

Measuring inhibitory control in emotionally dysregulated young and old adults using Stop Signal Paradigm

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

MASTER OF ARTS IN PSYCHOLOGY



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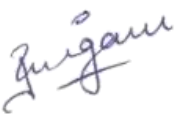
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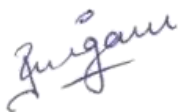
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List of Contents

CHAPTER 1 INTRODUCTION

- 1.1 Inhibitory Control
- 1.2 Inhibitory Control and Ageing
- 1.3 Inhibitory Control and Emotions
- 1.4 Inhibitory Control and Emotion Regulation
- 1.5 Inhibitory Control and Emotion Dysregulation

CHAPTER 2 LITERATURE REVIEW

- 2.1 Literature Review
- 2.2 Research Objectives

CHAPTER 3 METHODOLOGY

- 3.1 Participants
- 3.2 Designs
- 3.3 Measures
 - 3.3.1 Neuropsychiatry Inventory
 - 3.3.2 Addenbrooke 's Cognitive Examination -Revised
 - 3.3.3 Difficulties in Emotional Dysregulation
- 3.4 Stimuli
- 3.5 Experiment Paradigm and Procedure
 - 3.5.1 Emotional Stop Signal Task
 - 3.5.2 Procedure
 - 3.5.3 Statistical analyses

CHAPTER 4 RESULTS

- 4.1 Descriptive Statistics

4.2 Inferential Statistics

CHAPTER 5 DISCUSSION

CHAPTER 6 CONCLUSION

CHAPTER 7 REFERENCES

Abstract

Inhibitory Control is the ability to suppress pre-initiated responses, a fundamental executive process sensitive to emotional context as well as age related cognitive change. Increasing evidence show how emotional valence and emotion regulation difficulties independently modulate inhibitory processes, however little research has studied these factors together in young and old adult sample. The present study fills in this gap by examining how emotional valence, age related differences and differences in emotional regulation among people together influence inhibitory performance using Emotional Stop Signal Paradigm. A sample 64 participants (30 young; 34 old) was assessed on task and difficulties in emotion regulation. Negative emotional conditions showed greater inhibitory control performance which was reflected by longer Stop Signal Delay (SSDs) and shorter Stop Signal Reaction Time (SSRT), indicating the increased caution of the cognitive system towards environmental threat. Older Adults exhibited longer SSRTs compared to young adults suggesting the age-related slowing of inhibitory mechanism. Importantly, young and old adults both were modulated by emotional valence in similar manner, that can be interpreted through the Socioemotional Selectivity Theory that reflects the sophistication of emotion regulation resources with increase in age. Higher scores in difficulties in emotion regulation scale were associated with lower stop success, indicating that emotional dysregulation hampers the executive resources needed for efficient response inhibition. Taken together, these findings highlight the process of inhibitory control sensitive to emotional contexts, cognitive aging and individual regulatory capacity, unfolding a meaningful understanding of real-world processing of impulse control in emotional situations.

Keywords: Emotional Dysregulation, Cognitive Aging, Stop Signal Paradigm, Inhibitory Control, Socioemotional Selectivity theory

Chapter 1

Introduction

1.1 Inhibitory Control

Inhibitory control, defined as the capacity to suppress automatic or prepotent responses, is a fundamental component of executive functioning. This ability allows individuals to regulate behaviour in accordance with goals rather than immediate impulses, thereby supporting adaptive functioning across a wide range of everyday situations (Diamond, 2013).

Over the past decade, Research has inferred inhibitory control as a multi-component and context dependent process. Contemporary research has highlighted how inhibitory control overlaps and still remain distinct from other executive process like working memory and cognitive flexibility (Miyake et al.,2000; Diamond, 2013). Another recent development is the distinction between hot inhibitory control i.e. reward related and cool inhibitory control i.e. purely cognitive, emphasizing that inhibitory processes are influenced by affect, reward and context (Zelazo & Carlson, 2012; Pessoa, 2017). These findings have broadened the scope of inhibitory control research to study socio-emotional and development domains linking to academic performance, social functioning and also psychopathology (Eisenberg et al., 2019; Ioannidis et al., 2019).

Experimental Research has also contributed to examining of flexibility of inhibitory control by manipulating situational and individual factors. Paradigms such as stop-signal, go/ no-go, and Stroop tasks are now adapted to include emotional stimuli, reward contingencies and

other manipulations, showing the fluctuations in inhibitory control depending on cognitive load and motivational contexts (Shields et al., 2016; Pessoa, 2017).

1.2 Inhibitory Control and Aging:

Inhibitory control is not stable across the lifespan (Best & Miller, 2010; Salthouse, 2010). A substantial body of research demonstrates that advancing age is associated with gradual declines in executive processes, including slower response inhibition and increased susceptibility to distraction (Hasher & Zacks, 1988), that suggests underlying mechanisms altering behavioural pattern responsible for cognitive control. Prefrontal-striatal networks manage the filtering of irrelevant and pre-initiated responses required for inhibitory control. These networks with increase of age show thinning of the cortical mass and reduced neural connectivity leading to less efficiency in processing of inhibitory signals (Aron et al., 2014). Therefore, older adults show longer stop signal reaction times pointing to the delayed stopping processes but not complete inability to inhibit responses. In addition to this, Nigam and Kar, 2021, demonstrate how this inefficiency not merely deficits but also reorganized changes in adaptation to affective conflict. Their study found a stronger adaptation to negative affect in young adults and a positive affect adaptation in middle and older adults, supported by the Socioemotional Selectivity theory (Carstensen, 1991; Carstensen et al., 1999) that proposes the motivational shift in older adults called positivity effect, essentially more attention to positive information than negative due to their finite lives.

