Psychomotor Vigilance across Young and Older adults in the presence of Affective Primes

A Thesis submitted for the partial fulfillment of the requirements for the degree of

MASTER OF ARTS IN PSYCHOLOGY

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Certificate

This is to certify that the thesis entitled "**Psychomotor Vigilance across Young and Older adults in the presence of Affective Primes**" submitted by Pavneet Kaur (Enrolment No. 8624020037) is being submitted in partial fulfillment of requirements for the award of the degree of Master of Arts in Counseling Psychology, submitted in the Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala. This is a Bonafide work carried out under the supervision of Dr. Richa Nigam, Professor at Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala and that no part of this thesis has been submitted for the award of any other degree.

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This is to certify that the above statement made by the student concerned is true and correct to the best of my knowledge.

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Candidate's Declaration

I, Pavneet Kaur (8624020037), student of M.A. Psychology (2023-2025), declare that the work being presented in the thesis entitled, "**Psychomotor Vigilance across Young and Older adults in the presence of Affective Primes**" in partial fulfillment of the requirement for the award of Degree of Master of Arts in Psychology, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala, is an authentic record of my work carried out under the supervision and guidance of Dr. Richa Nigam, Professor, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala and refers other researcher's work which are duly listed in the reference section. The matter embodied in this thesis has not formed the basis for the award of any other degree of this or any other university.

Date: 04.06.2026

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This is to certify that the above statement made by the student concerned is true and correct to the best of my knowledge.

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Abstract

Sustained attention is an important part of everyday cognitive functioning, yet the factors that shape it remain incompletely understood, particularly the role of emotional processes that operate below the threshold of conscious awareness. The present study examined how subliminal emotional priming influences psychomotor vigilance performance across two distinct age groups: young adults and older adults. Using a mixed factorial design, 120 participants were exposed to happy or sad facial primes in a standard task of psychomotor vigilance. The primed condition of the task was compared with a non-primed condition of the task comparing the performance of younger versus older adults. Reaction time, inter-stimulus interval sensitivity, and attentional lapses served as the primary performance indices. It was suggested that due to motivational shift with aging, older adults would respond faster to trails following positive primes (than negative primes) when compared with younger adults. The suggestion is embedded in the classic socio-emotional selectivity theory which suggests a motivational shift occurring with aging due to which older adults prioritize positive emotions over negative or neutral emotions/information.

The findings are expected to shed light on how preconscious emotional information interacts with the sustained attention, and whether age-related shifts in affective processing style alter the way subliminal cues are integrated into moment-to-moment vigilance.

Keywords: **Cognitive aging, emotional priming, psychomotor vigilance, socio-emotional selectivity theory**

Content

Chapter 1

Introduction

The psychomotor vigilance task (PVT) has become one of the most widely used and validated measures of sustained attention and alertness in cognitive psychology and sleep research. Originally developed by Dinges and Powell (1985), the PVT requires participants to respond as quickly as possible to visual stimuli that appear at random intervals, providing a sensitive measure of behavioral alertness through reaction time (RT) and lapses in attention. The task's simplicity, minimal learning effects, and resistance to practice make it particularly valuable for assessing vigilance decrements associated with sleep deprivation, circadian misalignment, and fatigue (Lim & Dinges, 2008). However, despite extensive research on the effects of physiological factors on PVT performance, considerably less attention has been devoted to Understanding how emotional and motivational processes might modulate vigilance performance.

Recent theoretical developments in affective neuroscience and cognitive psychology have increasingly recognized that emotion and cognition are fundamentally intertwined rather than operating independent systems (Pessoa, 2008). Emotional information has been shown to capture attention preferentially, modulate working memory capacity, and influence decision-making processes across a wide range of cognitive tasks (Phelps, 2006). These findings have prompted researchers to examine whether emotional stimuli, —either presented within or outside conscious awareness, might similarly influence basic measures of sustained attention and psychomotor performance.

1.1 Role of subliminal emotional priming on attention

The investigation of subliminal emotional priming effects on vigilance tasks represents a convergence of two historically distinct research traditions that are a): the study of unconscious emotional processing and b) the measurement of sustained attention.

Subliminal priming refers to the presentation of stimuli below the threshold of conscious awareness, typically through techniques such as backward masking, where a target stimulus is rapidly followed by a masking stimulus that prevents conscious perception of the prime (Dehaene et al., 2006). Despite their imperceptibility, subliminal primes have been demonstrated

to influence subsequent cognitive processing across multiple domains. In the emotional realm, even in the absence of conscious awareness, subliminal presentation of affective stimuli— (facial expressions), —have been shown to activate neural structures associated with emotional processing, including the amygdala, (Morris et al., 1998; Whalen et al., 1998). These findings suggest that the human brain continuously monitors the environment for emotionally salient information through preconscious processing mechanisms that may have evolved to facilitate rapid detection of threats and opportunities. In support to this, the neurobiological mechanisms underlying subliminal emotional processing have been extensively characterized through neuroimaging research. The subcortical route hypothesis, (LeDoux, (1996), suggests that sensory information can reach the amygdala through a rapid, direct thalamo-amygdala pathway that bypasses cortical processing entirely. This "low road" permits fast, automatic emotional responses to potentially threatening stimuli before detailed cortical analysis occurs.

1.2 Theoretical frameworks linking subliminal emotional priming and Psychomotor vigilance

The potential for subliminal emotional primes to modulate vigilance performance derives from multiple theoretical frameworks. From an evolutionary perspective, the emotional stimuli should receive prioritized processing even when presented subliminally, and this prioritization might manifest as enhanced alertness or altered response patterns in subsequent tasks (Öhman & Mineka, 2001). Supporting this hypothesis, research has demonstrated that subliminal presentation of threat-related stimuli can facilitate subsequent detection of target stimuli in visual search tasks (Carlson & Reinke, 2008) and modulate attentional orienting (Mogg & Bradley, 1999). However, the direction and magnitude of these effects appear to depend on multiple factors, including the specific emotional valence of the prime, individual differences in anxiety or other affective traits, and the temporal dynamics of stimulus presentation. For instance, Brosch et al. (2008) found that positively valanced stimuli, such as images of infants, captured attention as effectively as threatening stimuli, suggesting that emotional salience rather than threat alone drives attentional prioritization. With respect to individual differences, Bar-Haim et al. (2007) demonstrated in a meta-analytic review that individuals with elevated anxiety consistently showed attentional bias toward threatening cues, a pattern robust across both supraliminal and subliminal conditions. Similarly, MacLeod et al. (2002) showed that experimentally induced attentional bias toward threat causally elevated anxiety-linked responses, underscoring the bidirectional relationship between affective traits and attentional allocation. Regarding temporal dynamics, Pessoa et al. (2005) found that the modulatory influence of emotional stimuli on attention was sensitive to the duration of stimulus exposure and the availability of cognitive resources, with effects attenuating markedly under conditions of high perceptual load. Similarly, arousal-based framework provides an alternative understanding that emotional stimuli, regardless of their specific valence, produce increases in physiological and psychological arousal that may enhance general alertness and readiness to respond (Lang et al., 1990). The arousal dimension hypothesis predicts that both positive and negative emotional primes should produce similar facilitative effects on PVT performance, as both types of stimuli activate arousal-related neural systems. Applied to the PVT context, this perspective suggests that subliminal emotional primes might reduce reaction times and decrease lapses through a general arousal-mediated enhancement of vigilance.

In contrast to arousal-based accounts, valence-specific theories propose that positive and negative emotional stimuli should produce distinct and potentially opposing effects on cognitive performance. The broaden-and-build theory of positive emotions (Fredrickson, 2001) suggests that positive affect expands scope of attention and promotes exploratory behavior, while negative affect narrows attention to focus on threat-relevant information. Applying this framework to vigilance performance, one might predict that subliminal positive primes would enhance overall performance by promoting sustained engagement with the task, whereas negative primes might produce more complex effects, potentially facilitate responses when presented immediately before target stimuli, but impairing sustained performance over longer intervals. Some evidence for valence-specific effects comes from studies of mood induction on cognitive performance, which have found that induced positive affect can enhance creative problem-solving and cognitive flexibility, while negative affect tends to promote analytical, Detail-focused processing (Isen, 2001).

Research on subliminal affective priming has generally found that effects are strongest when the interval between prime and target is brief (typically less than 300 milliseconds), with effects declining as the stimulus onset asynchrony increases (Murphy & Zajonc, 1993). However, some studies have suggested that repeated subliminal exposure to emotional stimuli may produce longer and lasting changes in affective state and cognitive performance (Winkielman et al., 2005).

