Influence of Affective State Priming on Effortful Decision Making: Image versus Words

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

MASTER OF ARTS IN PSYCHOLOGY

Submitted By

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UNDER THE SUPERVISION OF

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Certificate

This is to certify that the thesis entitled “Influence of Affective State Priming on Effortful Decision Making: Image versus Words” submitted by Ashman Marwaha (Enrolment No. 862302011) is being 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 Institute of Engineering and Technology, Patiala. This is a bonafide work carried out under the supervision of Dr. Richa Nigam, Professor at Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala and that no part of this thesis has been submitted for the award of any other degree.

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I, Ashman Marwaha (862202012), student of M.A. Psychology (2023-2025), declare that the work being presented in the thesis entitled, "Influence of Affective State Priming on Effortful Decision Making: Image versus Words" in partial fulfillment of the requirement for the award of Degree of Master of Arts in Psychology, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala, is an authentic record of my work carried out under the supervision and guidance of Dr. Richa Nigam, Professor, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala and refers other researcher's work which are duly listed in the reference section. The matter embodied in this thesis has not formed the basis for the award of any other degree of this or any other university.

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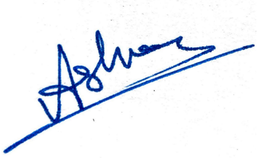

This is to certify that the above statement made by the student concerned is true and correct to the best of my knowledge.

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Acknowledgment

A note of gratitude and obligations to all those who have supported me through the entire process of writing this thesis. It has been a great honor and privilege to pursue my project in Psychology at Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala.

First and Foremost, I want to express my gratitude to my research supervisor, Dr. Richa Nigam (Assistant Professor at Thapar School of Liberal Arts and Sciences) for her valuable insights and consistent encouragement throughout my work. She has always made it a point to be available and being supportive of me even at the times of crises regarding the project or for my personal endeavors. I am grateful to her for her unwavering support and guidance, as well as for reminding me the importance of patience, hard work and resilience on numerous occasions. I would not have been able to finish this project without her. I would like to give a special acknowledgment to Dr. Jay Prakash Singh, Assistant Professor at Centre of Behavioral and Cognitive Sciences Allahabad, for his precious time and effort in helping with the data analysis.

I would also like to express my gratitude to Dr. Santha Kumari and Dr. Anuj Kumar Shukla for allowing me to use the laboratory resources for the data collection. I would like to express my gratitude to all the participants of this study, for taking their time and effort to perform the experiments. I would also like to thank my lab partners Khushi Rawat, Amita Kumari, Devika Nayyar, Sehajpreet Kaur, and Kriti Grover for helping me out in the project work, whether it be persuading the participants or equipping me with the software systems. I want to thank my seniors Avantika Garg, Roopal Bhardwaj and Palack deep Kaur Varaich for their support and guidance. I would like to thank the researchers for their contribution to the field and helping me navigate the depths of the human behavior. Finally, I would like to thank my family for their support throughout my college education and also for always giving me great encouragement. My project would be incomplete without their assistance.

Abstract

Understanding how affective states have an impact on effortful decision making is crucial for the advancement of cognitive and applied psychology. Affect states are known to shape attention, memory,and other executive functions, yet their impact specifically on the perceived effort and willingness to engage on challenging or difficult tasks remain under-explored. Previous research has established that positive and negative affect state modulate cognitive flexibility and risk-taking, there is limited knowledge regarding how different modalities of affect (visual vs semantic)influence effort-based decisions, particularly in young adults.is thesis aims to investigate the effects of positive affect and its arousal levels- induced using visual (images) and semantic (words) stimuli- on effortful decision making. The study seeks to determine how these affective states shape judgments of task difficulty and willingness to exert effort. A within-subjects experimental decision was employed where the participants, of age range 18-25 (mean age ≈ 22), were exposed to standardized image and word stimuli using an Effort Expenditure for Rewards Task. Their subjective ratings for valence and intensity along with their choice and effort exerted in the task were recorded and analyzed. The results reveal that affective states, particularly negative affect, significantly reduced the participants willingness to choose high effort/ high reward tasks, while positive affect showed more flexible decision making. Additionally, the modality of the stimulus (images vs words) independently influenced the risk propensity and task performance, with images showing more affective responses than words. These results suggest that both affect and the modality play a critical roles in shaping how individuals approach effortful decision making.

