The effect of discrete emotions on Cognitive Control

Project submitted for partial fulfillment of the degree of

MASTER OF ARTS IN PSYCHOLOGY

SUBMITTED BY: Khushi Agarwal (862102009)

UNDER THE SUPERVISION OF

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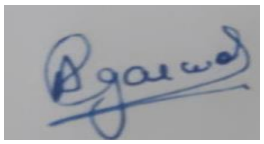
CERTIFICATE

This is to certify that the thesis entitled "The effect of discrete emotions on Cognitive control" being submitted in partial fulfillment of requirements for the award of the degree of Master of Arts in Clinical Psychology, submitted at the Thapar School of Liberal Arts and Sciences, Thapar Insititute of Engineering and Technology, Patiala is a Bonafide work carried out under the supervision of Dr. Richa Nigam, Assistant Professor, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala and that no piece of this venture has been submitted for the honor of some other degree.



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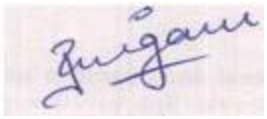

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CANDIDATE'S DECLARATION

I hereby declare that the work presented in this thesis entitled "The effect of discrete emotions over Cognitive Control**"** is submitted in partial fulfillment of requirements for the award of the degree of **Master of Arts in clinical psychology, submitted in the Thapar School of liberal arts and Sciences, Thapar Insititute of Engineering and Technology, Patiala** is an authentic record of my work carried out under the supervision and guidance of Dr. Richa Nigam, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala, and referred other researchers 'work which is duly listed in the reference section.

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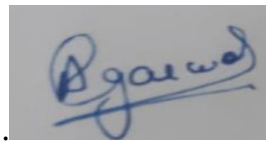
or any other university  .

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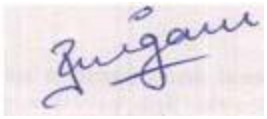

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Abstract

The Discrete emotion theory states that specific emotions are biologically determined and universal irrespective of ethnic and cultural differences. Each of these emotions should have a typical influence on our cognition. The current study is an attempt to study this theory by undertaking two discrete emotions, each from positive and negative valences and explore their variable influence (if any) on cognitive control using the emotional face–word Stroop task. Between the two tasks for each of the participants in the current study observed larger stroop effect among participants for face detection in comparison to word detection stroop task. However, the overall stroop effect was comparable across the four emotions within each task. The study was unable to find a variable effects of discrete emotional words on cognitive control in a face-word stroop task. The study implicates addition in terms of the use of discrete emotional face stimulus in combination with discrete emotional words to examine discrete emotion hypothesis.

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CHAPTER 1

INTRODUCTION

A key aspect of the human experience is emotion. They have a significant impact on our daily lives, affecting our attitudes, actions, and social relationships. Although there are differences across people and cultures in the strength and frequency of emotional experiences", the fundamental emotions are believed to be universal to all people. Keeping these views in mind, the Discrete Emotion theory offers a framework for understanding each of these emotions, which is crucial for comprehending human behaviour. According to the discrete emotion hypothesis, emotions are innate, universal, and distinct psychological states that have a biological basis and are unique from one another (Ekman, 1992). According to this hypothesis discrete emotions entail distinct patterns of physiological arousal, expressive behaviours, and cognitive evaluations in addition to feelings. This demonstrates that emotions are not learnt; rather, they are predetermined by genetics. According to this hypothesis, people are born with a core set of feelings that are shared across all cultures and languages, including anger, fear, happiness, sadness, disgust, and surprise. Discrete emotion theory further states that emotions have adaptive purposes that enable people to react swiftly and effectively to significant environmental conditions and occurrences. For instance, anger can spur people to confront risks and make their concerns known while fear might assist people avoid potential dangers(Frijda, 1986). Similar to happiness, sorrow can encourage social connection and inspire sympathy from others through difficult times (Lazarus & Lazarus, 1994). These triggers are frequently connected to a person's expectations, past experiences, and cognitive assessments of the environment (Lazarus 1991). The theory hence, emphasizes the significance

of expressive behaviors in emotion in addition to the physiological and cognitive aspects of emotions. Our emotional states and intentions are communicated to others through emotional expressions like facial emotions, body language, and vocalizations. These expressive behaviors are crucial for social engagement and communication and are thought to be universal throughout cultures. In general, the discrete emotion theory offers a thorough and cogent framework for comprehending the makeup and purpose of emotions. This idea emphasizes how emotions are fundamentally biological in origin and how significant they are to human experience and behavior. Discrete Emotion theory presents a comprehensive and complex understanding of this essential part of human experience by giving a thorough account of the physiological, cognitive, and behavioural components of emotions. Unfortunately, most of the research on emotion evades the significance of discrete emotions to evaluate their unique influence and the current study aims to explore the same in the context of cognitive control.

1.1 Stroop Effect

Stroop is an extensively used paradigm to explore cognitive control which pertains to the ability to inhibit interferences from certain aspects of a stimulus that might be irrelevant for task processing. A typical stroop task comprises of a participant identifying the colour of a word that is printed in a different colour than the word itself, which exhibits a delay in reaction time typically known as the Stroop Effect (Stroop,1935). For example, if a given word "green" was printed in red ink, for example, participants in a Stroop task would be required to name the colour of the ink (which is red in this case) rather than the word itself which is the cause of interference. In the Stroop task, the automatic processing of the word itself gets in the way of the conscious processing of the ink colour, which slows down reaction times and increases error rates.