The methodological challenges in studying subliminal emotional priming effects on PVT performance are substantial. Ensuring that primes are genuinely subliminal requires careful validation, typically through objective forced-choice discrimination tasks or subjective awareness checks (Hannula et al., 2005). The specific parameters of prime presentation, —including duration, masking technique, and stimulus intensity, —can significantly influence both the subliminal status of primes and their potential effects on subsequent processing.

Furthermore, the PVT itself introduces methodological considerations, as the task's long duration and repetitive nature make it vulnerable to practice effects, fatigue, and strategic adaptations that might interact with or obscure priming effects all of which needs to be carefully Balanced.

Chapter 2

Literature Review

Psychomotor vigilance was proposed by Dinges and Powell (1985) which they poroposed pertains to the neurobiological alertness of an individual where the participants sit, watch a display, and press a key at the moment the target appears. By reducing the cognitive demand to a bare minimum, the PVT isolates thrill alert, the organism's moment- to- moment readiness to act at all. Four decades of posterior exploration have verified that this single measure, and particularly its derivations similar as mean response time, response speed expressed as the complementary of RT, and the frequence of setbacks defined as trials on which RT equals or exceeds 500ms, are among the most sensitive available indicators of neurobiological alertness (Basner et al., 2021).

The most recent study of PVT performance conducted under natural conditions was by Yuda and Yoshida (2025), who analyzed data from 356 participants ranging from 18 to 76years of age. Using a general linear model with gender and reaction time as fixed factors and age as a covariate, they applied multiple regression to identify the relative weight of each predictor, while monitoring the time of day as one of the dominant influence on response time. Across both the genders (male and female), the RTs, MNLs, and MJL were significantly lower in the 13:00–18:00 time window compared to 8:00–12:00. Furthermore, the RTs and MNL were particularly lower in males during the early morning hours (8:00–12:59), suggesting higher concentration and better performance in males during that period. Both minor and major lapse rates bettered significantly moving from morning to evening for both men and women, a pattern the authors attribute to circadian modulation of the alert state that the PVT measures. The practical significance of this finding is substantial for any trial. The hour at which the test is conducted must be treated as a critical variable because it strongly affects performance. Because of the same high wharf in a morning-depleted thrill system and one may produce qualitatively different responses.

The most harmonious finding in the aging- PVT literature is that aged grown-ups are slower than younger individuals on trials. This has been verified in sufficiently large samples and under sufficiently varied conditions that it can be treated as a birth empirical fact taking explanation rather than farther replication. A meta- analysis by Staub and associates (2021) quantified age differences in sustained attention tasks including the PVT across multiple studies and set up substantial effect sizes, with aged participants (roughly 65 to 78 times) showing longer mean RTs and steeper alert reductions than younger participants (roughly 21 to 29 times), particularly when the signal taking discovery was perceptually degraded. Yuda and Yoshida (2025) singly verified the age effect in their regression model, with age as a significant negative predictor of RT indeed after counting for sex and time of day. Neither of these findings is surprising.

Robison and associates(2022), publishing in Psychology and Aging, conducted what's arguably the most comprehensive lifetime PVT study in the recent literature, pairing standard RT dimension with contemporaneous pupillometry, experience slice of mind- wandering, and tone- reports of provocation and fatigue. Aged grown-ups in their sample were indeed slower per trial, harmonious with every previous study. Yet across the ten-nanosecond session, they showed no alert diminishment their RTs didn’t outstretch over time, their lapse rates didn't rise, and their task-elicited pupillary responses, which indicator phasic LC NE activation in response to each target, were measurably larger than those of their younger counterparts. Aged grown-ups also reported smaller cases of task-unconnected study and rated themselves further engaged with the task. The dissociation between per- trial speed and session-position thickness isn't trivially explained by provocation differences, because the PVT contains nothing that a motivated party can use to ameliorate their individual trial quiescence; whatever avail the aged grown-ups showed in thickness was arising from within the system rather than from deliberate strategy. Robison et al. propose that the larger pupillary responses in aged grown-ups reflect compensatory overactivation of the LC- NE system a structurally declining network working harder to achieve what a younger interpretation of the same network accomplishes further routinely.

The term subliminal priming describes any situation in which a encouragement that escapes the bystander's mindfulness nevertheless produces a measurable change in posterior cognition. In experimental work, below- threshold donation is generally achieved through backward masking, in which the high is incontinently overwritten by a mask encouragement that prevents its cortical connection before mindfulness can form. Recent examinations employing a masked- reiteration priming paradigm have demonstrated that age - affiliated differences crop at the foremost stages of facial- emotion processing(Simonetti, Davis & Kim, 2022). In two trials, younger grown-ups showed robust reiteration priming for both happy(positive) and angry(negative) target faces, whereas aged grown-ups displayed a significant priming advantage only for happy faces and no priming for angry faces (trial 1 M = 561 ms for happy vs. M = 583 ms for angry; trial 2 replicated this pattern). Mixed- goods analyses of response times revealed a significant commerce between high type(repeated vs. neutral) and target emotion for aged actors, driven by briskly responses to happy targets ($p = 0.0129$) while responses to angry targets were n't significantly eased(p = 0.7126). By discrepancy, youngish grown-ups displayed similar facilitation for both feelings(happy ≈ 449 ms; angry ≈ 461 ms). Follow - up analyses of order(valence) priming — where flowers and targets participated emotional valence but not identity — showed no significant goods in either age group, indicating that the benefits are tied to the reiteration of identical expressions rather than to a generalized affective bias. These findings align with the "positivity effect" described in socio - emotional selectivity proposition, which posits that aged grown-ups preferentially reuse positive over negative information(Carstensen, 2006). Also, the results support the Dynamic Integration proposition, suggesting that aged grown-ups calculate on automatic, low - trouble heuristics that favor positive cues when visual information is limited(Labouvie - Vief, 2003). The authors propose that aged grown-ups attend preferentially to the lower facial region (mouth) beforehand in visual analysis; because a smile is conveyed primarily by the mouth, this region provides a salient cue for happiness, whereas wrathfulness is gestured more by the upper face(eyes, eyebrows), which may be missed under brief(50 ms) masked donations(Simonetti et al., 2022). This fete angry expressions and accordingly fail to induce a priming benefit for angry faces indeed when high duration is increased to 58 – 83 ms(no enhancement in angry - face priming). Overall, the work provides compelling substantiation that the age - affiliated positivity effect extends to automatic, early perceptual mechanisms, pressing masked priming as a sensitive tool for uncovering subtle age differences in the temporal dynamics of emotion perception.

Chapter 3

Methodology

3.1 Participants

A total of 120 individuals from Thapar University participated in the study, divided equally into two age groups: 60 young adults (Mean age = 23.2 years; females = 34) and 60 older adults (Mean age = 66.5 years; females= 39). Prior to the main task, a pilot study was conducted to assess the clarity of the experimental procedures. The pilot sample comprised 26 participants, of whom 14 were male and 12 females.

	Demographic Variables		**Young**	**Old**
	Mean Age (SD)	23.2 (1.981)		65.5 (4.264)
	Mean Education in years	15.833		7.683
	Female percentage	56.66%		65 %
	Student	60		
Occupation	**Business**		Not applicable	15%
	Government Job			3.33%

	Housewife		58.33%
	Retired		1.66%
	Agriculture		20%
Language	**Monolingual**	0	33.33%
	Bilingual	0	41.66%
	Multilingual	100%	25%
Health	**Diabetes**	Not applicable	21.66%
	Hypertension		45%
	Others		18.33%
	MMSE/30	29.9 (0.399)	28.033 (2.131)
	ACE-R	95.9 (3.106)	86.933 (6.024)
	NPI D	0.766 (1.934)	0.75 (2.311)
	FXS	1.866 (5.013)	1.516 (4.155)

3.2 Design

The study used a mixed factorial design with age group 2(young, old) which was the between-subjects factor and emotion prime 2(happy, sad) was the within-subject factor.

3.3 Materials

There are two experiments in which the first experiment is the standard psychomotor vigilance task and the second experiment is the psychomotor vigilance task with modulation of subliminal priming. Both experiments were programmed and administered using OpenSesame. Participants were tested individually in a controlled laboratory setting, seated at a comfortable distance from the laptop screen. Before the study began, all participants signed a consent form to confirm their voluntary participation in the study. They were requested to provide their details for on their gross demographics. This was followed by them completing two questionnaires that are the Narcissistic Personality Inventory (NPI; citation) and Addenbrooke's Cognitive Examination-Revised (ACE-R; (Alladi et al., 2015), with an aggregate score of >90 and Mini Mental State Examination (MMSE) with an aggregate score of >28 for all the participants across the two age groups.). The ACE-R was included mainly to any cases of neurological or memory disorder, particularly in the older adult group. The scores on these measures were matched across young and older adults.

