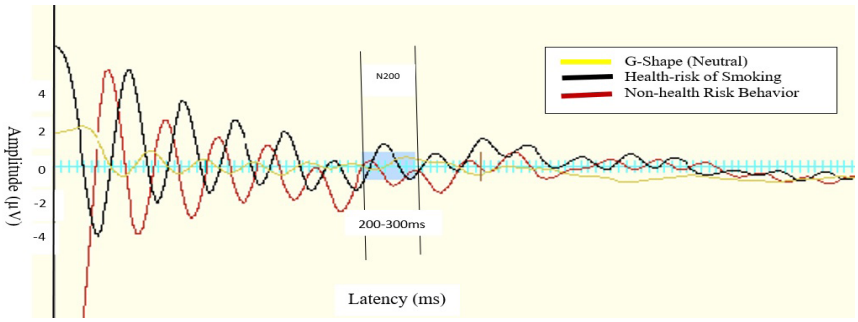

FIGURE 5: N200 Central brain wave in moral HiHs

TABLE 1: Attentional bias (N200 latency) in different trait of moral identity

Brain Region	N200 Latency: Mean (SE)[1]												F^a/F^b	df^a/df^b
	Health-risk of Smoking				Non-health Risk				Neutral					
	HiLs	LiHs	HiHs	LiLs	HiLs	LiHs	HiHs	LiLs	HiLs	LiHs	HiHs	LiLs		
Fronto-Parietal[a (ns)/b (ns)]	122.0	113.9	120.7	120.3	120.8	118.7	120.7	121.6	121.9	120.4	119.2	119.1	0.2^+/	1.7^+/
	(3.5)	(3.4)	(3.5)	(4.3)	(3.9)	(4.4)	(3.7)	(4.6)	(3.9)	(4.4)	(3.8)	(4.1)	0.5^+	5.2^+
Frontal[a (ns)/b (ns)]	309.3	311.0	309.1	306.7	304.1	310.5	312.7	308.4	304.5	315.0	312.6	300.1	0.05^+/	1.5^+/
	(6.2)	(7.5)	(6.6)	(8.8)	(7.1)	(7.2)	(7.7)	(8.7)	(7.0)	(7.7)	(7.6)	(9.0)	0.5^+	4.5^+
Central[a*,b*]	184.5	195.6	189.8	188.2	193.5	195.4	196.5	188.6	193.3	189.5	192.4	176.3	3.7^+/	2.0^+/
	(4.1)	(4.2)	(5.1)	(4.3)	(4.1)	(3.9)	(4.9)	(4.2)	(4.0)	(5.5)	(5.6)	(5.3)	2.5^+	5.9^+
Temporal[a (ns)/b (ns)]	239.6	243.5	235.8	244.3	242.8	247.2	234.6	235.6	243.5	240.8	234.8	232.6	0.8^+/	1.6^+/
	(4.3)	(4.2)	(6.0)	(5.2)	(3.9)	(4.7)	(4.3)	(4.2)	(3.8)	(4.3)	(4.5)	(4.4)	1.3^+	4.8^+
Parietal[a (ns)/b (ns)]	180.7	186.1	184.7	182.6	180.7	188.4	185.3	181.4	182.0	185.3	183.3	173.2	0.9^+/	1.8^+/
	(4.4)	(4.4)	(4.8)	(4.4)	(4.3)	(4.0)	(4.5)	(4.6)	(4.3)	(4.7)	(4.9)	(4.8)	0.5^+	5.4^+
Occipital[a (ns)/b (ns)]	125.6	123.4	121.0	118.8	117.0	123.3	119.0	119.4	121.6	123.7	119.5	120.8	1.5^{++}/	2^{++}/
	(3.4)	(4.3)	(4.3)	(3.9)	(2.9)	(3.4)	(3.7)	(3.6)	(3.0)	(3.7)	(3.8)	(3.6)	1.0^{++}	6^{++}