Keywords: Effortful Decision Making; Effort Expenditure Rewards Task; Risk Propensity; Affective State Priming; Affective Priming

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Chapter 1. Introduction

Decision making is a fundamental cognitive process that is influenced by various internal and external factors. It is classified under the dual processing model (Tversky & Kahneman, 1974) and proposed to be of two distinct types: a) Automatic or non-effortful decision making which refers to the rapid, low cost choices that are prone to biases; b) Effortful Decision making which is characterized by a deliberate, cost-benefit calculations of mental effort and also anticipated rewards that involves the use of cognitive control (Evans & Stanovich, 2013). Effortful and non effortful decision making are closely related to affect states. A recent study by Hewitt et al. (2025) shows that day-to-day fluctuations in motivation which is considered to be a positive affective state, positively influences effort-based decisions wherein individuals tend to perceive rewards as more valuable and are more willing to exert effort (Hewitt et al., 2025). In contrast, negative affect state like cognitive fatigue, that can accumulate during prolonged exertion in effort based tasks, may lead to an individuals preference towards non-effortful decision making because it provides automacity (Massar et al., 2018).

Among these factors is affective state, which refers to an individual's emotional condition at a given point of time (Schutter et al., 2023). Affect has gained a significant attention in terms of recent cognitive psychology and neuroscience researches (He & Wong, 2022; Byrne et al., 2022).. Affect is found to play a key role in modulating attention, memory and certain executive functioning (Phelps et al., 2014). Emotional states are not passive experiences but these actively shape how individuals perceive and adapt to their environments, particularly when dealing with situations involving effort expenditure, risks, or uncertainty of rewards .

Positive affect refers to the pleasant feelings that an individual experiences across a wide variety of different moods and emotions (van Steenbergen et al., 2021). Paul et al. (2021) proved that positive states of affect has an impact in enhancing cognitive flexibility, problem-solving, and motivation. In contrast, negative affect restricts attention and increases sensitivity to perceived threats or challenges, frequently resulting in the adoption of risk-averse or effort-conserving strategies (Lerner & Keltner, 2001). It has been extensively studied in relation to its effects on cognitive processes, including decision-making (Isen, 2001). Cristofaro (2019) proposed that decision making and affect are dynamically intertwined in the form of emotional states and cognitive evaluation of the physical and social environment. This suggests that affect is not just a factor that changes depending on the situation, but impacts cognitive processes in real time which in turn lead to changes in decision making (Cristofaro, 2019). A similar study by Clore et al. (2017) made use of mood induction and cognitive tasks like Remote Associates Test (RAT) and Flanker tests in order to test the impact of affect on cognitive processing and judgment. The study concluded that positive mood or affect enhanced the participants' performance on tasks by increasing their attention and creative or associative thinking abilities .

1.1 Decision Making as a cognitive process

Decision making is a process that chooses a preferred option or a course of actions from among a set of alternatives on the basis of given criteria or strategies (Wang et al., 2006). Decision making, like other executive processes, requires the synthesis of various information sources, including multi modal sensory inputs, autonomic and emotional responses, past associations, and future goals. Integrating inputs such as uncertainty, timing, cost-benefit, and risk is crucial for selecting appropriate actions (Fellows, 2004).