3.3.1 Neuropsychiatric Inventory

To evaluate the existence and intensity of neuropsychiatric symptoms, the Neuropsychiatric Inventory (NPI adapted version (Cummings et al., 1994)) is used. The NPI assesses psychological and behavioral symptoms in a number of areas, such as delusions. Depression, anxiety, apathy, irritability, disinhibition, abnormal motor behavior, sleep difficulties, hallucinations, agitation/aggression, and changes in appetite. A composite score is produced by ranking each symptom domain according to its frequency and severity. Cronbach's alpha coefficients for total scores usually fall between 0.80 and 0.88, indicating satisfactory to excellent internal consistency, according to studies.

The NPI was employed as a screening tool in this study to rule out participants with serious neuropsychiatric concerns that would have affected their performance in the study.

3.3.2 Addenbrooke ‘s Cognitive Examination- Revised

Addenbrooke's Cognitive Examination- Revised (ACE-R) was used to evaluate cognitive performance. The ACE is a quick yet comprehensive cognitive screening instrument that evaluates five cognitive domains: language, verbal fluency, attention and orientation, memory, and visuospatial skills. Higher scores indicate stronger cognitive functioning; the maximum score is 100. High internal consistency is demonstrated by the ACE-R, with Cronbach's alpha values usually reported in the range of 0.80 to 0.94. To make sure that every participant in the current investigation had intact global cognitive functioning, the ACE was utilized.

3.4 Stimuli

The experiment had face primes of 4 identities (2 males and 2 females) for each valence. The face were rated prior for valence and arousal by a group of 26 young students (Mean age = years) who did not participated in the main experiment. The faces matched for their overall arousal ratings, (t test results to be inserted) and differed only on the basis of valence (t test results to be inserted).

3.5 Procedure

In the main task, prime stimuli presented subliminally for 50 milliseconds and consisting of facial images varying in valence (happy or sad). Immediately following this a visual mask was presented for 500 milliseconds followed by the target stimulus in the form of a plus sign ("+") at the centre of the screen. Responses were recorded through a designated response button, i.e. "spacebar". Each experimental block consisted of 120 trials, and the inter-stimulus interval (ISI) between trials was randomized, ranging from 2 to 10 seconds, to prevent temporal anticipation of the target stimulus.

3.5.1 Experiment A:

In the first experiment, participants took part in a standard Psychomotor Vigilance Task (PVT). On every trial, a "+" sign appeared on the screen, and participants had to press a response button as quickly as they could when they saw it. The time between each appearance of the "+" sign varied randomly between 2 and 10 seconds, so participants could not predict when it would show up. The whole task took around 15 minutes to complete (refer to Figure 1).

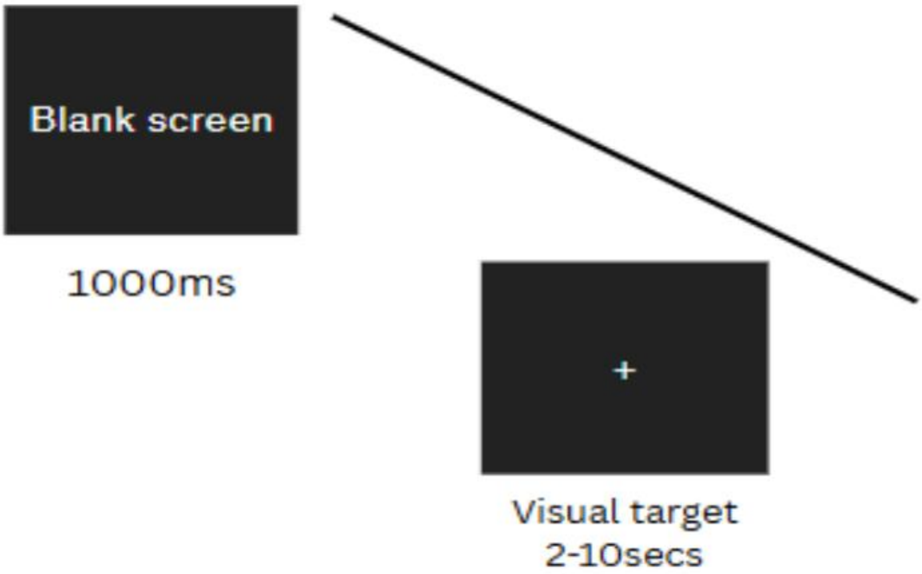


Figure 1 Trial Structure Experiment A

3.5.2 Experiment B:

Experiment B was similar to experiment A with the only difference that in this experiment, before the appearance of the "+" sign in each trial, participants were briefly shown a face prime (either a happy or sad),for just 50 milliseconds. which was immediately followed by a visual mask for 500 milliseconds. The "+" sign then appeared on the screen (jittered between 2 and 10 seconds), upon which the participants were instructed to press the response button (spacebar) as quickly as they could. The whole task took about 20 minutes to complete (refer to figure 2).

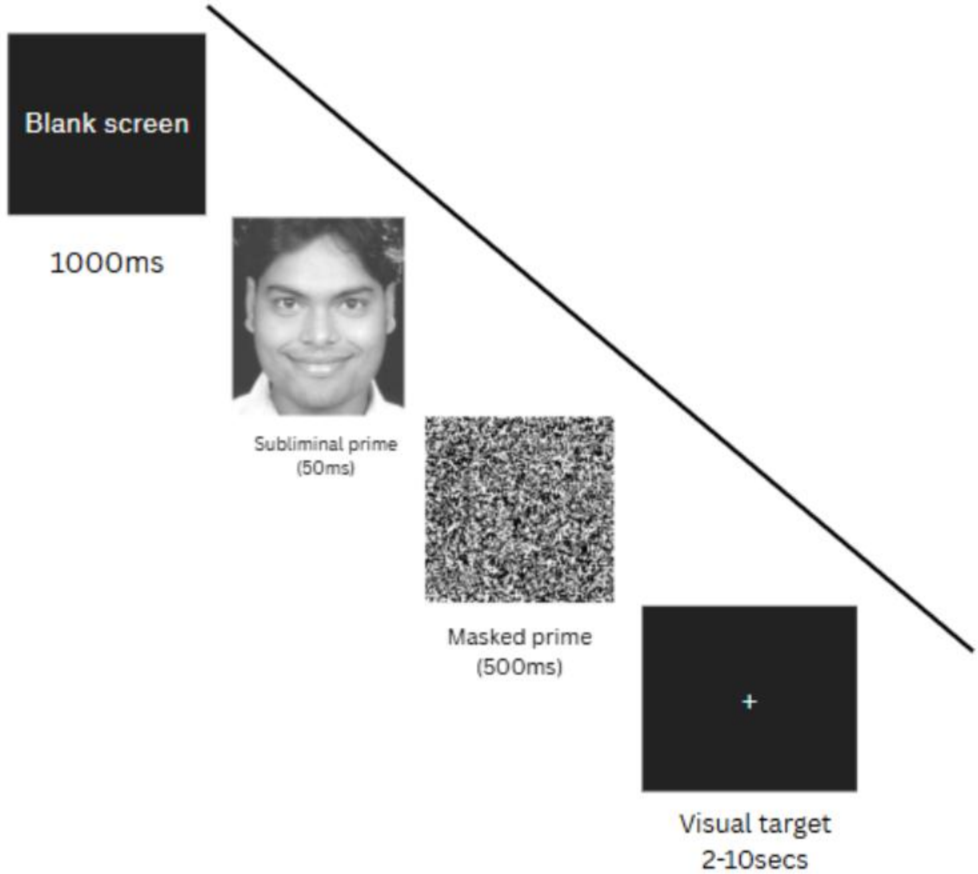


Figure 2: Trial Structure Experiment B

3.6 Statistical analysis

Jasp was used for statistical analysis. For data analysis reaction time (RTs), ISI, and accuracy were obtained from the experiment. Descriptive statistics were computed for ACE-r and NPI. The 2-way mixed factorial ANOVA was also computed for 2 age-groups (young, old) and 2 emotional prime (happy, sad).

CHAPTER 4

Results

Descriptive Statistics

Descriptive statistics were used to get a brief overview of the sample. The sample consisted of 120 participants, 73 female and 47 males, with age group scores indicating a roughly balanced distribution between younger and older adults within each gender subgroup. Average neutral prime reaction time was 589.0 ms (SD = 101.5) for female participants and 573.7 ms (SD = 1005.1) for male participants, suggesting broadly comparable vigilance performance across gender groups, although with notable variability in both. Mean for happy prime RT was 699.9 for females (SD = 196.6) and 628.1 (SD = 153.8) for males. Mean sad prime RT was 683.6 ms (SD = 156.9) for females and 629.3 ms (SD= 167.4) for males.

Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Prime Type (Non-Prime, Happy, Sad) using RTs:

A two-way repeated measures ANOVA was conducted to examine the effects of age (young and old) by 2 prime type (non-prime, happy, sad) and using reaction times (RTs). The analysis revealed a significant main effect of age was also observed, $F(1, 118) = 13.82$, $p < .001$, $\eta p^2 = .105$, suggesting that younger and older participants differed significantly in reaction times. *Post hoc* analysis indicated that younger participants (543.435 ms) demonstrated significantly faster reaction times compared to older participants (706.595 ms), $t\ (118) = -3.72$, $p < .001$.

The main effect of prime type was significant, $F(2, 236) = 16.54$, $p < .001$. *Post hoc tests* indicated that reaction times in the non-prime condition (583 ms) were significantly faster than both the happy prime condition (671.75 ms) as well as sad prime condition (662.3 ms), $t\ (118) = -4.26$, $p < .001$, $t\ (118) = -4.37$, $p < .001$, respectively. However, the difference between happy (671.75 ms) and sad prime (662.3 ms) conditions was not significant, $t\ (118) = 0.96$, $p = .340$.

The two-way interaction effect between age and prime type was not significant, $F\ (2, 236) = 0.16$, $p = .851$, $\eta p^2 = .001$, indicating comparable effects of prime type among younger and older adults.

Figure 1: *Mean reaction time of non-prime condition across two age groups*

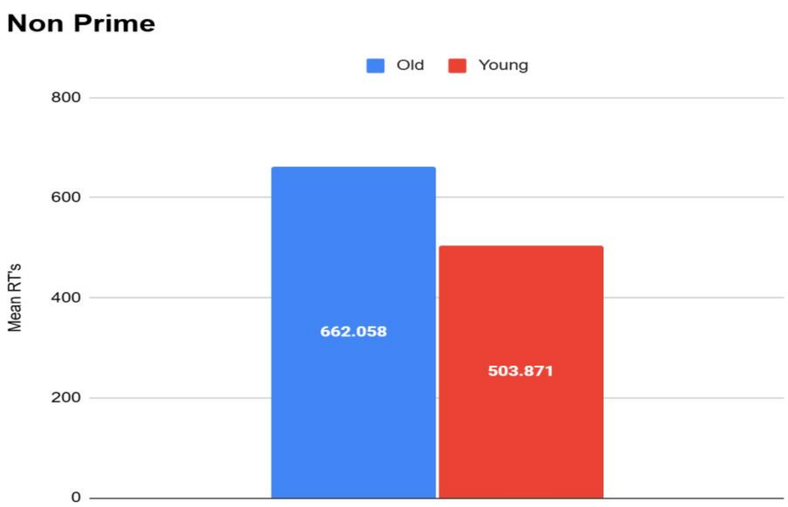


Figure 2: *Mean reaction time of happy prime condition across two age groups*

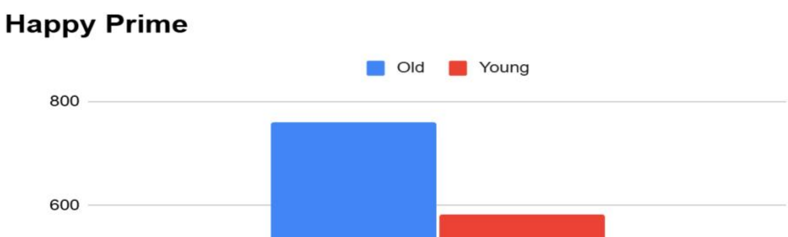
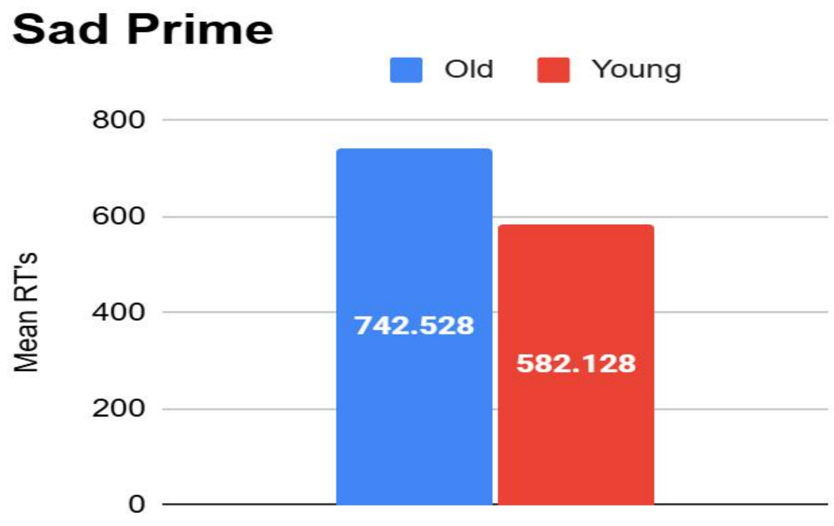


Figure 3: *Mean reaction time of sad prime condition across two age groups*



Three-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Prime Type (Non-Prime, Happy, Sad) x 3 Lapse type (Minor, Major, False Start) using frequency scores for each lapse type:

A three-way repeated measures ANOVA was conducted using 2 age (Young, Old) x 3 Prime Type (Non-Prime, Happy, Sad) x 3 Lapse type (Minor, Major, False Start). The results revealed a significant main effect of age, F (1, 118) = 43.21, p < .001, ηp^2

= .268. It indicated that the lapse frequency was more in older adults (24.058) in comparison to younger adults (12.269), $t\ (118) = -6.57$, $p < .001$.

The main effect of prime type was significant, $F\ (2, 236) = 74.25$, $p < .001$, $\eta p^2 = .386$. *Post hoc* comparisons demonstrated significantly greater lapses in the non-prime condition (24.847) compared to the happy prime condition (14.152), as well as sad prime condition (10.274), $t\ (118) = 8.73$, $p < .001$) and $t\ (118) = 8.70$, $p < .001$, respectively.

The interaction between prime type and age was significant, $F\ (2, 236) = 14.71$, $p < .001$, $\eta p^2 = .111$.

The three-way interaction between age, prime type, lapse type was significant, $F\ (4, 472) = 3.41$, $p = .009$, $\eta p^2 = .028$. *Post hoc* comparisons revealed older participants (39.45) to exhibit more minor lapses in comparison to younger adults in a non prime condition, $t\ (118) = -5.50$, $p < .001$.

Similarly, older adults (25.783) exhibited more minor lapses in happy prime condition in comparison to younger adults (14.85), $t\ (118) = -5.57$, $p < .001$.

Older exhibited more minor lapses in the non-prime condition (39.45) in comparison to the happy prime condition (25.783) as well as sad prime conditions (25.316), $t\ (118) = 7.19$, $p < .001$ and $t\ (118) = 7.29$, $p < .001$.