HiLs: High internalisation, Low symbolisation; LiHs: Low internalisation, High symbolisation; HiHs: High internalisation, High symbolisation; LiLs=Low internalisation, Low symbolisation

a = main effect; b = interaction effect

[1]Miliseconds

[+]Huynh Felt result (Sphericity Mauchly, $p<0.05$); [++]Multivariate Pillai's Trace (Sphericity Mauchly, $p>0.05$)

*$p<0.05$

TABLE 2: Attentional bias (N200 Amplitude) in different trait of moral identity

Brain Region	N200 Amplitude: Mean (SE)[1]												F^a/F^b	df^a/df^b
	Health-risk of Smoking				Non-health Risk				Neutral					
	HiLs	LiHs	HiHs	LiLs	HiLs	LiHs	HiHs	LiLs	HiLs	LiHs	HiHs	LiLs		
Fronto-Parietal[a**/b (ns)]	10.1	9.2	9.3	8.5	9.0	12.2	12.7	8.5	5.9	5.5	6.5	5.2	19.7^+/ 1.2^+	1.9^+/ 5.6^+
	(1.3)	(1.3)	(1.5)	(1.2)	(1.2)	(2.7)	(1.9)	(1.3)	(0.7)	(0.8)	(0.9)	(0.8)		
Frontal[a**/b (ns)]	16.3	12.5	15.0	14.7	13.0	11.4	13.5	12.9	12.1	9.9	10.4	9.9	7.1^{++}/ 0.3^{++}	2^{++}/ 6^{++}
	(1.5)	(1.7)	(2.6)	(2.5)	(1.3)	(1.3)	(1.5)	(1.3)	(1.5)	(1.2)	(1.3)	(1.7)		
Central[a**/b (ns)]	6.6	6.6	6.7	7.6	4.4	5.1	5.0	5.2	7.3	7.0	7.0	6.6	15.6^{++}/ 0.4^{++}	2^{++}/ 6^{++}
	(0.7)	(0.7)	(1.0)	(1.1)	(0.4)	(0.4)	(0.4)	(0.4)	(0.8)	(0.6)	(0.9)	(0.8)		
Temporal[a**/b (ns)]	11.8	11.7	11.0	11.4	12.1	10.8	12.5	10.5	5.4	5.9	6.3	5.5	70^+/ 0.7^+	1.6^+/ 4.7^+
	(1.2)	(1.0)	(1.3)	(1.6)	(0.7)	(0.9)	(0.8)	(0.7)	(0.4)	(0.4)	(0.3)	(0.4)		
Parietal[a*/b (ns)]	12.2	10.0	8.7	9.3	9.6	7.7	8.5	7.7	9.0	8.9	8.8	8.6	3.6^{++}/ 0.7^{++}	2^{++}/ 6^{++}
	(1.1)	(1.5)	(1.2)	(1.4)	(0.6)	(0.8)	(1.0)	(1.0)	(0.9)	(1.1)	(1.2)	(1.1)		
Occipital[a**/b (ns)]	12.1	10.5	11.1	9.8	15.1	9.8	11.2	11.4	4.7	4.7	4.7	4.7	65.9^{++}/ 1.7^{++}	2^{++}/ 6^{++}
	(1.3)	(1.3)	(1.6)	(1.4)	(1.1)	(1.2)	(1.4)	(1.5)	(0.4)	(0.5)	(0.6)	(0.6)		

HiLs: High internalisation Low symbolisation; LiHs: Low internalisation High symbolisation; HiHs: High internalisation High symbolisation; LiLs: Low internalisation Low symbolisation

a = main effect; b = interaction effect; [1]Microvolt-μV; [+]Huynh Felt result (Sphericity Mauchly, $p<0.05$); [++]Multivariate Pillai's Trace (Sphericity Mauchly, $p>0.05$)
$p<0.05$*; $p<0.01$**

behaviour, non-health risk behaviour, neutral) across different domains of moral identity, with the central part of the brain region predominating. The central brain revealed an important neural activity associated with differentiating visual images of health-risk smoking behaviour and non-health risk behaviour in different moral identity. Specifically, there are two moral domains associated with high internalisation (i.e. HiLs, HiHs) that indicated the attentional bias towards the target stimuli. These two moral domains indicated shorter latency for the health-risk of smoking stimuli than the non-health risk behaviour stimuli. Meanwhile, the attentional bias towards target stimuli was not observed among those with low internalisation (regardless of symbolisation level i.e. LiHs, LiLs).