Various hypothesis formulated in order to study the phenomenon of decision making. On such hypothesis is Somatic marker hypothesis, proposed by *Antonio Damasio* in *1990s* which refers to the idea that decisions are influenced by the emotional value generated by various options (Damasio, 1996). This emotional mechanism directs the individual by producing emotional states that preemptively inform him of the potential outcomes of actions with uncertain results although some studies on affective and physiological measures have supported the hypothesis by showing affective cues can unconsciously influence risk assessment and decision making processes (Dolcos & Denkova, 2014).

1.2 Affect and Cognition:

Affect which refers to feelings/ states like emotions and moods that may vary in terms of their duration, intensity, specificity, pleasantness, and level of arousal. Emotions are relatively short lived with a known cause, mood on the other hand tends to be a prolonged state with no indicated starting point of formation (Ekman & Davidson, 1994). Emotions are considered to be a more complex construct applying aspects that are temporary while mood, if it exists for a more than average period of time can cause some neurological and psychological damage. Affect has been a center of many research topics over the period of time garnering much interest in the field of psychology are believed to play an important role in regulating cognition, behavior, and social interactions (Abrams et al., 2012)

1.2.1 Role of Affect Heuristics in decision making

Barrett and Russell (1998) proposed a model for affective states and believed that there are two major components of affect: Arousal and Valence (Barrett & Russell, 1998) where a) arousal is the degree to which an individual reacts when stimulated. For instance, Anger provokes a high degree of physiological reaction relative to lower states such as boredom, which does not elicit the same degree of physiological change, b) valence describes the positive or negative affective state induced by a stimulus. In the same continuum Cittadini et al., (2023) in their study "Affective state estimation based on Russell's model and physiological measurements showed real-time estimation of emotional valence and arousal using physiological signals (like skin conductance, heart rate and respiration) and machine learning, leading to the conclusions that participants' higher ratings in terms of their valence and intensity reflecting positive experience can demonstrate greater cognitive flexibility , and lower ratings reflecting negative states that might give rise to stress, anxiety, or irritation .

Few researches in the recent past have shown Affect to regulate the processes of decision making through mechanisms such as the *affect heuristic*, in which difficult decisions are simplified through use of emotional impressions rather than rational consideration (Finucane et al., 2000; Slovic et al., 2004). This affect heuristic explains how positive emotions towards an activity lead to underestimating its risks while overestimating its benefits, and vice versa for negative emotions (Finucane et al., 2000; Slovic et al., 2004). This dual-process framework highlights two systems of risk evaluation:

a) Analytic System: Deliberate and logical, relying on probability theory.
b) Experiential System: Intuitive and emotion-driven, leveraging past experiences (Slovic et al., 2004).

Positive affect diminishes effort perception for difficult tasks, and as a result adopting effort is encouraged, whereas negative affect increases effort perception, resulting in preference for low-effort options (Isen, 2001). Affect and decision making has been worked on extensively over the years. A latest study worked on affect state and risky decision making where they aimed to explore how emotional status, such as happiness and sadness, influence decision-making under risk. The results revealed that participants in the sad condition exhibited a higher probability for risk-seeking behaviour compared to those in the happy condition (Peng, 2024). Affect heuristics are vital drivers to modulate decision making process. In a comprehensive review titled "Cooperative versus competitive influences of emotion and cognition on decision making: A primer for psychiatry research.", Chick (2019) concluded using findings from experimental and clinical studies which demonstrate that a dynamic interplay of affect and cognition shapes choices leading to a cooperative and competitive influence on decision making (Chick,2019).

1.2.2 Affect and Decision Making

The findings of Byrne et al. (2022) clearly indicate that emotional states, particularly those with negative valence, significantly diminish individuals' inclination to engage in challenging, high-reward endeavors.the conducted EFeRT task and found out that

that negative affect increases the perceived effort cost, leading individuals to avoid challenging activities; furthermore, arousal, rather than valence alone, may drive the motivational mechanisms underlying effort-based decision-making (Byrne et al., 2022).