The Stroop Effect is frequently employed in psychological studies as a gauge of executive function and cognitive control. It is thought that a key element of cognitive control is the capacity to suppress automatic processing and pay attention to information that is task-relevant.

Research studies have delved into the relationship between the Stroop task and emotion, uncovering intriguing findings. These studies have demonstrated that emotional stimuli or emotional states can impact performance on the Stroop task, highlighting the interplay between emotion and cognitive processes. Williams, Mathews, and MacLeod (1996) discuss the application of the emotional Stroop task in psychopathology research, demonstrating how emotional stimuli interfere with task performance and highlighting its relevance to cognitive biases in psychological disorders. McKenna and Sharma (2004) emphasize the utility of the emotional Stroop task in clinical research, particularly for investigating intrusive cognitions in mental health disorders. They showcase how emotional stimuli related to specific disorders elicit interference effects, shedding light on cognitive biases and intrusive thoughts. Koster, Crombez, Verschuere, and De Houwer (2004) focus on attentional biases toward threatening stimuli using a modified version of the Stroop task, the dot probe paradigm. Their study reveals the assessment of attentional biases and the role of selective attention to threat, contributing to our understanding of anxiety disorders. These studies collectively highlight the adaptability of the Stroop task for studying emotional processing, cognitive biases, and psychopathology, providing valuable insights into the interplay between emotion and cognition. Cognitive Control needs to be explored in the context of discrete emotions.

1.2 Anxiety

Feelings of dread, worry, and unease are characteristics of the typical emotional state of anxiety. State anxiety and trait anxiety are the two main classifications of anxiety in psychology.

State anxiety is a brief, transient form of anxiety that is frequently felt in response to a particular event or circumstance (Spielberger, Gorsuch, & Lushene, 1970). For example, before an exam, a speech in front of an audience, or a job interview, for instance, a person could have state anxiety. Trait anxiety, on the other hand, is a permanent propensity to feel anxious in a wide range of circumstances and experiences (Dugas, Gosselin, & Ladouceur, 2001). Brosschot, Gerin, and Thayer (2006) found high trait anxiety makes people more likely to worry, feel uneasy, and get tense even in unthreatening circumstances. Trait anxiety is frequently linked to many anxiety disorders, including generalized anxiety disorder, panic disorder, and social anxiety disorder. It is thought that trait anxiety has both genetic and environmental components. Though conceptually separate from one another, state anxiety and trait anxiety are linked. High trait anxiety levels may make people more prone to developing state anxiety in response to stressful situations. On the other hand, people who experience state anxiety regularly may eventually become more vulnerable to developing trait anxiety (Robinson & Alloy, 2003; Davey, Tallis, & Capuzzo, 1996). The current study extends its views on exploring if there is an influence of an individual's state-trait anxiety on their overall cognitive control and whether its variant for each discrete emotion.

CHAPTER 2

Review of literature

Discrete Emotion theory proposes that emotions are innate, universal, and discrete psychological states that are biologically based and distinct from one another. Ekman and Friesen (1971) conducted a series of cross-cultural studies on emotional expression and recognition, demonstrating that facial expressions of emotions such as anger, fear, happiness, sadness, and surprise are universally recognized and displayed across different cultures. Similarly, studies on emotion induction have shown that discrete emotions are associated with unique patterns of physiological arousal, expressive behavior, and cognitive appraisals (Levenson, Ekman, & Friesen, 1990; Scherer, 2005). Dolcos, F., & McCarthy, G. (2006) investigates the neural mechanisms underlying cognitive interference caused by emotional distraction. It highlights the complex interactions between emotions and cognition, shedding light on how emotional stimuli can interfere with cognitive processes.

2.1 Discrete Emotion Theory and Cognitive Control

Studies on the Stroop task have demonstrated that it is a robust and reliable measure of cognitive control and executive function (MacLeod, 1991). The Stroop Effect is a cognitive phenomenon that occurs when individuals are asked to name the color of a word that is printed in a different color than the word itself. The Stroop task has also been used to investigate various clinical and neuropsychological disorders, such as ADHD and schizophrenia, which are associated with deficits in cognitive control (Bora, Yucel, & Pantelis, 2009; Nigg, 2006).

Several studies have explored the relationship between Discrete Emotion theory and the Stroop Effect. A study by Murphy, O'Leary, and Cooney (1996) found that emotional words have a stronger Stroop effect than neutral words, suggesting that emotional processing interferes more strongly with controlled processing. Similarly, a study by Algom, Chajut, and Lev (2004) demonstrated that the Stroop Effect can be influenced by the emotional valence of the stimuli, with negative stimuli leading to greater interference than positive stimuli.

Overall, as per the literature Discrete Emotions and the Stroop Effect should be associated with unique influences from each discrete emotion in each of the two valence. The complex interplay between emotion and cognition in human behavior and experience should further be modulated by discrete emotions. Further research on the relationship between these two phenomena may lead to a deeper understanding of the mechanisms underlying emotional processing and cognitive control.

2.2 Face (emotion) versus word Detection in the context of stroop task

Detection of facial emotion in a face-word stroop task are cognitive tasks that are used to assess an individual's ability to recognize and differentiate between different emotional expressions while inhibiting the irrelevant emotional word reading. Discrete Emotion theory proposes that emotions are innate, universal, and distinct psychological states that are biologically based and can be characterized by specific patterns of physiological arousal, expressive behavior, and cognitive appraisal. MacNamara, A., Foti, D., & Hajcak, G. (2009) has explored the relationship between cognitive control and emotion while using face detection in a face-word stroop task when compared across the two valences, that is positive versus negative, providing insights into the cognitive processes involved in emotional perception and recognition. Other studies have

investigated the neural mechanisms underlying face detection in the context of emotional stroop task.