1.3 Inhibitory Control and Emotions:

Emotional information represents one powerful source of interference in inhibitory tasks (Pessoa, 2009). Emotional stimuli especially negative cues tend to capture attention more strongly than neutral information and compete for limited cognitive resources (Mather & Sutherland, 2011). Research examining the influence of mood states over response inhibition indicates that induced negative feelings hinder response inhibition and promote impulsive behaviour (Verbruggen & De Houwer, 2007; van Wouwe et al., 2011). Likewise, investigations utilizing emotional images as irrelevant distractors have demonstrated that negative visuals impair executive functioning and decrease inhibitory accuracy, especially under conditions of high cognitive demands (Dolcos & McCarthy, 2006; Jordan & Dolcos, 2015).

Research particularly using the Emotional Stop-Signal Task (SST) demonstrated reliably impaired stop trial performance for negative emotional images, leading to slower Stop-Signal Reaction Times (SSRT) and reduced stop accuracy in comparison to neutral stimuli (Allen et al., 2021). These findings extend to older populations as well, who are shown to exhibit impaired behavioural accuracy and delayed inhibitory processing for negative emotional images, indicating persistent influence of emotional interference even in later life (Wang et al., 2024). Together, these findings highlight the close interaction between affective processing and executive control mechanisms.

1.4 Inhibitory Control and Emotion Regulation:

Research suggests emotional regulation itself may change across adulthood in meaningful ways indicating that older adults demonstrate relatively preserved or even enhanced emotional response modulation under certain conditions (Nigam and Kar, 2025). Older adults are found to exhibit effective emotional response regulation, particularly to positive emotional cues as compared to younger adults who are shown to exhibit greater impulsive reactivity (Waring et al., 2019). Similarly, emotional valence is seen to differentially influence inhibitory performance across age groups, with older adults sometimes benefiting from positive emotional contexts Williams et al. (2020). These findings suggest that age-related shifts in emotional priorities and regulatory strategies may shape how emotional stimuli influence response inhibition. Importantly, emotional regulation capacities are not entirely fixed. Evidence suggests that adaptive practices, such as mindfulness and meditation training, can enhance self-regulation and cognitive flexibility (Sahdra et al., 2011). This indicates that emotional inhibitory control may be shaped by both developmental changes and experiential factors across the lifespan (Gross, 2015; Carstensen, 2006). While older adults may benefit from accumulated regulatory strategies, younger adults may still be developing these capacities, potentially contributing to age-related differences in emotional response inhibition.

1.5 Inhibitory Control and Emotion Dysregulation:

Beyond age-related differences, individual differences in emotional functioning may further influence inhibitory control. Emotional dysregulation (ED) which is characterised by a difficulty in managing and modulating emotional responses, has been consistently associated with impairments in executive functioning. Individuals with higher emotional dysregulation often display heightened emotional reactivity and difficulty disengaging from negative information. Empirical research in younger populations demonstrates that emotional dysregulation is associated with poorer inhibitory control and greater interference during emotionally salient tasks (Cardinale et al., 2019). Inhibitory deficit model (Joormann, 2010) provides a framework for understanding this relationship by suggesting that individuals with elevated emotional dysregulation struggle to inhibit negative emotional material in working memory, thereby compromising broader cognitive control processes. This mechanism offers a plausible explanation for why individuals with greater difficulties in emotion regulation show slowed or less efficient response inhibition in emotional contexts.

Despite converging evidence that aging influences inhibitory control, disrupting stopping performance, and that emotional dysregulation impairs executive functioning in younger samples, these lines of research have rarely been integrated. It remains unclear whether difficulties in emotional regulation in older population modulate emotional response inhibition similarly in young and in older adults. It is plausible that age-related regulatory

shifts buffer emotional interference in older adults, and that age-related executive decline somewhat amplifies vulnerability among individuals with difficulties in emotion regulation.

To address this gap, the present study directly examines inhibitory control among young and older adults, of varying levels of difficulties in emotion regulation (low, mild, moderate), using an Emotional Stop-Signal Task. By integrating lifespan cognitive research, emotional interference paradigms, and theoretical models of emotional dysregulation, this study aims to clarify how age and individual differences in emotion regulation jointly shape inhibitory control under emotional conditions.

Chapter 2

Literature Review

Landmark research by Joormann and Gotlib (2010) demonstrated that deficits in cognitive inhibition in individual resulted in increased difficulty to regulate emotional material, particularly negative information. This research highlighted the critical interaction between inhibitory processes and difficulties in emotional regulation suggesting that emotional dysregulation interfere with cognitive processes by impairing attentional and regulatory resources, affecting the efficiency of inhibitory mechanism. Adding to this perspective contemporary frameworks highlight that emotional dysregulation emerges from disturbed interactions between cognitive control and emotional systems, both influencing each other bidirectionally rather than independently (Mcrae & Zanolia, 2018).

This understanding that emotion impacts inhibitory control was further strengthened by experimental research in recent times. A study in 2018 demonstrated that action stopping measured through the Stop Signal Task is closely associated with processing of emotional stimuli, emphasizing that emotionally relevant information can trigger and modulate inhibitory control mechanisms. This study highlights how response inhibition is not just a motor process but also sensitive to emotional influences (Wessel, 2018).

Neurocognitive research has provided more insight into the mechanism underpinning the relationship between emotional dysregulation and inhibitory control. Bounous et al. (2022) demonstrates that the impact of emotional dysregulation on dysfunctional outcomes is significantly increased when inhibitory control is low, suggesting the moderating role of cognitive control processes.

Evidence further supports this association by demonstrating that emotional stimuli impair inhibitory control significantly. Cardinale et al. (2019) devised emotional dysregulation as a

transdiagnostic construct stemming from compromised cognitive control mechanisms, especially involving prefrontal regulation of emotional responses (Cardinale, 2019). Furthermore, increased level of anxiety and depressive symptoms have been linked with slower reaction times and reduced inhibitory control, reinforcing the relationship between emotional dysregulation and impaired cognitive control in clinical and non-clinical population as well. (Eysenck, Derakshan, Santos, & Calvo, 2007).