In a study carried out by Asutay and Västfjäll (2024), researchers explored how moment to moment affective states, particularly arousal and anxiety influence decision making under risks. They found out that the results reported that the subject's emotional state acted as real time signals to their choices as when the arousal level were high, participants tended to avoid risky options (Asutay & Västfjäll, 2024).

In a systematic review of 120 studies, Marques et al.(2024) highlighted how emotional regulation influences strategic decision-making in organization settings. They found out that collective emotional intelligence improves judgment, governance and reduces biases, with certain affect states like anger was found to be linked with defensive strategies and hope/rage affecting high stakes-decision making (Marques et., 2024).

1.3 Risk propensity

Risk propensity refers to an individual's perceived preference towards risks (Sitkin & Pablo, 1992). These are influenced by the perceived threats and personal bias when exposed to risks. These factors that are found to be the cause of these are gender, age, education background, income levels (Sjöberg, 2003), self-efficacy (Jani, 2011), confidence, locus of control and classical personality factors (Alexopoulos et al., 2009). It has found its application in the theoretical modeling of risk behavior and for practical insights into the motives underlying individual level choices about engaging in risky behavior.

1.3.1 Risk Propensity and Decision Making

Decision making has shown to be be influenced by an individual's risk taking tendencies. Guan et al. (2020) conducted an in-depth cognitive modeling analysis using self report measures (Risk propensity scale, DSRT,etc.) and behavioral decision making task (Balloon analogue Risk task, IGT, etc). The results show that cognitive models provided a refined evaluation of risks propensity rather than experimental measures as they corporate the influence of individual differences in risk attitudes.

Volz and Gigerenzer (2012) highlighted the difference between risk (assuming that the probabilities are known) and uncertainty (where the probabilities are unknown), emphasizing that cognitive processing in the two contexts are fundamentally different. They found out that in terms of risk, decision-making relies on a value-based thinking in which the individual uses the probabilities to draw informed conclusions whereas in the context of uncertainty, heuristic based thinking is adopted where the individual uses mental shortcuts that preexists in the brain.

1.3.2 Affect and Risk Propensity

Affect significantly shapes risk perception. The "risk-as-feelings" hypothesis posits that instinctive emotional responses often outweigh logical deliberation in risk evaluation. Positive emotions lead to underestimating risks and overestimating benefits, while negative emotions amplify perceived risks (Slovic et al., 2004). Empirical evidence demonstrates that mental imagery eliciting negative affect heightens risk perception through stress-induced evaluations (Traczyk & Zaleskiewicz, 2015).

A study on affect heuristics (Valence and Arousal) and risk perception tested whether the influence of heuristics is consistent across different risk elicitation methods. The results derived were positive and showed that the risk benefit correlation is stable across different elicitation methods and domains like social,sensation seeking, health and economic, along with influence of individual cognitive abilities. This implies that affect heuristics are strong across different contexts while individual differences in cognitive processing further enhances its magnitude (Skagerlund et al., 2020). Perception of risk as modulated by affect of various arousal and valence remains an unexplored facet and should be prioritized.

Chapter 2. Literature Review

2.1 Role of Affect in Effort Based Decision Making (EBDM)

Effort-based decision-making involves determining whether a specific outcome (typically a reward) justifies the mental or physical effort required to do in order to obtain it (Westbrook & Braver, 2015). In a a recent study, Renz et al (2022) characterized EBDM tasks as indicators of "the extent of effort an individual is prepared to invest for a specific reward: Participants select between a challenging and a simple method to execute a physically or cognitively taxing task across multiple trials." These paradigms rely on an *effort-cost computation* that weighs the individual effort necessary to attain a goal against potential rewards, facilitating the direct quantification of goal-directed behavior in controlled environments. This leads to the conclusion that while different EBDM tasks measure motivation they do not correlate with other self report measures leading to the idea that EBDM shows a different level of motivation.