A another study by Schupp et al. (2004) used event-related potentials (ERPs) to investigate the temporal dynamics of emotional processing in a face-word stroop task. The study found that emotional expressions elicited specific ERP components, such as the P100 and N170, that were associated with attentional processing and perceptual analysis. Overall, the literature suggests that face detection tasks in the context of stroop are valuable tools for studying emotional perception and recognition, and that Discrete Emotion theory provides a useful framework for understanding the underlying cognitive and neural mechanisms involved in emotional processing across a spectrum of unique emotions within the two valence as well that are positive and negative.

There have been similar attempts to look at the effect of words if they become the target in a face-word stroop task. Interestingly, studies have found that the attentional biases observed in the general context of word and face detection tasks differ in their temporal dynamics. The attentional bias for emotional words is thought to occur at an early, automatic processing stage, whereas the attentional bias for emotional faces is thought to occur at a later, more controlled processing stage (Schupp et al., 2006; Vuilleumier, 2005). Further research has investigated the neural mechanisms underlying attentional biases towards emotional stimuli in the word detection task and the face detection task. For instance, neuroimaging studies have found that emotional words elicit greater activity in brain regions associated with emotional processing, such as the amygdala, than neutral words (Hamann, 2001; Dolcos et al., 2004). Similarly, emotional faces elicit greater activity in brain regions involved in face processing and emotion recognition, such as the fusiform gyrus and the ventral striatum (Sabatinelli et al., 2011; Sprengelmeyer et al., 2003). Cognitive control task

for both word and face detection using a stroop paradigm has already shown larger stroop effect observed for face as compared to word as target (Pessoa & Japee, 2018). Given these evidences, a large gap exists to explore influence of discrete emotions over cognitive control. In particular, what needs to be explored in both these circumstances is the possibility of modulation in stroop effect as a function of discrete emotions within each valence.

2.5 Cognitive Control and anxiety

The relationship between attentional biases and emotional stimuli in the word detection task and the face detection task has been found to be influenced by individual differences, such as personality traits and clinical conditions. For example, a study by Fox et al. (2001) found that individuals with high levels of trait anxiety showed a greater attentional bias towards threatening words in the word detection task. Similarly, studies have found that individuals with clinical anxiety or depression show greater attentional biases towards negative faces in the face detection task (Mogg & Bradley, 1999; Koster et al., 2004). Moreover, some studies have explored the effects of emotional context on attentional biases in the word detection task and the face detection task. For instance, a study by Hansen and Hansen (1988) found that the anger superiority effect (i.e., the faster detection of angry faces in a crowd of neutral faces) was enhanced when the participants were primed with an angry context. Similarly, a study by Murphy et al. (1999) found that the attentional bias towards threat words in the word detection task was greater when the participants were primed with an anxious context. The Stroop task is a widely used measure of attentional control and has been frequently employed to investigate cognitive biases in anxiety. The task involves presenting words printed in colored ink, with the task being to name the ink

color while ignoring the word's semantic meaning. However, individuals with anxiety disorders often show an attentional bias towards threat-related words, which can interfere with their ability to disengage attention from negative stimuli (Williams et al., 1996). Studies using the Stroop task have consistently found that individuals with anxiety exhibit greater interference from threat-related words than non-anxious individuals (MacLeod and Mathews, 1988; Bradley et al., 1998; Bar-Haim et al., 2007). For example, in a study by Bar-Haim et al. (2007), individuals with social anxiety disorder showed longer response times when naming the color of threat-related words compared to neutral words. Similarly, a study by MacLeod and Mathews (1988) found that individuals with high levels of trait anxiety showed greater interference from threat-related words in the Stroop task. Further research has investigated the neural mechanisms underlying attentional biases in anxiety and the Stroop task. For instance, neuroimaging studies have found that threat-related words elicit greater activity in brain regions associated with emotional processing, such as the amygdala and the anterior cingulate cortex, in individuals with anxiety compared to non-anxious individuals (Etkin et al., 2004; Bishop et al., 2004). These findings suggest that individuals with anxiety may have a heightened sensitivity to threat-related stimuli, which can lead to attentional biases and interfere with cognitive control. Moreover, some studies have explored the effects of anxiety treatment on attentional biases in the Stroop task. For instance, cognitive-behavioral therapy (CBT) has been found to reduce attentional biases towards threat-related stimuli in individuals with anxiety disorders (Amir et al., 2009). Additionally, studies have found that pharmacological treatments, such as selective serotonin reuptake inhibitors (SSRIs), can also reduce attentional biases in the Stroop task (Mogg et al., 2004).

In summary, the Stroop task is a useful paradigm for investigating attentional biases in anxiety. Studies using this task have consistently found that individuals with anxiety exhibit greater

interference from threat-related words, and neuroimaging studies. It would be interesting to explore whether individual's state-trait anxiety shows any link to the modulations in cognitive control in the context of discrete emotions perspective.