Following Cardinale 's study, Allen et al. (2021) created an emotional stop signal task and found that emotional stimuli, particularly negative ones impair response inhibition associated with negative urgency, validating the role of impaired emotional response inhibition in psychopathology.

Likewise experimental findings using emotional stop signal task paradigms have found that individuals showcase poorer inhibition on negatively charged stimuli prolonging stop-signal reaction times (SSRT) (Wang et al., 2024). In contrast to this William at al. (2020) found that positive emotional information helps facilitate response inhibition when it is task-relevant, emphasizing the contextual and task-related nature of emotion-cognition interplay.

Additionally, Zinchenko et al. (2020) found that depending on task settings and attentional demands, both positive and negative emotional cues can have variable effects on inhibitory performance. Their results support the notion that context-dependent emotional modulation of inhibitory control changes according to stimulus attributes like valence and arousal.

Research Objectives

This study aims to investigate the effect of emotional valence (positive, neutral, negative) on the measures of Stop Signal Task such as Go Accuracy, Go Reaction time, Stop Accuracy, SSD (Stop Signal Delay) and SSRT (Stop Signal Reaction Time) in young and old Adults. We also predict to see poorer inhibitory control, reflected by longer SSRTs in older adults compared to young adults as an age-related difference.

Also to examine the relationship between difficulties in emotion regulation measured through Difficulties in Emotion Regulation Scale (DERS) and inhibitory control performance. Through this study we will also see if negative emotional stimuli have differential effect on inhibitory control performance (possibly impairing accuracy) in comparison to positive and neutral conditions.

Chapter 3

Methodology

3.1 Participants

A sample of 64 participants was collected comprising of 30 young adults (mean age =21.83) and older adults (mean age =67.05). Sample of the young participants were mostly taken from Thapar Institute of Engineering and Technology and older adults sample mostly obtained by conducting visits in localities and old-age care homes. Informed consent was taken from the participants prior to the testing and experiment.

	Demographic Variables	Young	Old	
	Mean Age	21.83333	67.05882	
	Mean Education in years	16.33	12.14	
	Female percentage	70%	50%	
Occupation	Student	34		
	Business	Not applicable	29.8%	
	Government Job		9.7%	
	Housewife		50.2%	
	Retired		2.88%	
	Private Job		7.9%	
	Language	Monolingual	0	0
		Bilingual	0	20.4%
		Multilingual	100%	79.6%

Health	Diabetes	Not applicable	27.6%
	Hypertension		46.8%
	Others		25.6%
Neuropsychiatric Profile	MMSE/30	29.7(0.52)	27.8(2.24)
	ACE-R	95.5(3.42)	87.4(5.78)
	NPI D	0.71(1.88)	0.82(2.19)
	FXS	1.94(5.26)	1.62(4.01)

3.2 Design

This study follows a mixed factorial design where age (Young vs Old) was between subject variables and emotional valence (Positive, Neutral, Negative) was within-subject variable. In addition to this, difficulties in Emotion Regulation scores obtained from DERS Scale were examined through correlational analyses to whether it is linked to inhibitory control performance.

3.3 Measures

Each participant underwent assessments to test for cognitive, neuropsychiatric and psychopathological symptoms on various scales as mentioned below. Following this the participants were categorized to different groups based on their DERS (Difficulties in Emotion Regulation scale) score and only participants following in low, mild or moderate difficulties in emotion regulation were taken.

3.3.1 *Neuropsychiatric Inventory*

To evaluate the existence and intensity of neuropsychiatric symptoms, the Neuropsychiatric Inventory (NPI) is used (Cummings et al., 1994) to screen out any participant with neurological or psychological issues. The scale had three dimensions of frequency (between 1-3), severity (between 1-5) and Distress (1-3). The overall score less than 5 indicated normal range on neuropsychological issues.

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

The Addenbrooke's Cognitive Examination- Revised (ACE-R) was used to rule out cases of dementia (Mioshi et al., 2006). The ACE-R 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. Scores above 90 were considered within normal range.

3.3.3 *Difficulties in Emotional Dysregulation*

The Difficulties in Emotion Regulation Scale is a 36- item measure designed to evaluate elements of emotional dysregulation. The DERS is a widely used self-report instrument developed by Gratz and Roemer (2004). This scale includes 36 items rated on a 5-point

Likert scale from 1 (almost never) to 5 (almost always). It measures six areas of emotional dysregulation: non-acceptance of emotional responses, challenges in engaging in goal-directed behaviour, difficulties with impulse control, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. Higher total scores reflect greater challenges in regulating emotions. The DERS demonstrates strong psychometric properties across various studies in both clinical and non-clinical groups. The internal consistency for the entire scale is consistently excellent, with Cronbach's alpha values ranging from 0.93 to 0.95. The internal consistency of subscales varies from generally good to excellent (alpha = 0.80-0.92). The scores categorised the responders into either of the 5 categories low, mild, moderate, high or very high, indicating the level of difficulty faced in emotional regulation.

For this study, only the sample following in low, mild, moderate difficulties of emotion regulation was taken.

3.4 *Stimuli*

A total of 60 emotional images were used in the experiment which were taken from the Open Affective Standardized Image Set database (OASIS; (Kurdi et al., 2017)) were extracted as stimuli for the experiment. This data set was developed in 2016 by the Department of Psychology, Harvard University, Cambridge (Kurdi et al., 2016). The 60 images were selected on the basis of picture ratings taken from participants prior to the experiment before

including them as the emotional stimulus. The images were rated on the basis of Valence and Arousal by the participants. The images were divided into equal parts on the basis of Valence (Positive, Negative and Neutral).