In another study EBDM paradigm is used in a smartphone compatible gamified version of reward discount task. This study revealed that individuals were more inclined to select the more challenging option when the difference in effort exerted was less and the perceived rewards was great, thereby confirming the notion that decisions were influenced by the total value of reward and effort in accordance with reward-effort discounting (Hewitt et al., 2025). In other words, EBDM results from both an internal cost-benefit computation as well as the resulting motivational states. This way one may assume a direct modulation of task choices as a function of variation on affect in the context of EBDM tasks that is affect specifically alters these internal motivational states in terms of perceived reward value or willingness to exert effort.

Effortless or Automatic decision is characterized by rapid, low-effort cognitive operations that rely on mental shortcuts of heuristics rather extensive cognitive control (De Andreis, 2020). Kahneman and Tversky were first to introduce the concept of heuristics and biases in decision making and describe how people rely on limited numbers of heuristic principles, which reduce the complex task predicting value of reward or assess possibilities (Watson, 2011). Automatic decision making are efficient in routine or low stakes contexts, although it negates the ambiguity, risk, or significant consequences to the decisions (De Andreis, 2020).

Affect plays a central role in effortless decision making as well, as it acts as both a source as well as a modulator of cognitive processes (Asutay & Västfjäll, 2024). Recent computational models reveal that changes in affect can modulate decision making parameters on a moment-to-moment basis, suggesting a complex interplay between emotional dynamics and intuitive judgments (Rutledge et al.,2014). A recent neuroimaging study also shows that affective signals are integrated in the vetromedial prefrontal cortex, directly influencing valuation and choice behavior in real time (Viviani, 2013).

Despite the prevalence of Effortless decision making in everyday life due to it being rapid and less intensive, Effort based decision making is more valuable for advancing the understanding of adaptive behavior. By integrating affective states and effort expenditure, EBDM research offers a richer, more precise framework for understanding of behavioral decision making in regards of real-world, high stakes and uncertain environment (Audiffren et al., 2023).

So far EBDM has only been explored using image based affective stimuli (Katahira et al., 2011; Bryne et al., 2023). For instance, it has been found in the past how emotional pictures are remembered better in comparison to emotional words (Kensinger, 2009). Li et al (2022) in fact have found images producing stronger biases in valuation tasks as compared to words. As such, one needs to explore whether affective pictures versus words would have a differential influence in modulating internal motivational states in the context of EBDM tasks.

2.2 Research objectives

Previous research has confirmed that emotional states affect the perception of effort. For instance, people in a positive emotional state will perceive challenging tasks as less effortful and have a higher tendency to engage in them (Isen, 2001). Negative emotions, on the other hand, can enhance the perceived effort and therefore prefer low-effort alternatives.

The aim of this proposed research is to investigate the impact of Positive Affect, its arousal levels conveyed through visual stimuli (static images and words), on the decision-making processes. This research is driven by the assumption that emotional states play a significant impact on the choices as well as the level of judgments that can be made. It also aims to find difference in the visual and semantic processing of the brain leading to generating vivid mental imagery or language. In terms of decision making, the aim would be the impact of the affect state on judging the task difficulty and the willingness to perform as well as whether they are able to confidently complete the tasks.

The research can be beneficial to practical world as it poses as a integrative work both in the field of positive psychology as well as cognitive psychology. It can be advantages in marketing and advertising as the difference of visual or semantic stimuli can make the brand or product more appealing.

Chapter 3. Methodology

3.1 Participants and Experiment Design

Participants were selected on the basis of their being a criterion. The age range was selected to be 18 to 25. A pilot study was conducted using 50 trials on a sample of 25 participants in order to test the experiment and data output. Out of 25, only 14 were selected to due hardware limitation and data loss. For the main study, a sample of 62 participants was collected and only 60 were used owing to data loss. Informed consent was collected and questionnaires were filled prior to the testing.

The study follows a within-subjects design, hence the sample was introduced to both conditions of Pictures and Words.