Figure 4: *Average lapse frequency for major happy prime across two age groups*

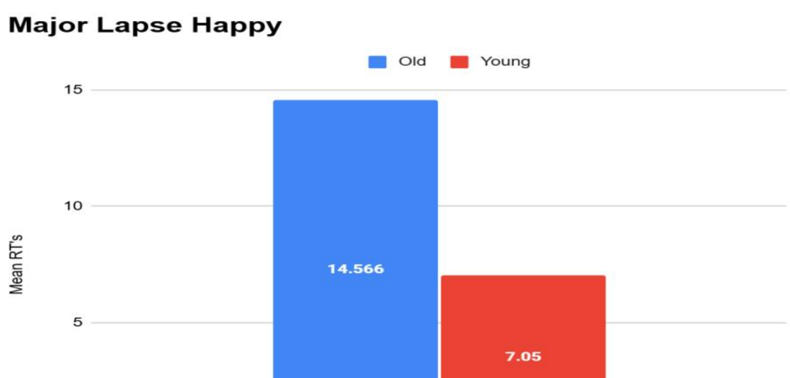


Figure 5: *Average lapse frequency for minor happy prime across two age groups*

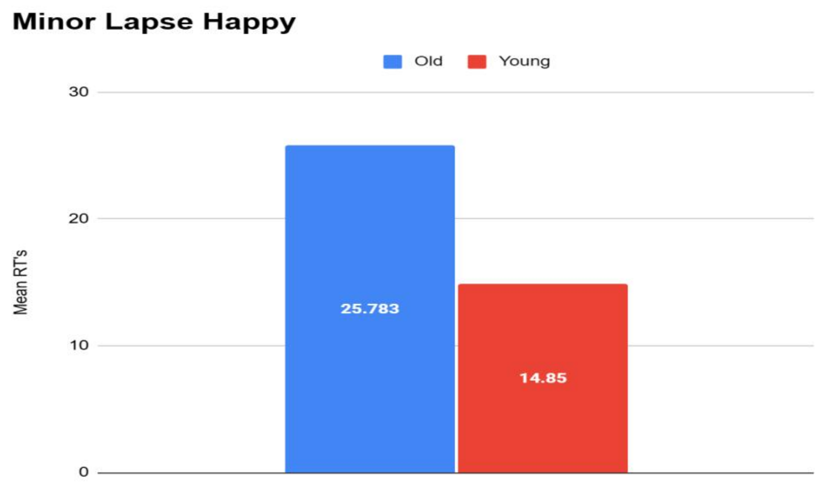


Figure 6: *Average lapse frequency for major sad prime across two age groups*

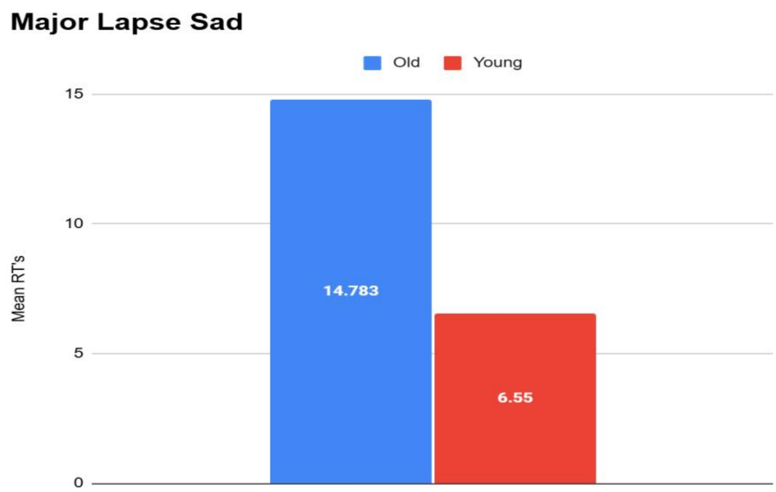
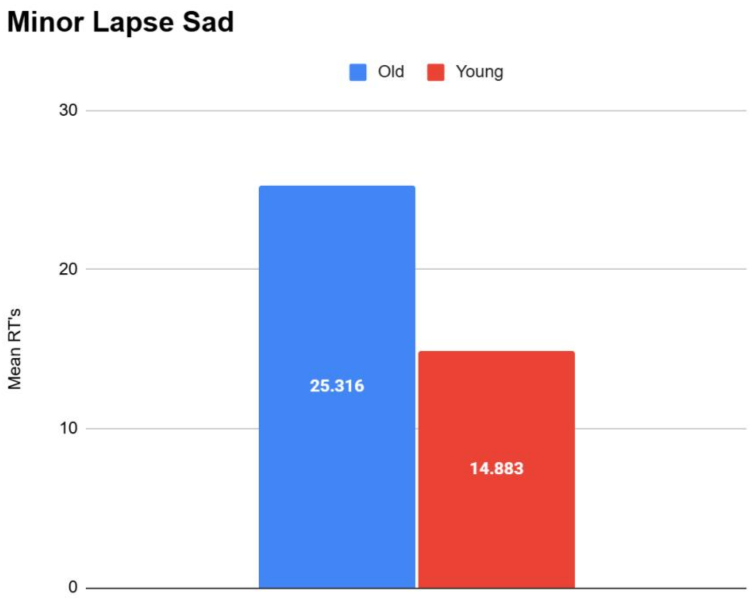


Figure 7: *Average lapse frequency for minor sad prime across two age groups*



Repeated Measures ANOVA: 2 Age (Young, Old) x 3 Prime Type (Non-Prime, Happy, Sad) x 2 Phase (Early vs Late) using RTs

A three-way repeated measures ANOVA was conducted using 2 Age (Young, Old) x 3 Prime Type (Non-Prime, Happy, Sad) x 2 Phase (Early vs Late). The results indicated a significant main effect of age, F (1, 118) = 20.86, $p < .001$, $\eta p^2 = .150$. *Post hoc* comparisons revealed younger adults (532.073 ms) to respond faster than older adults (718.919 ms) in both the phases of the study, t (118) = −4.57, $p < .001$.

The main effect of prime type was significant, F (1, 118) = 10.32, $p = .002$, $\eta p^2 = .080$. *Post hoc* comparisons indicated that both younger and older adults were slower in the subliminal prime condition (young = 563.733 ms; old = 735.389 ms) in comparison to the non-prime condition (young = 500.414 ms; old = 702.449 ms), t (118) = −3.21, p = .002.

The main effect of phase was significant, *F* (1, 118) = 5.19, $p = .024$, $\eta p^2 = .042$. The results indicated that overall, the participants were faster in early phase (609.68ms) of the task in comparison to late phase (641.39ms) of the task.

The two-way interaction effect between age and prime type was not significant, *F* (1, 118) = 1.03, $p = .313$, $\eta p^2 = .009$.

The two-way interaction effect between age and phase was significant, *F* (1, 118) = 4.88, $p = .029$, $\eta p^2 = .040$. *Post hoc* comparisons revealed younger adults to be faster in their early phase (500.941 ms) in comparison to their late phase (563.206 ms) in the task, *t* (118) = −3.17, $p = .004$ as well as faster than old adults in the early phase (718.433 ms) of the task, *t* (118) = −5.14, $p < .001$). Younger participants also responded faster in the late phase (563.206 ms) of the task in comparison to older adults (719.404 ms), *t* (118) = −3.55, $p = .002$). However, no significant difference was observed amongst older adults in their early (718.433 ms) versus late phase (719.404) conditions of the task, *t* (118) = −0.05, $p = .961$.

The two- way interaction between prime type and phase was significant, *F* (1, 118) = 8.78, $p = .004$, $\eta p^2 = .069$. *Post hoc* comparisons revealed no significant difference between the two phases (early =604.631 ms, late phase= 598.232 ms) of the non-prime conditions of the task, *t* (118) = 0.36, $p = 1.000$). However, the two phases (early = 614.643 ms, late = 684.379 ms) were significantly different in the subliminal prime condition of the task, *t* (118) = −3.51, $p = .003$. Additionally, no significant difference was observed in the early phase of the non-prime condition (604.631 ms) and subliminal-prime condition (614.643 ms), *t* (118) = −0.61, $p = 1.000$. There is a significant difference in the late phase of both non-prime (598.232 ms) condition and subliminal prime (684.379 ms) condition.

The three way interaction between age (Young, Old), prime type (Non-Prime, Happy, Sad) and phase (Early vs Late) was not significant , $F(1, 118) = 0.04$, $p = .844$, $\eta p^2 = .0003$, indicating that the combined effect of age, prime type, and phase on reaction time did not significantly differ across conditions.

Paired Samples T-test across age groups for the two phases

Paired-samples *t*-tests were conducted to compare performance across phases within the non-prime and subliminal-prime conditions. The analysis revealed no significant difference between the early phase (604.643 ms) and late phase (598.232 ms) in the non-prime condition, $t\ (119) = 0.35$, $p = .724$, indicating stable performance throughout the task. However, a significant difference was observed between the early phase (614.643 ms) and late phase (684.379 ms) in the subliminal-prime condition, $t\ (119) = -3.50$, $p < .001$, suggesting that performance significantly changed across phases under subliminal priming. Furthermore, the participants were faster in the late phase of non prime (598.232 ms) trials in comparison to the subliminal-prime (684.379 ms) trials, $t\ (119) = 3.85$, $p < .001$. In contrast, no significant difference was found between the early phase of subliminal-prime (614.643 ms) trials and the early phase of non-prime trials (604.631 ms), $t\ (119) = 0.61$, $p = .544$.