CHAPTER-3
RESEARCH GAP, OBJECTIVES, RATIONALE AND HYPOTHESES

3.1 Research gap:

Discrete Emotion Theory states that a particular emotion can vary along multiple sub emotions each of which may have a unique function. As such each discrete emotion within a valence should have its unique influence upon overall cognition. Functional approaches traditionally have focused on the adaptive value of negative emotions mainly thereby influencing one's cognitive control. The present study involves comparing discrete emotions across two valence, positive (Happy and Joy) and negative (Sad and Sorrow) using a Face-word stroop task where the task is divided into two phases : face detection versus word detection which has not been explored earlier.

3.2 Objective

The objective of this research is to investigate the relationship between cognitive control and discrete emotions from a comprehensive perspective. In particular, the current study investigates whether each discrete emotion has a distinct influence on cognitive control. Further associations between state trait anxiety is explored with the modulating cognitive control as a fucntion of discrete emotions.

2.3 Hypotheses:

H_0 : There is no significant difference between the stroop effects of particular for both positive and negative valence discrete emotion.

H_2 : There will be no correlationbetween the emotional Stroop effect and state-trait anxiety across participants.

CHAPTER-4

METHODOLOGY

4.1 Sample

A sample of thirty student volunteers from Thapar University (mean age: 19.13 years; females = 15) with normal or corrected-to-normal vision participated in the experiment. Written informed consent was obtained from all participants

4.2 Design

The research followed a within subject design with Independent variable being discrete emotion and dependent variable was stroop effect.

4.5 Measures

Stimulus:

The stimuli were emotional faces with happy or sad expressions with an emotional valence word (happy , joy, sorrow or sad) written over the face in red color . The faces were selected from an Indian emotional faces database (Grewal, Kar, & Kumar, 2012)

State and Trait Anxiety Inventory :

The State and trait anxiety Inventory was developed by Charles Spielberger, R.L. Gorsuch, and R.E. Lushene (1970). The scale is used to measure anxiety in a participant. The scale has a total of 40 questions. These 40 questions are subdivided into two forms. The first 20 questions form the

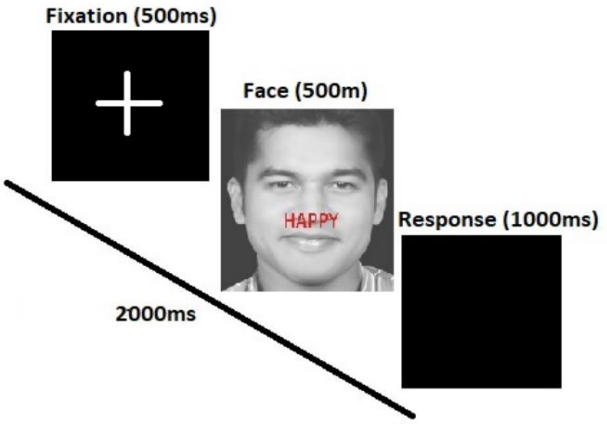
"Y-1" scale, while the last 20 or questions from 20-40 form the "Y-2" scale. It's a 4-point Likert scale. The "Y-1" scale measures your state anxiety, while the "Y-2" scale measures trait anxiety. The testee has to rate the question of the "Y-1" scale among 1-Not at all,2 - Somewhat 3-Moderately so, and 4- Very much so. For the "Y-2" inventory, the test takers had to choose among 1-Almost never 2-Sometimes 3-often 4-Almost always. The scoring was done according to the manual provided for the same. At last, the collected raw scores were converted to percentile scores from the manual which was used for the analysis.

4.7 Procedure:

The subjects were called into the laboratory and made to sit comfortably. A rapport was established with the participant following which they filled up the consent form regarding their participation. After this they were asked to fill state-trait anxiety inventory (STAI) which was debriefed to be 40 statement questionnaire which they have to read and respond based on their current response (part of state anxiety) and general responses (part of trait anxiety) to the situations described in the form. After the completion of STAI form they were briefed about the experiment which was in two phases. The participants were asked instructed to see the experiment and respond to face images (either positive or negative) that would appear one at a time with an emotional word written on it (either happy, sad, joy or Sorrow) followed by a plus sign. Each trial began with a fixation cross in the middle of the screen for 500 milliseconds, followed by the emotional face-word stimulus for 500 milliseconds with a response window of 1000ms (Fig.1). In the first phase, they were asked to detect the emotion of the face and ignore the word written on it using a face-word stroop task. In the second phase they were instructed to detect the emotion of the word and ignore the facial expression using a face-word stroop task. The participants recorded their

responses by pressing “z” key for positive emotion and “/” key for negative emotion which was counterbalanced throughout the course of the experiment. The participant were provided with breaks at appropriate interval which they could end by pressing the “space key” of the keyboard. The stroop task was arranged in each phase by having block of Happy-sad (congruent-incongruent) face-word images appear first followed by block of joy-sorrow (congruent-incongruent) face-word images which was also counterbalanced across participants. A total of 360 trials were presented with a break between the two blocks in each phase. Each phase roughly took 10 minutes to finish.

Fig 1: Trail structure



4.6 Task 1

. The participants were asked to respond on the affect on the face. Participants reacted by pushing the index finger on the "z" key for a positive facial expression and “/” key for the negative facial expression. The experiment was designed in two blocks to study the effect valence word. One block had Happy and sad on the stimulus while the other block had joy and sorrow written on them . A total of 360 trials were presented with a break between the two blocks . The experiment was

counterbalanced by randomly assigning the presentation of the blocks .For eg for some people block one was with the word happy and sad while for others it was reversed .