3.5 Experiment Paradigm and Procedure

3.5.1 Emotional Stop Signal Task

The present study used the Emotional Stop Signal Task (ESST; Logan and Cowan 1984) which is grounded in the independent race model, in which a “go” process (response execution) and a “stop” process (response inhibition) compete against one another. Successful inhibition occurs when the stop process finishes before the go process; failure occurs when the go process finishes first. During this process, the SSD is dynamically adjusted using a staircase procedure: it increases after successful inhibition and decreases after failed inhibition, ensuring that stopping probability converges around 50%. The primary outcome measure, Stop-Signal Reaction Time (SSRT), provides an estimate of the latency of the inhibitory process. The ESST was designed to assess response inhibition under emotionally salient conditions. Unlike the traditional neutral Stop Signal Task, this version incorporated emotional stimuli (positive, negative, and neutral images) to examine how emotional valence modulates inhibitory control.

The Experiment was built on PsychoPy-2024 2.3 builder. The stop signal task consisted of go trials and stop trials, with 25% stop trials and 75% go trials. There was a total of 360 trials,

270 go trials and 90 stop trials. The experiment started with an Emotional image (500 ms) (Pawliczek et al., 2013), then the fixation point “+” appears (300 ms), then go stimulus i.e. number “1” or “2” for which the participants had to press “F” key when “1” appeared and the “J” key when “2” appeared and lastly a blank screen (1000 ms) marked the end of a trial (see Figure 1). The go stimulus disappeared as soon as the key is pressed and dissolved after 1000 ms if no input occurs. The emotional stimuli were presented in a pseudo-random order. The only addition in the stop trial was a red square (stop signal) that appeared after a “1” or “2” (go stimulus). The stop signal was the cue to not to respond with any keypress. Go stimulus and stop signal were co-presented within the time of 1000 ms. The delay between the presentation of the go stimulus and the stop signal which is Stop Signal Delay kept on varying through the experiment in a staircase dynamic tracking manner (50- 800ms) according to the participant ‘s performance in the preceding stop trial (Berger et al., 2013). The initial SSD was set at 250 ms. The stop signal disappeared immediately when the participant responded with a key press and dissolved after (1000-SSD) ms when no key presses were presented. Stop Signal Reaction Time (SSRT), which is the time required for a stopping response, was calculated as the difference between the averaged RT to the go signal and the averaged SSD (Alyagon et al., 2020).

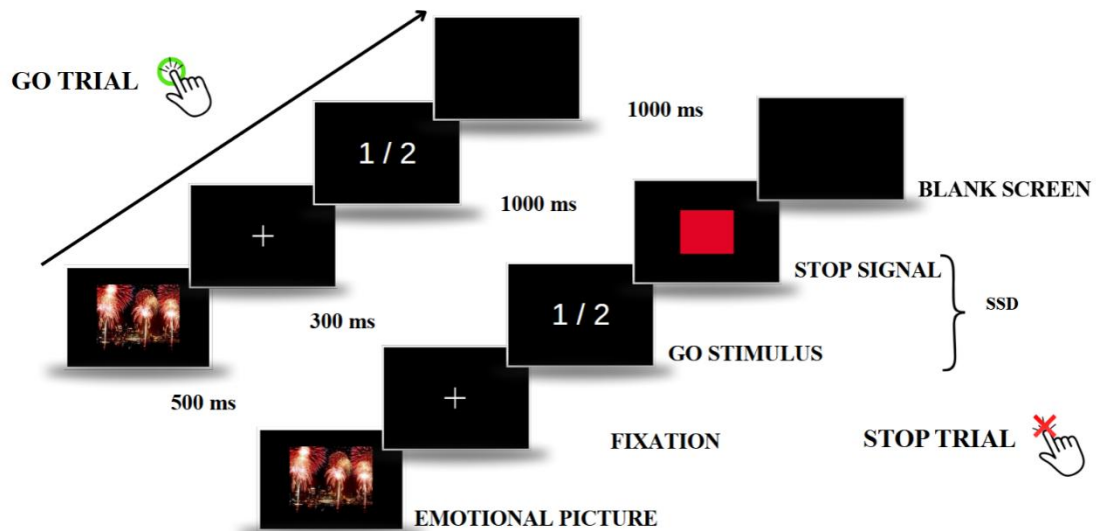


Figure 1: Trial Structure

3.5.2 Procedure

Participants were seated in a dark room in the lab. Firstly, an informed consent was filled by the participants following which they filled the DER Scale, then NPI and ACE-R were administered to fulfil the inclusion criteria. This was followed by a practice phase ensuring a minimum of 70% accuracy before they are allowed to participate in the main experiment. They were instructed to read the instruction carefully before proceeding in the main task.

3.5.3 Statistical Analysis

Jamovi was used for statistical analysis. For data analysis Go reaction time, Go accuracy, Stop Signal Delay SSD, stop accuracy, Stop Signal Reaction Time (Mean Go RT – Mean SSD) in Positive, Negative and Neutral conditions were obtained from the experiment.

Descriptive Statistics were computed were for scores of DERS, NPI, ACE-R. Inferential Statistics used was a repeated measures ANNOVA to assess emotional condition on Go RT, Go accuracy, SSD, Stop accuracy and SSRT and Correlational analyses was done to investigate the interaction between the behavioural data and scores on DERS scale.