The significant main effect of N200 amplitude as a neurophysiological marker in discriminating health-risk of smoking and non-health risk behaviour stimuli should also be given high attention. Even though the N200 amplitude did not index the influence of moral trait in the emotional cognition processing of the visual stimulus (health-risk of smoking and non-health risk behaviour images), this N200 amplitude indicated the significant main effect (i.e. the effect of the visual stimulus regardless of moral trait) was consistent in all brain regions, including the central area. The central brain appears to be an important hub for emotional cognitive processing of visual inputs, which is also indexed by N200 latency. It was discovered that, some brain regions showed greater amplitude for health-risk of smoking images than for non-health-risk behaviour, particularly in the frontoparietal, central, and parietal areas.

Again, attention should be given to the main effect in the central area as indexed by both N200 amplitude and latency. Greater amplitude was observed in response to health-risk of smoking images than non-health risk behaviour images and neutral stimuli. Meanwhile, for N200 latency, shorter latency was observed for the health-risk of smoking images than for non-health risk behaviour and neutral stimuli. Those with the trait of HiLs had significantly shorter N200 latency in the central brain area in response to health-risk of smoking images (than non-health risk behaviour images), which draw our attention. The importance of the N2 component of the ERP to index a cognitive control process has been strongly highlighted in many studies, such as Buzzell et al. (2014). Buzzell et al. (2014) found that the N2 brainwave of smokers was significantly smaller than that of non-smoker controls.

Thus, from this discovery, at least two important facts could be suggested. First, the central brain region indicated the most affected area associated with attentional bias towards health-risk of smoking and non-health risk behaviour. Second, high internalisation (regardless of symbolisation level) is a dominant moral trait that influences the attentional bias in discriminating the health-risk of smoking from non-health risk behaviour.

The role of N200 in visual and

emotional processing, indeed, has been debated for over a decade (Hong et al. 2009). In Balconi & Vanutelli (2016), the ERP N200 indexed the emotional difference in a variety of conditions (i.e., participants who only viewed visual stimulation and subjects who viewed and heard both visual and auditory stimulation) depending on whether the stimulation was associated with a positive or negative emotional content.

The importance of N200 to index emotional cognition processing in relation to cognition categorisation has been proven previously. However, from the literature, the inconsistencies in the amplitude and latency parameters of N200 are possible depending on the issues being studied and the visual stimulation involved. For example, the significance of N200 latency has been highlighted in smoking behaviour research that investigates abstinence-induced ERP changes in young smokers (Liu et al. 2019). Liu et al. revealed electrophysiological evidence for the association of N200 latency with inefficient inhibitory control of the abstinence condition.

The importance of the latency parameter as electrophysiological evidence to index inhibition control impairments has also been underlined by Yin et al. (2016) in their study among adolescent smokers. Other than that, Domino (2003) also discusses the significance of latency as an electrophysiological evidence to explain smoking behaviour. Domino (2003) postulated a down-and-up latency pattern linked with abstinence and post-abstinence, in which medium and long-latency potentials decreased during abstinence and increased shortly after smoking tobacco.

Our finding might be inconsistent with some other studies that revealed the electrophysiological evidence of N200 amplitude as an neural index. As mentioned, the context of study or visual stimulation involved may have a great impact on emotional cognition processing and attentional bias. For example, Pletti et al. (2022) discovered that a higher explicit moral self was connected to a lower N2 amplitude for prosocial scenarios in their study to determine if the moral self-concept is related to how people understand prosocial and antisocial activities. Given the association between antisocial behaviour and smoking behaviour (Weiss et al. 2019), the lower N2 amplitude for prosocial scenarios may provide some indication to explain the antisocial behaviour (including smoking behaviour). Zhang et al. (2015) also noted the importance of the N200 for indexing emotional cognition processing in moral context and discovered that moral disgust processing was related with larger N2 amplitudes than core disgust processing.