Task 2

Each trial began with a fixation presented by a ‘cross’ in the middle of the screen for 500 milliseconds, followed by the emotive face-word stimulus for 500 milliseconds with a response window of 1000ms (Fig.1) . The participants were asked to respond on the word written on the face. Participants reacted by pushing the index finger on the "z" key for a the word “happy” and “m” key for the word “sad” written across the emotive face . The experiment was designed in two blocks to study word detection. One block had Happy and sad on the stimulus while the other block had joy and sorrow written on them . A total of 480 trials were presented with a break between the two blocks . The experiment was counterbalanced by randomly assigning the presentation of the blocks .For eg for some people block one was with the word happy and sad while for others it was reversed.

The data analysis was done using Statistical Package for Social Science (SPSS-21.0). The descriptive statistics (mean and stand deviation), and Anova were computed to describe the results. Microsoft Excel was used to analyze Stroop effect for each participant.

Chapter-5

RESULTS

The mean and standard deviation was computed for all the variables. The discrete emotion was taken as the independent variable. Dependent variable was the stroop effect.

Table 1: Descriptive Statistics

	N	Mean	Std. Deviation
Sorrow word	30	1.7169	37.54268
Joy word	30	-3.7235	32.06723
Happy word	30	-16.4775	44.04741
Sad word	30	-.2505	43.18111
Sorrow face	30	44.2090	36.59673
Joy face	30	32.1921	44.86313
Happy face	30	27.4315	47.61077
Sad face	30	33.6196	51.80290
State	30	60.1000	27.17168
Trait	30	80.6000	18.51300

Table no 1: Shows descriptive statistics of participants for discrete emotion words and their Stroop effect for both tasks.

Table 4: Showing ANOVA for face and word detection task

	Sum of Squares	df	F	Sig.
Sorrow	104956.721	59	19.961	.000
Joy	107538.223	59	12.725	.001
Happy	150921.882	59	13.749	.000
Sad	149104.017	59	7.567	.008

This table shows Three way ANOVA for the face detection task and word detection task which

comprised of 2 emotions (Positive; negative) X 2 congruence (Congruent; Incongruent) X 4 words (: happy, joy, sad, sorrow). The repeated measures ANOVA found the main Stroop effect for all the words within the two tasks each of which is listed henceforth: Sorrow: $F(59) = 19.961$, $p < 0.000$; Joy: $F(59)= 12.725$, $p<0.000$; happy $F(59)= 13.749$, $p<0.000$; Sad showed a significant difference at $F(59)= 7.567$,p = 0.008

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Task type	emotion	congrence	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Task type	Linear			15638237.807	1	15638237.807	173.557	.000	.857	173.557	1.000
Error(task type)	Linear			2613031.168	29	90104.523					
emotion		Linear		10822.255	1	10822.255	.471	.498	.016	.471	.102
		Quadratic		1325.718	1	1325.718	.078	.782	.003	.078	.058
		Cubic		58.493	1	58.493	.007	.932	.000	.007	.051
Error(emotion)		Linear		666961.284	29	22998.665					
		Quadratic		490820.694	29	16924.852					
		Cubic		226897.016	29	7824.035					
congrency			Linear	28834.085	1	28834.085	33.027	.000	.532	33.027	1.000
Error(congrency)			Linear	25318.691	29	873.058					
tasktype * emotion	Linear	Linear		883.653	1	883.653	.036	.851	.001	.036	.054
		Quadratic		3498.913	1	3498.913	.185	.670	.006	.185	.070

		Cubic		873.513	1	873.513	.133	.718	.005	.133	.064
Error(tasktype*emotion)	Linear	Linear		709484.893	29	24464.996					
		Quadratic		547643.847	29	18884.271					
		Cubic		190799.961	29	6579.309					
Task type * congrence	Linear		Linear	43355.907	1	43355.907	41.596	.000	.589	41.596	1.000
Error(task type*congrence)	Linear		Linear	30227.129	29	1042.315					
emotion * congrence		Linear	Linear	650.402	1	650.402	.980	.330	.033	.980	.160
		Quadratic	Linear	3629.369	1	3629.369	2.758	.108	.087	2.758	.362
		Cubic	Linear	808.954	1	808.954	.994	.327	.033	.994	.161
Error(emotion*congrence)		Linear	Linear	19251.606	29	663.848					
		Quadratic	Linear	38161.941	29	1315.929					
		Cubic	Linear	23591.044	29	813.484					
Task type * emotion * congrence	Linear	Linear	Linear	398.018	1	398.018	.470	.498	.016	.470	.102
		Quadratic	Linear	143.678	1	143.678	.120	.731	.004	.120	.063
		Cubic	Linear	474.156	1	474.156	.819	.373	.027	.819	.141
Error(task type*emotion*congrence)	Linear	Linear	Linear	24565.624	29	847.090					
		Quadratic	Linear	34707.110	29	1196.797					
		Cubic	Linear	16779.277	29	578.596					

a. Computed using alpha = .05

Table 2: Shows Anova table for Task Type, emotion and congruence

The main effect of task type was significant, $F(58) = 173.557$, $p < .001$, $\eta_p^2 = .857$.

The main effect of emotion was not significant, $F(58) = .471$, $p = .498$, $\eta_p^2 = .016$.

The main effect of congruence was significant, $F(58) = 33.027$, $p < .001$, $\eta_p^2 = .532$.

The two way interaction between task type and emotion was not significant, $F(58) = .036$, $p = .851$, $\eta_p^2 = .001$.