Chapter 4

Results

4.1 Descriptive Statistics

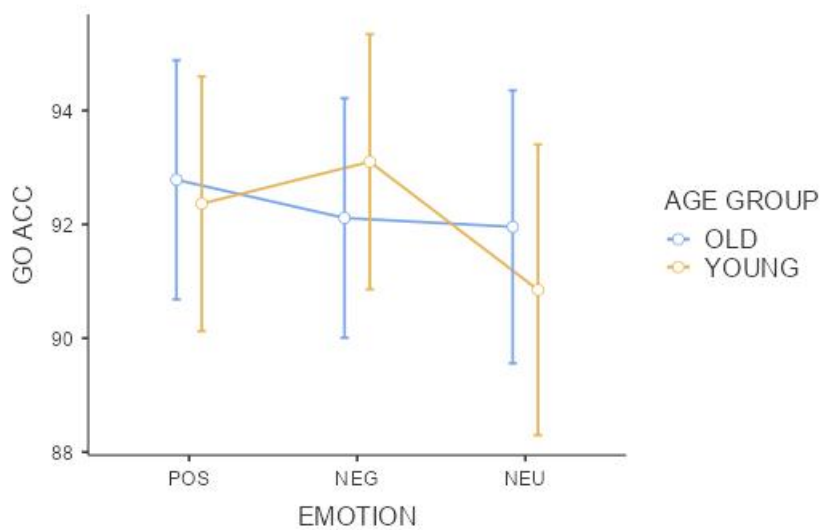
Descriptive statistics were used to get an overview of the sample. The sample consisted of 64 participants, 30 were young adults and 34 old adults. The mean Go accuracy for older adults came out to be 92.3% (SD=6.15), younger adults showed mean Go accuracy of 92.1% (SD=5.59). Mean Go Reaction time was 592 ms (SD=101) for older adults and 580 ms (SD=105) for younger adults. Older adults showed mean Stop Accuracy of 50.3% (SD=4.44) and younger adults showed mean of 51.4% (SD=1.92). Mean SSD was 318 ms (SD=130) for older adults and 360 ms (SD=127) for young adults. Mean SSRT for older adults came out to be 274 ms (SD=54.0) and young adults mean SSRT 220 ms (SD=33.8), indicating relatively slower inhibitory control in older adults.

4.2 Inferential Statistics

Correlational Analysis of DERS Scores (measure for emotional dysregulation) and Inhibitory Control variables.

First is the correlation analysis between DERS scores for difficulties in emotion regulation and the inhibitory control measures (Stop Accuracy, SSRT, SSD and Go Accuracy). The findings are as follows. DERS scores were found to be significantly negatively correlated with measures of Stop Accuracy, ($r=-.300$, $p=.016$). This finding was complemented by a significant negative correlation between SSRT and Stop Accuracy, ($r=-.605$, $p<.001$). Moreover, SSD was found to be significantly and negatively correlated with SSRT, ($r=-.667$, $p<.001$). Of particular note in this regard, SSD was also found to be significantly and positively correlated with Stop Accuracy, ($r=.693$, $p<.001$). Go Accuracy was found to be significantly and negatively correlated with SSD, ($r=-.534$, $p<.001$), and significantly and positively correlated with SSRT, ($r=.331$, $p=.008$).

EMOTION * AGE GROUP



Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Emotional condition

(Positive, Negative, Neutral) on Go Accuracy:

A two-way repeated measures ANOVA on Go Accuracy of young and old adults in 3 Emotional conditions (Positive, Negative, Neutral). A trend-only effect of the Emotion factor was found, $F(2,124) = 3.03, p = .052, \eta^2 = .047$. The main effect of the Age Group factor was not significant, $F(1,62) = 0.015, p = .904, \eta^2 = .000$. The interaction between the two factors was also not significant, $F(2,124) = 1.84, p = .163, \eta^2 = .029$.

The estimated marginal means for Go Accuracy were very high across all conditions for both younger and older adults with only minor variation across emotional valence.

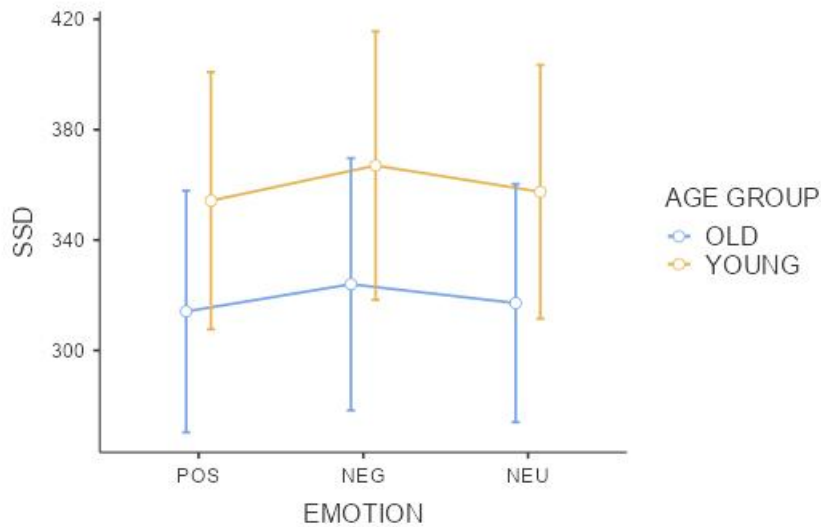
Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Emotional condition (Positive, Negative, Neutral) on Go Reaction Time.

A two-way repeated measure on Go Reaction Time (Go RT): 2 (Young, Old) x 3 (Positive, Negative, Neutral) was administered. There were no significant main effects of emotion, $F(2,124) = 1.476, p = .233, \eta p^2 = .023$). The main effect of Age Group was also non-significant, $F(1,62) = 0.244, p = .623, \eta p^2 = .004$). Additionally, the Emotion \times Age Group interaction was non-significant, $F(2,124) = 0.132, p = .877, \eta p^2 = .002$.

Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Emotional condition (Positive, Negative, Neutral) on Stop Accuracy.

A two-way repeated measures ANOVA was used to compare the data from 2 Age Groups (Young and Old) under three Emotional conditions (Positive, Negative, Neutral) on the variable of Stop Accuracy. The results revealed that there was no significant main effect of Emotion, $F(2,124) = 2.335, p = .101, \eta p^2 = .036$, or of Age Group, $F(1,62) = 1.70, p = .198, \eta p^2 = .027$). The interaction between the two factors was also found to be non-significant, $F(2,124) = 0.349, p = .706, \eta p^2 = .006$). Thus, it appeared that both young and old adults processed information under the three Emotional conditions in a similar manner.