The significance of the N200 component as an electrophysiological marker to index the neural processing can also be observed in other studies surrounding health risk behaviour. A study examined the effects of taking cannabis on brain potentials in subjects at high risk for psychosis and those at low risk for psychosis found a prolonged N200 latencies among those at low risk for psychosis who used cannabis.

It was not observed among those who did not take cannabis, regardless of whether they were at high or low risk for psychosis. This may imply a decline in information processing speed associated with cannabis usage (van Tricht et al. 2013). In the meantime, the N200 has also been debated to link with the successful suppression of the behaviour response in the impulse control process associated with risky behaviour (Dong et al. 2009).

Cognitive processing linked with differentiating and categorising visual stimuli has long been a focus paradigm in ERP techniques. We discovered the main effect in some brain regions, such as the frontoparietal, central, and parietal areas, with greater amplitude stimulated by health-risk of smoking images as compared to non-health risk behaviour images. In visual processing, it typically involves 'bottom-up' and 'top-down' processing in which the physical characteristics of the stimuli being processed first through early selective attention. Attentional resources are then reorganised to gather more task-relevant information generated by the task. An appraisal of the emotional experience is produced after information and memory content are matched (Katsuki & Constantinidis 2014).

In one ERP study that looked into the neural processing towards alcohol-related pictures (pictures of alcoholic and non-alcoholic beverages) in young adult binge drinkers, alcohol-dependent individuals exhibited dissociable ERP responses to alcohol-related cues. It was discovered that, participants who experienced more intoxication reacted to alcoholic stimuli with an elevated N200 compared to those who experienced less intoxication episodes (Watson 2016).

Understanding the link between moral identity and preference towards smoking can shed light on how moral considerations might influence this behaviour and inform clinical implications for healthy lifestyle programs. Clinicians can tailor the health promotion plan (such as tobacco cessation interventions) to the individual's moral identity. For those with a strong moral identity, highlighting the moral aspects of quitting from unhealthy behaviour, such as the health benefits and alignment with personal values, can be an effective strategy. In addition, encouraging individuals to reflect on the moral dimensions of their smoking behaviour can be incorporated into therapy. This might involve discussing their values and how preference towards smoking aligns or conflicts with those values.

The relationship between moral identity and smoking preference is actually a complex relationship. People with a strong moral identity may experience internal conflict when it comes to decide whether to be a smoker or non-smoker, and this can either motivate them to practice healthy behaviour or lead to rationalisations to continue unhealthy behaviour. Clinicians can use this understanding to tailor the interventions to align with an individual's moral values and motivations, ultimately improving their chances of successfully quitting

unhealthy behaviour.

Despite the fact that the current discovery revealed limitations in terms of socio-demographic characteristics such as gender proportion and socio-cultural and geographical influences on smoking behaviour perception, the strength of the study should be emphasised which determined the strength of two moral identities-intrinsically (internalisation) and extrinsically (symbolisation)-in influencing attentional cognition towards the health-risk of smoking behaviour.

CONCLUSION

There are several key findings related to attentional bias, moral identity, and neural activity associated with visual stimuli related to smoking behaviour and non-health risk behaviour. The findings suggest that the central brain region plays a crucial role in attentional bias towards health-risk smoking behaviour, and individuals with high internalisation are more likely to exhibit this bias. The N200 component of the ERP is a valuable marker in distinguishing between different types of visual stimuli and can provide insights into emotional cognition processing and inhibition control related to smoking behaviour. The current study acknowledges limitations related to socio-demographic characteristics and socio-cultural influences on smoking behaviour perception, suggesting the need for further research in these areas.

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