The two way interaction between task type and congruence was significant, $F(58) = 41.596$, $p < .001$, $\eta_p^2 = .589$

The two way interaction between emotion and congruence was not significant, $F(58) = .980$, $p = .330$, $\eta_p^2 = .033$.

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	69488859.354	1	69488859.354	866.614	.000	.968	866.614	1.000
Error	2325344.230	29	80184.284					

a. Computed using alpha = .05

The three way interaction between task type, emotion and congruency was not significant, $F(58) = .470$, $p = .498$, $\eta_p^2 = .016$.

In table3, tests of within –subject's contrasts: the sum of squares for the intercept came out to be 69488859.354 whereas the df value came out to be 1. The mean square came out to be 69488859.354.The partial eta squared came out to be 0.968 and observed power is 1.000.

Table 2: Showing paired t-test for face detection task

	Mean	t	df	Sig. (2-tailed)
Happy - Sad	-6.18807	-.496	29	.624
Joy - Happy	4.76064	.575	29	.570
Sorrow - Sad	10.58940	1.044	29	.305
Sorrow - Joy	12.01683	1.240	29	.225
Traitanx - Stateanx	20.50000	5.488	29	.000

The table above shows the values for paired t-tests for the happy versus sad Stroop effect, happy versus joy Stroop, sad versus sorrow Stroop, and joy versus sorrow Stroop.

The results show no significant difference between happy stroop and sad Stroop, $t(29)$ -.496, p = 0.624. No significance difference was found between joy stroop and happy stroop, $t(29)$ 0.575, p = 0.570. No significance difference was found between sorrow stroop and sad Stroop as well as between sorrow stroop and joy Stroop, $t(29)$ 1.044, p = 0.305 and $t(29)$ 1.240 , p = 0.225, respectively.

Table 3: Showing paired T-test for word detection task

	Mean	t	df	Sig. (2-tailed)
Happy - Sad	-16.22706	-1.305	29	.202
Joy - Happy	12.75403	1.211	29	.236
Sorrow - Sad	2.13292	.257	29	.799
Sorrow - Joy	5.60595	.627	29	.536

The table above shows the values of paired t-test for the happy versus sad Stroop effect, happy versus joy Stroop, sad versus sorrow Stroop, and joy versus sorrow Stroop. The values show no significant difference between happy and sad Stroop $t(29)$ -1.305, p=0.202. No significance was found for the Stroop of joy and happy $t(29)$ 1.211, p=0.236. The same was for sorrow and sad Stroop and sorrow and joy Stroop,$t(29)$0.257;p=0.799 and $t(29)$0.627;p=0.536, respectively.

3. 4 (Face: Happy, Sad, Joy, Sorrow) X 4 (Word: Happy, Sad, Joy, Sorrow) X 2 (Congruence: Congruent, Incongruent) x Emotions (Positive, Negative) ANOVA was conducted

Correlations

		Sorrow F	Joy F	Happy F	Sad F	Sorrow W	Joy W	Happy W	Sad W	State	Trait
Sorrow F	Pearson Correlation	1	.163	-.014	.247	.370*	.202	-.028	.406*	-.154	-.048
	Sig. (2-tailed)		.389	.941	.188	.044	.283	.884	.026	.417	.801
	N	30	30	30	30	30	30	30	30	30	30

Joy F	Pearson Correlation	.163	1	.520**	-.106	.195	.177	-.131	.488**	-.024	-.283
	Sig. (2-tailed)	.389		.003	.579	.301	.350	.490	.006	.901	.129
	N	30	30	30	30	30	30	30	30	30	30
Happy F	Pearson Correlation	-.014	.520**	1	.055	.329	-.040	-.088	.357	-.072	-.051
	Sig. (2-tailed)	.941	.003		.771	.076	.833	.643	.053	.705	.788
	N	30	30	30	30	30	30	30	30	30	30
Sad F	Pearson Correlation	.247	-.106	.055	1	.016	-.097	.038	.387*	.181	-.039
	Sig. (2-tailed)	.188	.579	.771		.935	.612	.843	.035	.339	.838
	N	30	30	30	30	30	30	30	30	30	30
Sorrow W	Pearson Correlation	.370*	.195	.329	.016	1	-.051	-.100	.369*	-.179	.074
	Sig. (2-tailed)	.044	.301	.076	.935		.788	.600	.045	.343	.698
	N	30	30	30	30	30	30	30	30	30	30
Joy W	Pearson Correlation	.202	.177	-.040	-.097	-.051	1	-.128	.046	-.239	-.310
	Sig. (2-tailed)	.283	.350	.833	.612	.788		.502	.807	.202	.095
	N	30	30	30	30	30	30	30	30	30	30
Happy W	Pearson Correlation	-.028	-.131	-.088	.038	-.100	-.128	1	-.220	-.017	.045
	Sig. (2-tailed)	.884	.490	.643	.843	.600	.502		.243	.930	.815
	N	30	30	30	30	30	30	30	30	30	30
Sad W	Pearson Correlation	.406*	.488**	.357	.387*	.369*	.046	-.220	1	-.105	-.130
	Sig. (2-tailed)	.026	.006	.053	.035	.045	.807	.243		.579	.495
	N	30	30	30	30	30	30	30	30	30	30
State	Pearson Correlation	-.154	-.024	-.072	.181	-.179	-.239	-.017	-.105	1	.658**
	Sig. (2-tailed)	.417	.901	.705	.339	.343	.202	.930	.579		.000
	N	30	30	30	30	30	30	30	30	30	30
Trait	Pearson Correlation	-.048	-.283	-.051	-.039	.074	-.310	.045	-.130	.658**	1
	Sig. (2-tailed)	.801	.129	.788	.838	.698	.095	.815	.495	.000	
	N	30	30	30	30	30	30	30	30	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