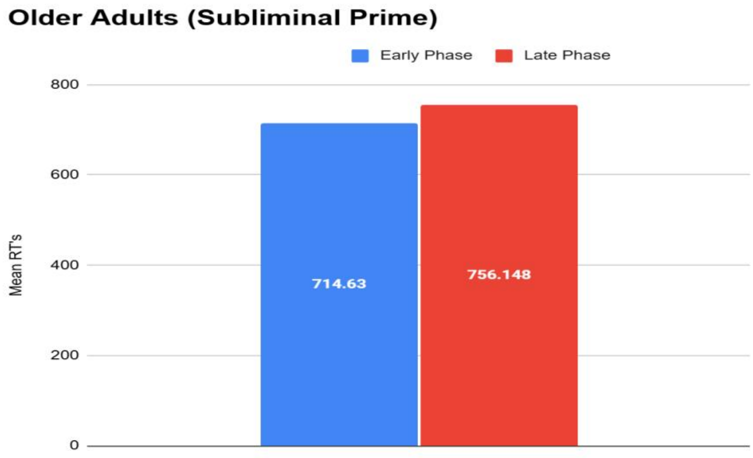


Figure 8: *Mean reaction time of older adults across two phases of task in subliminal prime condition*

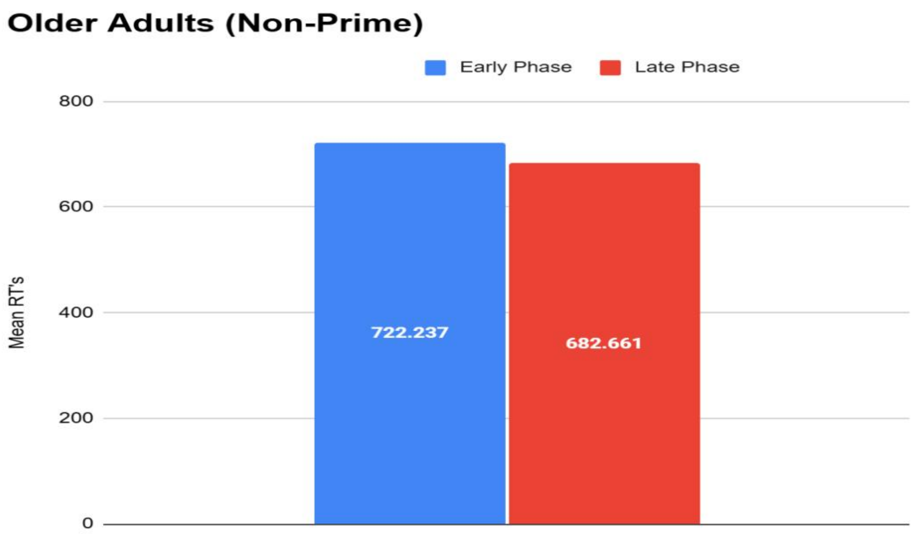


Figure 9: *Mean reaction time of older adults across two phases of task in non-prime condition*

Figure 10: *Mean reaction time of younger adults across two phases of task in subliminal prime condition*

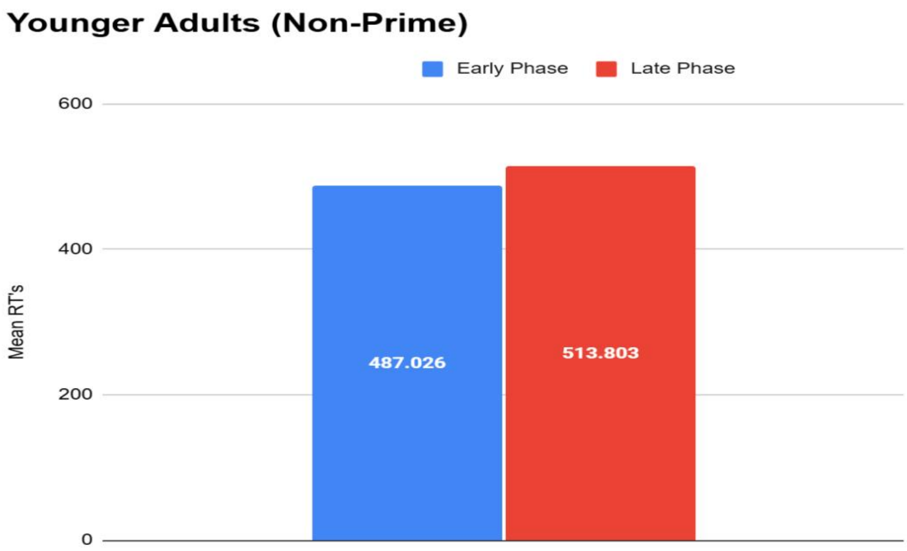
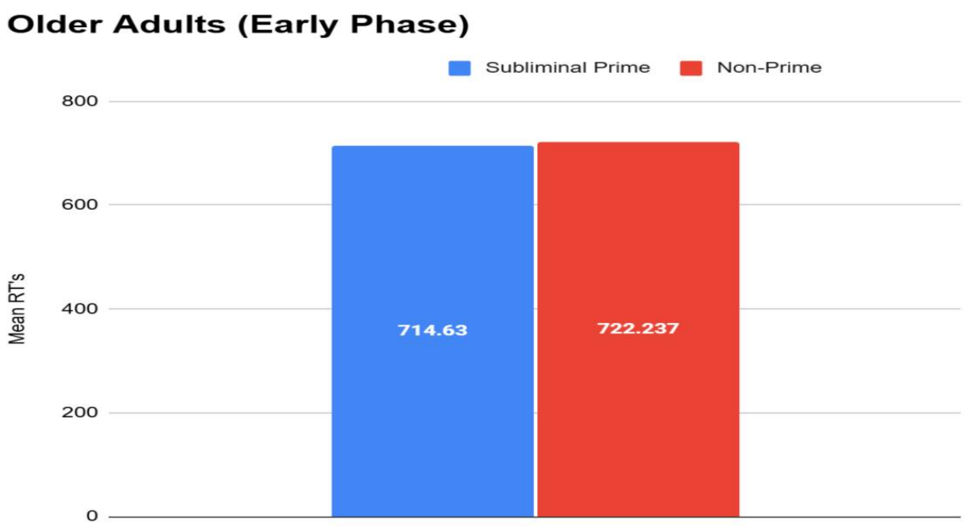


Figure 11: *Mean reaction time of younger adults across two phases of task in non-prime condition*



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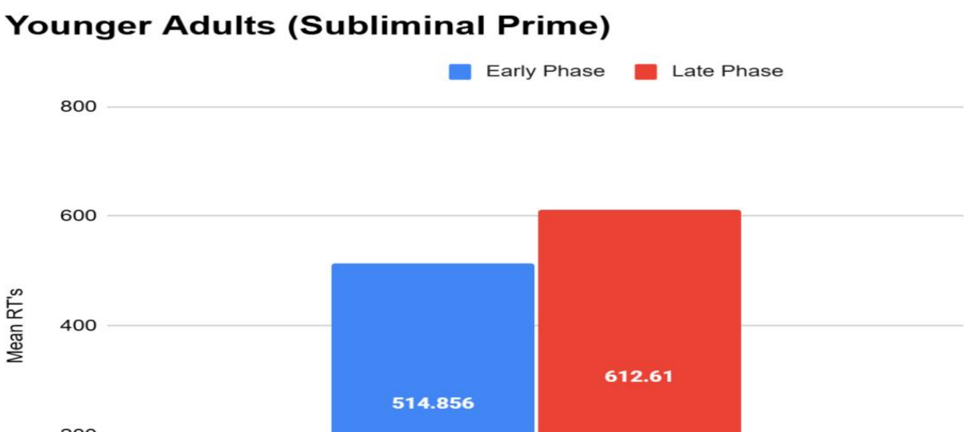

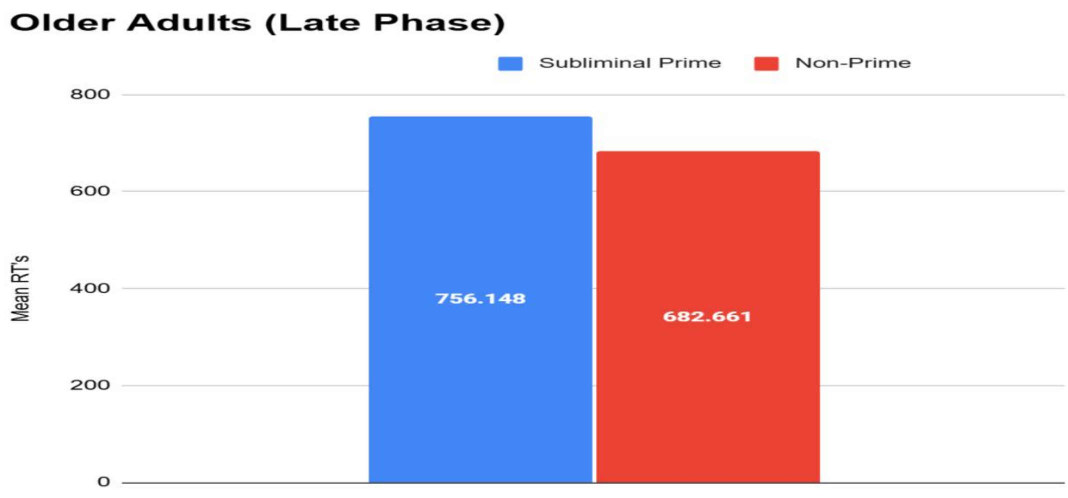

Figure 13: *Mean reaction time of older adults in late phase across two tasks*

CHAPTER 5

Discussion

The aim of the study was to examine whether emotional subliminal priming modulates performance in the Psychomotor Vigilance Task over time across the two age groups (young and old). More specifically, the study sought to determine whether subliminal primes carrying positive (happy) or negative (sad) affective valence differentially alter reaction times, lapse frequency, and performance in younger versus older adults.