EMOTION * AGE GROUP

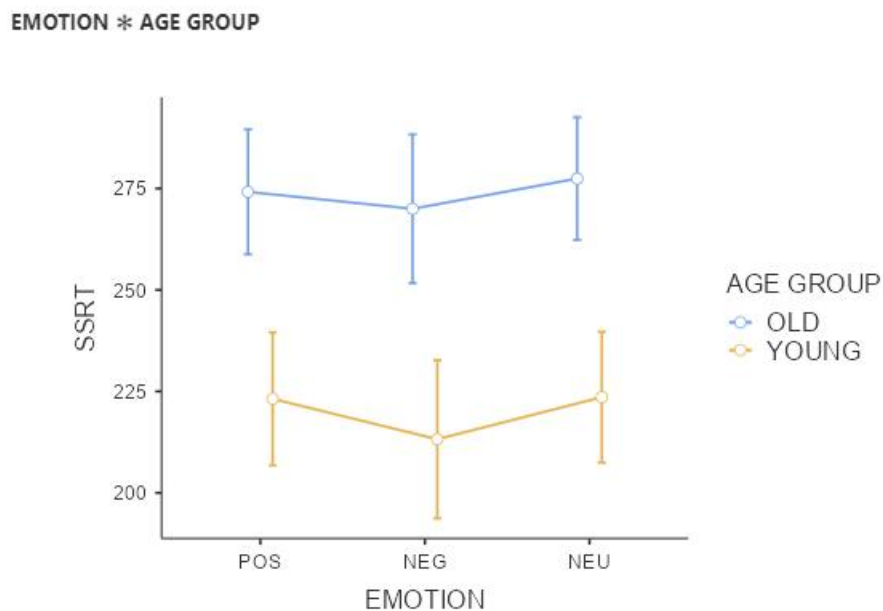


Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Emotional condition (Positive, Negative, Neutral) on SSD:

SSD data was analysed for main effects of and interactions between two between subject factors, i.e., 2 Age groups (young, old) and 3 Emotional conditions (Positive, Negative, Neutral). The results revealed a highly significant main effect of the Emotional factor, $F(2,124) = 34.474, p < .001, \eta p^2 = .357$. Following from this analysis, all three possible pairwise comparisons between conditions were found to be significant: Positive vs. Negative, $p < .001$; Positive vs. Neutral, $p = .030$; and Negative vs. Neutral, $p < .001$. There was no significant main effect of the Age Group factor, $F(1,62) = 1.63, p = .207, \eta p^2 = .026$, indicating that SSD did not differ between young and old adults. The two-way interaction between the two factors was

not significant, $F(2,124) = 0.655$, $p = .521$, $\eta^2 = .010$. Thus, young and old adults exhibited similar SSD under all three conditions.

Estimated marginal means revealed for both young and old adults' variation in SSD between emotional conditions, with the largest SSD values in the negative condition, followed by neutral and positive condition.



Two-way repeated measures ANOVA: 2 Age (Young, Old) x 3 Emotional condition (Positive, Negative, Neutral) on SSRT.

For the analysis of SSRT there was a significant main effect of Emotion, $F(2,124) = 5.126$, $p = .0072$, $\eta^2 = .076$. This indicates that there were significant differences between the three conditions. Between the negative and neutral conditions there were significant differences,

$p=.011$. The positive vs. the negative condition just failed to reach significance, $p=.050$. There were no significant differences between the positive and neutral condition, $p=.799$. The main effect of Age Group was also significant, $F(1,62) = 22.2, p < .001, \eta p^2 = .263$. The older adults had significantly longer SSRTs than the young adults. However, there was no significant Emotion x Age Group interaction, $F(2,124) = 0.481, p = .619, \eta p^2 = .008$. This indicates that both age groups were modulated by emotion in the same way. On this measure the SSRTs were relatively short for the negative condition and longer for the positive and neutral conditions. There was a significant main effect of Age Group, $F(1,62) = 22.2, p < .001, \eta p^2 = .263$, with older adults having significantly longer SSRTs than younger adults. The Emotion \times Age Group interaction was not significant, $F(2,124) = .481, p = .619, \eta p^2 = .008$. It appeared that SSRT values were the shortest for the negative condition. SSRT values for the positive and neutral emotional conditions were longer.

CHAPTER 5

Discussion

This study examined how emotional valence, age, and inhibitory control performance interact using an Emotional Stop Signal Task, while also exploring how difficulties in emotion regulation relate to inhibitory functioning. The results add to an expanding corpus of research on how emotion and cognitive control interact throughout the lifespan.

The first and fourth hypotheses examined how emotional valence affects performance on the Stop Signal Task. Consistent with these hypotheses, performance was observed to have differential influence under negative emotional conditions compared to positive or neutral ones but not impairing but showing superior performance on negatively conditioned trials. Specifically, the Stop Signal Delay was greatest under negative emotional valence and smallest under positive emotional valence. Regarding the tracking algorithm's logic, this indicates that stopping was most consistent and efficient under negative conditions and least consistent under positive conditions. The longest reaction times occurred during stop trials under negative emotional context, indicating the strongest stopping. Conversely, the reaction time for stop trials in a positive emotional context was the shortest, indicating the weakest inhibitory control. The intermediate level of stopping occurred within a neutral emotional context. Theoretically, it is functionally adaptive for a system to enhance caution by inhibiting prepotent responses when the external environment signals threat (Pessoa, 2009; Dreisbach & Goschke, 2004). As stated before, a system's level of caution is allocated by the

quantity of resources assigned to that objective. Consequently, the system would prioritize processing stop signals when they signal potential danger over instances where they do not. Providing extra resources would raise the threshold for automatic prepotent responses, thereby increasing the amount of stopping.