In Table 6 the two emotions(sorrow, happy, joy, sad) and anxiety scale i.e. State and Trait anxiety inventory has been correlated and pearson correlation was done. No correlation was found between sorrow face detection task and state anxiety(r=0.154, p=0.417) or trait anxiety(r= -0.048, p=0.801). For, sorrow word detection task also no correlation was found with the state(r= -0.179, p=0.343) and trait anxiety(r=0.074, p=0.698). For joy face detection task and state(r= -0.024, p=0.901) and Trait anxity(r= -0.283, p=0.129) no correlation was found. While for joy word detection task also no correlation was found between state(r= -0.239, p=202.) and trait anxiety(r= -0.310, p=0.095). No correlation was found for happy face detection task and state anxiety(r= -0.072, p=0.705) or trait anxiety(r=-0.051, p=0.788). For, happy word detection task also no correlation was found with the state(r= -0.017, p=0.930) and trait anxiety(r=0.045, p=0.815). For sad face detection task and state(r=0.181, p=0.339) and Trait anxity(r=-0.039, p=0.838) no correlation was found. While for sad word detection task also no correlation was found between state(r= -0.105, p=0.579) and trait anxiety(r= -0.130, p=0.495).

CHAPTER-6

DISCUSSION

The present research study titled was designed to study discrete emotion theory. For the discrete emotion perspective, we took four happy, joy, sad and sorrow and compared their Stroop effects to see whether those stroop effects of the discrete words for the same valance would be different. Hypothesis 1 stated no significant difference between the Stroop effects and particular discrete emotional words. This hypothesis was accepted since we could not find any differences in the mean values of the four words. Some studies have found that the Stroop effect may not be universal and can be influenced by factors such as language and colour perception abilities. One such study used a modified version of the Stroop task, known as the "face Stroop task," and found that colour-blind participants did not exhibit a significant difference in reaction time between congruent and incongruent trials (Bub, Masson, & Lalonde, 2015). Another study by Durgunoglu and Akin (1979) found that Turkish-speaking participants did not exhibit a significant Stroop effect. This study used the Stroop task differently, where participants were presented with colour words in their native language and were asked to name the colour of the ink. The results showed no significant difference in reaction time between congruent and incongruent trials.

Hypothesis 2 stated that there would be no significant difference between the Stroop effect in the word and face recognition task was accepted as the mean value on comparing showed a significant difference in the Stroop effect of the two tasks. The results are consistent with other studies. A study by S. Ovaysikia & K. A Tahir (2011) found an increased emotional Stroop effect for identifying emotional faces was greater than word identification task in both young adults and older people.

From the current study we gather that stroop is a small effect and hence word as target detection in a face-word stroop task might have additional interference in terms of greater attention towards the same and hence dissolves the interference caused. According to a study, the faster processing

of reading words compared to reporting facial expressions suggests that over-learned behaviors have stronger stimulus-response associations than instinctive ones, which could also be explained by the difference between awareness and selective attention, thus standing in tune without results suggesting that the Stroop effect was greater for affect recognition task than the word identification one. The discrete emotions hence may be manipulated at the level of face stimulus itself in future to examine the influence of discrete emotions over control processes.

CHAPTER 7

CONCLUSION, IMPLICATIONS, LIMITATIONS, AND SCOPE FOR FUTURE RESEARCH

7.1 Conclusion

It was also proved that discrete emotion perspective was not found as the Stroop effects of happiness and joy and that of sad and sorrow did not show any significant difference.

7.2 Implication

1. The Stroop task, a classic cognitive paradigm, has been widely used to explore the effects of emotional interference on attention and cognitive control. While the traditional Stroop task focuses on color-word interference, researchers have recognized the importance of investigating the implications of the Stroop task with discrete emotions for word and face detection tasks. This review aims to examine the current literature on the implications of the Stroop task with discrete emotions, specifically focusing on the effects on word and face perception. By investigating emotional interference in these tasks, we can gain insights into attentional biases, cognitive processes, and neural mechanisms associated with emotion-word and emotion-face perception.
2. The Stroop task with discrete emotions can provide valuable insights into emotional interference in word detection tasks. Emotional stimuli, such as words with emotional content, can impact the speed and accuracy of word recognition. Previous research suggests that negative emotional words may result in slower response times and increased interference compared to neutral or positive emotional words. This interference effect reflects attentional biases towards emotionally salient information and the influence of emotional processing on word perception
3. Investigating the Stroop task with discrete emotions in face detection tasks allows us to explore the influence of emotional interference on face perception. Emotional stimuli, such

as facial expressions, can modulate face processing and recognition. Studies have shown that emotional faces, particularly those expressing fear or threat-related emotions, can capture attention and interfere with face detection processes. This interference effect suggests a bias towards attending to emotionally salient facial expressions and highlights the impact of emotional processing on face perception.