The study revealed faster performance in the prime condition in comparison to non-prime condition showing a facilitatory effect of emotions on psychomotor vigilance. The study is the first attempt to depict a direct influence of emotions on psyhcomotor vigilance. The current study further predicted a faciltatory influence of subliminal emotional priming on psychmotor vigilance. This facilitation was predicted more in the early (phase) trials and decreasing over time (in late phase) as vigilance fatigue accumulates. The study further predicted an age-related differences in psychomotor vigilance following primes of variable valence for each phase. The study observed faster performance among young adults in comparison to older adults in general in psychomotor vigilance. These findings are consistent with the well-established age-related slowing hypothesis and replicate a pattern documented extensively in the literature for psychomotor vigilance (Emi Yuda and Yutaka Yoshida, 2025; Yutaka Yoshida and Kiyoko Yokoyama,2026). Consistent to the hypothesis both the age groups were faster in early phase than in late phase of the current study. The results emphasize natural and gradual decline in vigilance among participants, an effect which sustains with increase in age. However, in older adults this trend of gradual slowing in psychomotor vigilance occurred only in the case of prime conditions. They showed reverse effects (slower in early and faster towards the late phase) in the non prime conditions. The observed results bear two implications: a) they get better in their vigilance as the task progresses in a non prime condition and, b) given this, the emotional primes were certainly modulating psychomotor vigilance in elderly population with faster performance in the early phase of the task itself which tapers off in the late phase due to many reasons such as fatigue.

Lastly, the result in the current study demonstrated significant age-related differences in lapse performance due to emotional prime conditions for the different lapse categories. In both happy and sad prime conditions, older adults as well as younger adults exhibited significantly greater minor lapses compared to major lapses. Comparing across age groups, lapse rate is lower in younger participants in comparison to their older counterparts. These findings suggest that younger adults generally demonstrate lower frequencies of severe attentional lapses, reflecting better attentional control and cognitive efficiency relative to older adults across different prime conditions.

Older adults certainly show greater number of minor and major lapses for trials following sad emotional primes as well as minor lapses for trials following happy emotional primes, when compared to younger adults. The greater amount of lapses with increase in age is supported by the existing literature suggesting similar trends in general across these age groups (Emi Yuda and Yutaka Yoshida, 2025). However, it is to note that older adults show comparable performance for major lapses with younger adults for trials following Happy primes. The observed results show how Happy primes preserve older adults from committing major lapse as well as younger adults thereby, showing a facilitatory effect of positive emotions in the presence of sufficient time (SST; Mather and Carstensen, 2003).

There was no group difference observed for false start across any of the prime conditions. This indicates the absence of any anticipatory responses in wither of the group as a consequence of any priming conditions.

Overall, the findings suggest that aging is associated with increased attentional lapses across emotional prime conditions, particularly minor lapses. Younger adults consistently demonstrated lower lapse frequencies and fewer severe attentional failures, indicating more effective attentional regulation and cognitive processing efficiency.

CHAPTER 6

Conclusion

Overall, the results showed that young participants had faster response times and lower frequency of lapses than older adults, supporting the age-related slowing phenomenon extensively reported in the literature on psychomotor vigilance tasks (Yuda & Yoshida, 2025; Yoshida & Yokoyama, 2026). More importantly, while both age groups showed the predicted vigilance decrement for each phase of the task during subliminal prime trials, older adults showed an unusual reversal of their expected decrease during non-prime trials, performing better over time; hence, indicating that emotional priming is a significant factor in regulating psychomotor vigilance among older adults. In addition, results showed that while older adults showed higher rates of lapses compared to younger adults in all prime trials, being exposed to positive primes reduced the frequency of major lapses in older adults to levels similar to those of younger adults, which is consistent with theoretical claims about positivity-focused emotional regulatory processes among older adults (Mather & Carstensen, 2003). Finally, there were no significant differences between groups in the number of false starts in all prime trials, implying that neither group made anticipatory responses due to priming.

Chapter 7

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Appendix- A

CONSENT FORM

Participant Consent Form Title of the Study: Modulation in Psychomotor Vigilance Task (PVT) as a Function of Emotional Subliminal Priming

Researcher: Pavneet Kaur, master's Student, TSLAS (pkaur1_ma24@thapar.edu)

Supervisor: Dr. Richa Nigam, Assistant Professor, TSLAS (richa.nigam@thapar.edu)

Purpose of the Study- You are invited to participate in an academic research study that aims to examine how emotional priming influences performance on the Psychomotor Vigilance Task (PVT). The experiment is of 30 minutes approximately.

Your participation in this study is entirely voluntary. You may withdraw at any time without providing a reason and without any negative consequences. Your responses will be kept strictly confidential and will be used only for academic and research purposes.

By completing the form below, you acknowledge that you have read and understood the purpose and procedure of the study. You confirm that you agree to participate.

Participant Information

Email: ____

Name: ____

Age: ____

Gender: ____

Educational Qualification: ___________________________

■ I voluntarily give my consent to participate in this experiment.

Signature of Participant: ____________________________

Date: ____________________

Appendix- B

DEMOGRAPHICS FORM

Thapar School of Liberal Arts and Sciences
Thapar Institute of Engineering and
Technology Patiala, Punjab

S.No. MC Date:

Name:

Age:

Gender:

Address:

Mobile no.:

Education:

Occupation:

Languages known:

Medical history:

Prevalence of :

- Hypertension
- Diabetes
- Thyroid
- Alcoholism or substance abuse
- Head injury
- Epilepsy
- Anxiety

CURRENT MEDICATION:

ACTIVITY PROFILE:

- How do you spend your day?
- Meditation/ Exercise:

FAMILY HISTORY:

- Genetic disorder
- Dementia
- Neurological/ psychiatric disorder

Appendix- C

Neuropsychiatric Inventory (NPI)

Behaviors	F	S	D	FXS
Delusions				
Hallucinations				
Agitation				
Depression				
Anxiety				
Euphoria				
Apathy				
Irritability				
Aberrant motor behavior				
Night-time behaviors				
Appetite and eating disorders				
Total				

Frequency is rated as:

1. Occasionally – less than once per week

2. Often – about once per week

3. Frequently – several times a week but less than every day

4. Very frequently – daily or essentially continuously present

Severity is rated as:

1. Mild – produces little distress in the patient

2. Moderate – more disturbing to the patient but can be redirected by the caregiver

3. Severe – very disturbing to the patient and difficult to redirect

Distress is rated as:

0 – No distress

1 – Minimal

2 – Mild

3 – Moderately severe

4 – Moderately severe

5 – Very severe or extreme

Appendix- D

Addenbrooke's Cognitive Examination- Revised (ACE-R)

ADDENBROOKE'S COGNITIVE EXAMINATION - ACE-R

English version (2006) NIMS, Hyderabad

Name :
Age :
M C No. :
Sex :
Language : R W S

Date of testing :
Tester's Name :
Years of Education :
Occupation :
Handedness :

ORIENTATION

➢ Ask : What is the	Day	Date	Month	Year	Season	[Score 0-5]
➢ Ask : Which	Hospital	Floor	Town	State	Country	[Score 0-5]

REGISTRATION

➢ Tell : 'I'm going to give you three words and I' d like you to repeat after me: lemon, key and ball After subject repeats, say 'try to remember them because I'm going to ask you later'. Score only the first trial (repeat 3 times if necessary).

Register number of trials...........

[Score 0-3]

ATTENTION & CONCENTRATION

➢ Ask the Subject : Could you take 7 away from a 100 ?After the Subject responds, ask him or her to take away another 7 to a total of 5 subtractions. If Subject make a mistake, carry on and check the subsequent answer (i.e. 93, 84, 77, 70, 63-Score 4) Stop after subtractions (93, 86, 79, 72, 65)........... ....

➢ Ask the Subject : Could you please spell **WORLD** for me ? Then ask him / her to spell it backwards :

....

[Score 0-5]
(For the best performed task)

ATTENTION & ORIENTATION

MEMORY - Recall

➢ Ask : 'Which 3 words did I ask you to repeat and remember ?'