The SSRT findings offered additional backing for this hypothesis. On average, negative emotional stimuli produced the quickest stopping times, neutral stimuli yielded intermediate results, and positive stimuli resulted in the slowest stopping times. Nevertheless, the discrepancy between the positive and negative conditions did not achieve statistical significance. Notably, emotional content did not significantly influence either Go accuracy or Go reaction time. Consequently, the influence of emotional stimuli on stopping seems specific to the inhibition mechanism itself, rather than stemming from broad effects such as heightened arousal, greater task involvement, or other variables that could accelerate or degrade Go responses.

The second hypothesis examined whether older adults exhibit slower performance on a Stop Signal Task than younger adults, as reflected by longer SSRT values. The data confirmed this hypothesis, as evidenced by longer SSRT values indicating reduced inhibitory performance in older adults relative to younger adults. Furthermore, the fact that older and younger adults performed similarly on Go reaction time, Go accuracy, and Stop accuracy suggests that the observed differences stem specifically from impairments in the stopping mechanism, rather than a broad decline in cognitive function. A substantial body of evidence supports the

finding that inhibitory control processes decline with age, specifically through the deterioration of the fronto-subthalamic network responsible for response suppression (Aron & Poldrack, 2006; Williams et al., 1999). The absence of a significant Emotion \times Age Group interaction for SSRT is also meaningful. According to Socioemotional Selectivity Theory (SST), aging individuals shift their motivational focus from gathering information to regulating emotions, thereby maximizing the meaning of their remaining time (Carstensen, 1991; Carstensen et al., 1999). Consequently, older adults are believed to exhibit greater efficiency in emotional regulation, implying that both younger and older participants in the current study may leverage these abilities to inhibit responses at the threshold of negatively conditioned trials, thereby mitigating potential harm., these effects are generally seen only when study participants can voluntarily direct their attention to emotional stimuli.

The third hypothesis, predicting that individuals with more emotion regulation challenges would demonstrate weaker inhibitory control on the Stop Signal Task, was likewise confirmed. Among individuals who struggled more with recognizing, accepting, and regulating their emotions, higher DERS scores were associated with lower stopping accuracy. This result implies that emotion-regulation processes operating outside conscious awareness may impose a subtle but persistent demand on the executive resources required for response suppression.

Numerous emotion regulation models (e. g., Ochsner & Gross, 2005; Etkin, Egner, & Kalisch, 2015) suggest that diverse regulatory strategies rely on the same prefrontal systems used for

other executive functions, such as stop-signal control. Consequently, people who struggle to regulate their emotions (reflected by elevated DERS scores) are likely to exhibit weak inhibitory control (indicated by reduced Stop Accuracy scores) because of a straightforward competition for cognitive resources. The observed negative relationship between SSRT and Stop Accuracy, alongside the positive associations between SSD and both SSRT and Stop Accuracy, aligns with the straightforward "horse-race" framework of the stop signal task (Logan & Cowan, 1984), thereby establishing a robust basis for our stopping metrics.

Overall, the findings establish that inhibitory control as an important cognitive mechanism is influenced by both the immediate emotional context and an individual's capacity for emotional regulation. The specificity of emotional effects to stopping variables as opposed to response execution in general, suggests a theoretically distinct role of the inhibitory system at the interface of affective and cognitive processing. This is in line with neurobiological models identifying the right inferior frontal cortex and subthalamic nucleus as regions where motivational and inhibitory signals converge (Aron, 2011). The directionality of valence effects, with negative emotional material yielding the clearest inhibitory advantage, further highlights the adaptive significance of the sensitivity of the stopping system to signals of threat in the environment. Inhibitory advantage yielded by negative emotional material, emphasizes the sensitivity of the stopping systems towards indicators of danger in the environment.

Chapter-6

Conclusion

This study investigated the relationship between emotional valence, age and inhibitory control along with exploring the relation of difficulties in emotional regulation with inhibitory control. The findings show a meaningful understanding of interaction of affective and cognitive processes in young and old adults. The results showed how emotional valence possesses directional influence on inhibitory control. Negative emotional contexts facilitated more stopping tendencies in comparison to positive and neutral conditions highlighting the executive system's vulnerability towards environmental threat. A clear age-related difference in inhibitory mechanisms was evident, with older adults demonstrating longer SSRTs than younger adults, however difference in emotional valence was not found suggesting the preservation of body's affective sensitivity even in older age. The association between difficulties in emotional regulation and lower stopping accuracy was also another important finding validating the aim of our research.

Many factors still limit the scope of this study. The moderate sample size reduced the sensitivity to nuanced interaction effects. The cross-sectional design did not permit inferential results about age related changes. A longitudinal approach combining neuroimaging with behavioural measures will clarify the relationship between difficulties in emotional regulation and inhibitory performance under various affective contexts.

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APPENDIX A NPI

Neuropsychiatric Inventory (NPI):

Behaviors	F	S	D	FxS
Delusions				
Hallucinations				
Agitation				
Depression				
Anxiety				
Euphoria				
Apathy				
Disinhibition				
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- produce 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 B
DEMOGRAPHICS FORM

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:





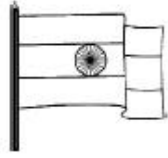







- How do you spend your day?