4. The implications of the Stroop task with discrete emotions for word and face detection tasks shed light on the underlying cognitive and neural mechanisms involved. Attentional biases towards emotionally salient stimuli, automatic processing of emotional content, and the interaction between emotion and cognitive control are key factors influencing performance in these tasks. Neuroimaging studies have revealed the involvement of brain regions such as the amygdala, prefrontal cortex, and fusiform face area in the processing of emotional interference during word and face perception
5. Understanding the implications of the Stroop task with discrete emotions for word and face detection tasks has important clinical and applied implications. In clinical settings, this knowledge can aid in the assessment and diagnosis of emotional disorders, as well as inform therapeutic interventions targeting attentional biases and emotion perception. Moreover, in applied domains such as advertising and marketing, the findings can guide the design of stimuli to evoke specific emotional responses and capture attention effectively.

7.3 Limitation

1. The emotional stimuli used in the Stroop task may not always reflect real-world emotional experiences. The task often relies on written words or static facial expressions, which may

not fully capture the dynamic and multifaceted nature of emotions as they are experienced in everyday life.

2. The findings from the Stroop task with discrete emotions may not generalize to all individuals or populations. Emotional processing and attentional biases can vary across cultures, age groups, and clinical populations. Therefore, precaution should be taken when extrapolating the results to broader contexts.
3. The Stroop task focuses primarily on attentional interference effects, which may not fully capture all aspects of emotion-word or emotion-face perception. Other cognitive processes, such as memory, judgment, and social cognition, are also involved in the perception of emotional stimuli and may have additional influences on performance.
4. Emotions are complex constructs that involve a range of dimensions, including valence (positive vs. negative) and arousal (low vs. high). The Stroop task with discrete emotions often focuses on a limited set of discrete emotions, such as joy, sadness, sorrow, and happiness, which may not fully capture the diversity and complexity of emotional experiences.
5. Variability in individual emotional experiences, cognitive abilities, and attentional control can influence the results of the Stroop task. Factors such as mood, personality traits, and previous experiences with emotional stimuli may contribute to individual differences in performance and attentional biases.
6. While neuroimaging studies have provided insights into the neural mechanisms underlying emotional interference, there is still much to be understood. The complex interplay of brain regions involved in emotion, attention, and perception requires further investigation to fully comprehend the underlying neural processes.

7. The Stroop task itself may introduce biases or confounding factors that could influence the results. Factors such as word salience, response biases, and task demands may impact performance and attentional biases, thereby affecting the interpretation of the findings.

7.4Scope for Future Research

1. Conducting longitudinal studies to examine the stability and changes in attentional biases and cognitive processes related to emotion-word and emotion-face perception over time. This would provide insights into the developmental trajectories of these processes and their potential implications for emotional well-being.
2. Investigating individual differences in attentional biases and cognitive processes within the context of emotion-word and emotion-face perception. Exploring factors such as personality traits, emotional intelligence, and cultural influences could help identify specific characteristics that modulate the effects of emotional interference on perception.
3. Examining the effectiveness of various emotion regulation strategies, such as cognitive reappraisal or mindfulness, in modulating attentional biases and improving cognitive control during the Stroop task with discrete emotions. This line of research could have implications for therapeutic interventions targeting attentional biases in individuals with emotional disorders.
4. Utilizing advanced neuroimaging techniques, like functional magnetic resonance imaging (fMRI) or electroencephalography (EEG), to investigate the neural correlates of emotional interference in word and face perception tasks. Understanding the underlying neural

mechanisms can provide a more comprehensive understanding of the brain regions and networks involved in emotion-cognition interactions.

5. Incorporating ecologically valid emotional stimuli, such as dynamic facial expressions or emotionally evocative scenes, to enhance the ecological validity of the Stroop task. This would allow for a more realistic representation of emotional experiences and their impact on perception.
6. Extending research on the implications of the Stroop task with discrete emotions to clinical populations, such as individuals with anxiety disorders or mood disorders. Investigating how attentional biases and cognitive processes manifest in these populations could aid in the development of targeted interventions and treatment strategies.
7. Employing multimodal approaches that combine behavioral measures, neuroimaging techniques, and physiological assessments (e.g., heart rate variability) to provide a comprehensive understanding of the interplay between emotion, cognition, and physiological responses during the Stroop task.

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Appendix A

Consent Form

In the present experiment, you will be given a short task. It is a computer-based task where color words will be shown on the screen with different ink colors randomly. The task requires you to detect the ink color of the word presented to you. You will give your response via a key press which I will specify.

The complete experiment will require approximately 10 minutes of your time. All information you provide will remain confidential and not be associated with your name.

The results of this experiment may be presented at professional meetings or published in the scientific literature. Your name will not be used in the reporting of the results. Only group data

will be used; however, your scores and name will be coded for a possible follow-up study or reanalysis of the data. All personal details will be kept confidential.

If you wish to withdraw from the experiment, you may do so at any time without penalty. Following the experiment, I will discuss the experiment's results with you if needed.

If you have any questions, please feel free to ask me or the advisor of the research, *Dr. Richa Nigam, TSLAS, Thapar Institute of Engineering and Technology, Patiala.*

Thank you for participating in the experiment.

I, _____ _____, understand that my participation in

(First Name) *(Last Name)*

this experiment is voluntary and I may refuse to participate or withdraw from the experiment at any point of time without penalty.

_____

Date

_____

Signature of Participant

_____

Signature of Experimenter

Appendix B

State Trait Anxiety Inventory (STAI)

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

Name_____ Date_____ S_____

Age_____ Gender (*Circle*) **M** **F** T_____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

SELF-EVALUATION QUESTIONNAIRE

STAI Form Y-2

Name_____ Date_____

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate you *generally* feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4