....

[Score 0-3]

MEMORY - Anterograde Memory

➢ Tell : ' I' m going to give you a name and address and I'd like you to repeat after me. We'll be doing that 3 times, so you have a chance to learn it. I'll be asking you later'

Score only the third trial

[Score 0-7]

	1st Trail	2nd Trail	3rd Trail
Sunil Kumar Singh	....	....	....
52, Station Road,	....	....	....
Gandhinagar,	....	....	....
Allahabad	....	....	....

MEMORY - Retrograde Memory

➢ Name of current Chief Minister ....
➢ Name of the women who was Prime Minister..
➢ Name the actor who was hero in the film "Mera Naam Joker "..
➢ Name the Father of our nation..

[Score 0-4]

MEMORY

VERBAL FLUENCY- Letter 'P' and animals

➢ Letters

Say: 'I'm going to give you a letter of the alphabet and I'd like you to generate as many words as you can beginnig with that letter, but not names of people or places. Are you ready? You've got a minute and the letter is P'

[Score 0-7]

total	Correct
>17	7
14-17	6
11-13	5
8-10	4
6-7	3
4-5	2
2-3	1
<2	0

➢ Animals

Say: 'Now can you name as many animals as possible, beginning with any letter?

[Score 0-7]

total	Correct
>21	7
17-21	6
14-16	5
11-13	4
9-10	3
7-8	2
5-6	1
<5	0

FLUENCY

LANGUAGE-Comprehension

➢ Show written instructions

[Score 0-1]

Close Your Eyes

➢ 3 Stage command

'Take the paper in your right hand. Fold the paper in half. Put the paper on the floor'

[Score 0-3]

LANGUAGE - Writing

➢ Ask the subject to make up a sentence and write in the space below :
Score 1 if sentence contains a subject and a verb (see guide for examples)

[Score 0-1]

LANGUAGE

LANGUAGE

LANGUAGE-Repitition

- Ask the subject to repeat: **'hippopotamus'; 'eccentricity; 'unintelligible'; 'statistician'**
  score 2 if all correct ; 1 if 3 correct; 0 if 2 or less.

[Score 0-2]

- Ask the subject: **'Above, beyond and below'**

[Score 0-1]

- Ask the subject: **'No ifs , ands or buts '**

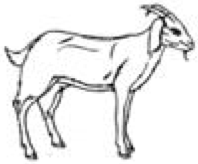
[Score 0-1]

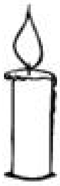
LANGUAGE-Naming

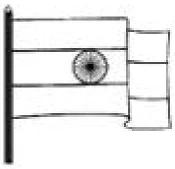
- Ask the subject to name the following picturese:

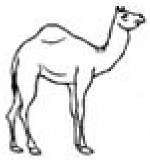
[Score 0-2]
pencil+
watch

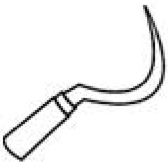
[Score 0-10]

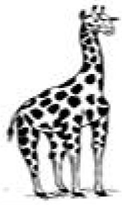


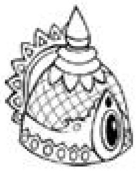


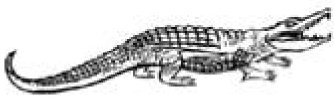












LANGUAGE-Comprehension

- Using the pictures above, ask the subject to:
  - Point to the one which shows time...
  - Point to the one which emits light...
  - Point to the one which is associated with farming...
  - Point to the one which is found in deserts ....

[Score 0-4]

LANGUAGE - Repetition

LANGUAGE

➢ Ask the subject to repeat the following words : [score 1 only if all correct]

[Score 0-1]

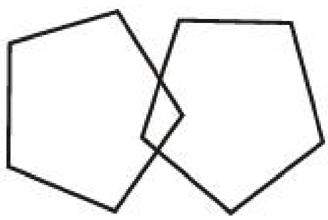
sew
pint
soot
dough
height

VISUO SPATIAL ABILITIES

VISUOSPATIAL

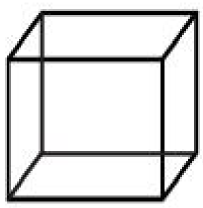
➢ Overlapping figure : Ask subject to copy this diagram :

[Score 0-1]



➢ **Ask the subject to copy this drawing (for scoring, see instructions guide)**

[Score 0-2]



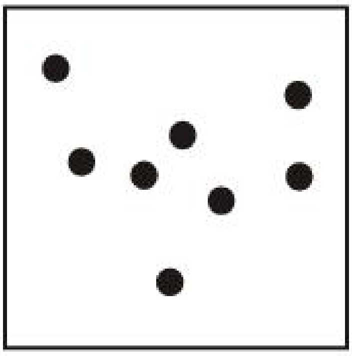
➢ Clock : Ask the Subject to draw a clock and the hands showing three. Instead of Numbers draw lines [for scoring see instructions guide ; circle=1, numbers=2, hands=2 if all correct-5]

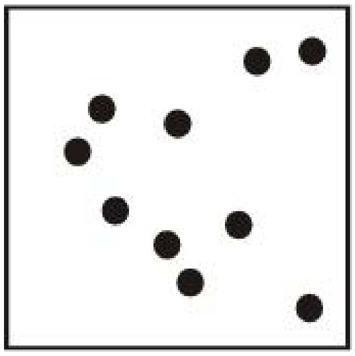
[Score 0-5]

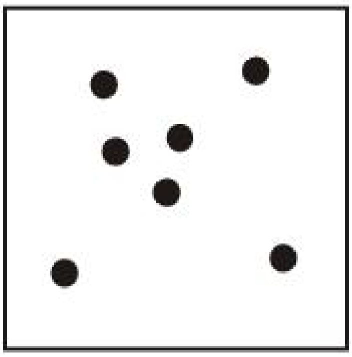
PERCEPTUAL ABILITIES

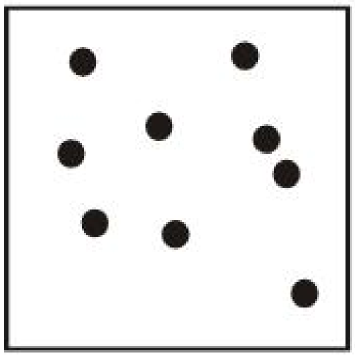
➢ Ask the subject to count the dots without pointing them

[Score 0-4]









VISUOSPATIAL

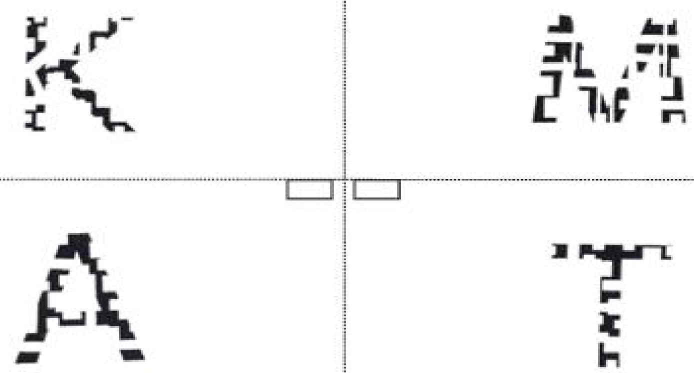
ADDENBROOKE'S COGNITIVE EXAMINATION - ACE-R

PERCEPTUAL ABILITIES

VISUOSPATIAL

➢ Ask the subject to identify the figures

[Score 0-4]



RECALL

MEMORY

➢ Ask "Now tell me what you remember of that name and address we were repeating at the beginning"

Sunil Kumar Singh 52, Station Road, Gandhinagar, Allahabad	______ ______ ______ ______ ______ ______ ______	[Score 0-7]

RECOGNITION

➢ This test should be done if subject failed to recall one or more items .If all items were recalled, skip the test and score 5.If only part is recalled start by ticking items recalled in the shadowed column on the right hand side Then test not recalled items by telling "ok, I"ll give you some hints : was the name X,Y or Z ?" and so on. Each recognised item scores one point which is added to the point gained by recalling.

Sunil Kumar Sharma		Sunil Kumar Singh		Rakesh Yadav		recalled		[Score 0-5]
25		52		37		recalled		
Market Road		Sastri Marg		Station Road		recalled		
Prakash Nagar		Gandhi Nagar		Patel Nagar		recalled		
Allahabad		Gwalior		Indore		recalled		

General Scores

MMSE	/30
ACE-R	/100

Subscores

SCORE

Attention & Orientation	/18
Memory	/26
Fluency	/14
Language	/26
Visuospatial	/16