- Meditation/ Exercise:

FAMILY HISTORY:

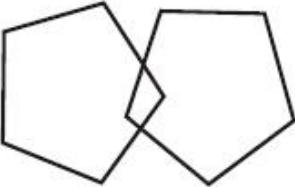
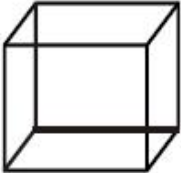
- Genetic disorder
- Dementia
- Neurological/ psychiatric disorder

LANGUAGE-Repitition	
<p>➤ Ask the subject to repeat: 'hippopotamus'; 'eccentricity'; 'unintelligible'; 'statistician' score 2 if all correct ; 1 if 3 correct; 0 if 2 or less.</p>	<p>[Score 0-2] <input type="text"/></p>
<p>➤ Ask the subject: 'Above, beyond and below'</p>	<p>[Score 0-1] <input type="text"/></p>
<p>➤ Ask the subject: 'No ifs , ands or buts '</p>	<p>[Score 0-1] <input type="text"/> <input type="checkbox"/></p>

LANGUAGE-Naming			
<p>➤ Ask the subject to name the following pictures:</p>	<p>[Score 0-2] pencil+ watch <input type="text"/> <input type="checkbox"/></p>		
<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	<p>[Score 0-10] <input type="text"/></p>
<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	
<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	
<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	<p>_____ <input type="text"/></p> 	

LANGUAGE-Comprehension	
<p>➤ Using the pictures above, ask the subject to:</p> <ul style="list-style-type: none"> • 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 	<p>[Score 0-4] <input type="text"/></p>

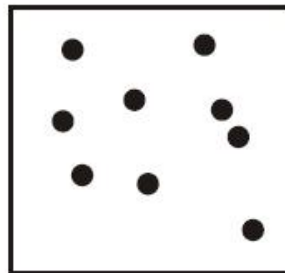
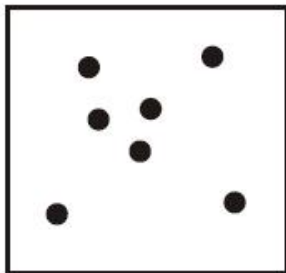
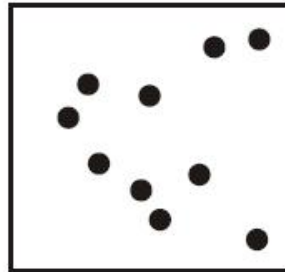
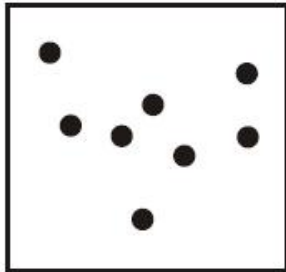
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L

LANGUAGE - Repetition		LANGUAGE
<p>➤ Ask the subject to repeat the following words : [score 1 only if all correct]</p> <p style="text-align: center;">sew pint soot dough height</p>	<p>[Score 0-1] <input type="text"/></p>	
VISUO SPATIAL ABILITIES		V I S U O S P A T I A L
<p>➤ Overlapping figure : Ask subject to copy this diagram :</p>	<p>[Score 0-1] <input type="text"/> <input type="checkbox"/></p>	
		
<p>➤ Ask the subject to copy this drawing (for scoring, see instructions guide)</p>	<p>[Score 0-2] <input type="text"/></p>	
		
<p>➤ 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]</p>	<p>[Score 0-5] <input type="text"/></p>	





PERCEPTUAL ABILITIES

➤ Ask the subject to count the dots without pointing them

[Score 0-4]



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L

PERCEPTUAL ABILITIES					V I S U O S P A T I A L
➤ Ask the subject to identify the figures			[Score 0-4]	<input type="text"/>	
					
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>		
RECALL					
➤ Ask "Now tell me what you remember of that name and address we were repeating at the beginning"					
Sunil Kumar Singh	_____			[Score 0-7]	
52, Station Road,	_____			<input type="text"/>	
Gandhinagar,	_____				
Allahabad	_____				
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		<input type="text"/>
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					
Attention & Orientation				/18	
Memory				/26	
Fluency				/14	
Language				/26	
Visuospatial				/16	

APPENDIX D

DERS SCALE

Difficulties in Emotion Regulation Scale (DERS)

Response categories:

- 1 Almost never (0-10%)
- 2 Sometimes (11-35%)
- 3 About half the time (36-65%)
- 4 Most of the time (66 – 90%)
- 5 Almost always (91-100%)

1. I am clear about my feelings.
2. I pay attention to how I feel.
3. I experience my emotions as overwhelming and out of control.
4. I have no idea how I am feeling.
5. I have difficulty making sense out of my feelings.
6. I am attentive to my feelings.
7. I know exactly how I am feeling.
8. I care about what I am feeling.
9. I am confused about how I feel.
10. When I'm upset, I acknowledge my emotions.
11. When I'm upset, I become angry with myself for feeling that way.
12. When I'm upset, I become embarrassed for feeling that way.
13. When I'm upset, I have difficulty getting work done.
14. When I'm upset, I become out of control.
15. When I'm upset, I believe that I will remain that way for a long time.
16. When I'm upset, I believe that I'll end up feeling very depressed.
17. When I'm upset, I believe that my feelings are valid and important.
18. When I'm upset, I have difficulty focusing on other things.
19. When I'm upset, I feel out of control..
20. When I'm upset, I can still get things done.
21. When I'm upset, I feel ashamed with myself for feeling that way.
22. When I'm upset, I know that I can find a way to eventually feel better.
23. When I'm upset, I feel like I am weak.
24. When I'm upset, I feel like I can remain in control of my behaviors.
25. When I'm upset, I feel guilty for feeling that way.
26. When I'm upset, I have difficulty concentrating.
27. When I'm upset, I have difficulty controlling my behaviors.
28. When I'm upset, I believe there is nothing I can do to make myself feel better.
29. When I'm upset, I become irritated with myself for feeling that way.
30. When I'm upset, I start to feel very bad about myself.
31. When I'm upset, I believe that wallowing in it is all I can do.
32. When I'm upset, I lose control over my behaviors.
33. When I'm upset, I have difficulty thinking about anything else.
34. When I'm upset, I take time to figure out what I'm really feeling.
35. When I'm upset, it takes me a long time to feel better.
36. When I'm upset, my emotions feel overwhelming.