3.2 Stimuli and Apparatus

3.2.1 Stimuli

125 Images from Open Affective Standardized Image Set (OASIS) database 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). A rating task was conducted prior to use of images for this experiment on affective dimension of Valance and Arousal. The task was conducted using E-Prime3 software where all the 125 images were part of the rating task. The images were rated on the basis of Valence and Arousal from 30 participants from which 60 images were selected which further divided into three equal parts on the basis of Valence (Positive, Negative and Neutral). The images are of the size 500x400 pixels which were stretched to full screen in the main experiment.

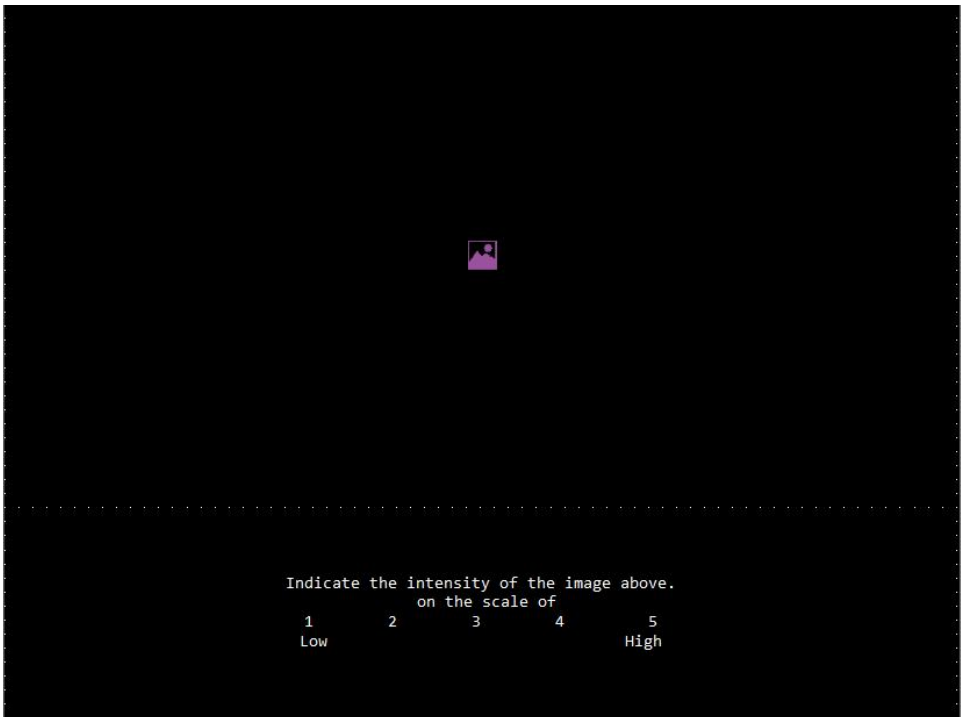

Figure 1: Illustration of Trial Structure for Image Rating task performed on E-prime 3.

3.2.2 Word Stimuli

Another rating task was done for the Word Stimuli. For that task, data set of 80 words, curated to of the length of 3-5 letters, was developed using online sources, dictionaries and thesauruses. The words were then rated on the basis of Valence and Arousal from another set of 30 participants using Microsoft Excel and WPS office suites. The ratings of 30 participants was then averaged and then sorted on the basis of highest levels. From this rating task a set of 60 words was selected which, similar to images, were divided into three equal parts on the basis of Valence (Positive, Negative and Neutral).

3.2.3 General Risk Propensity scale (GRiPS)

General Risk Propensity Scale was by developed by Zhang et al. (2018). the scale is a uni-dimensional, self report measure consisting of 8 questions on a 5 point likert scale. It aims to measure an individual's general propensity towards risks across various situations. The cronbach alpha reliability of the scale is found to be .90 and using test retest reliability r=.80.

3.3 Experiment structure and Procedure

The experiment follows a within subject approach as the participants were exposed to both the conditions of images and words. The participants were individually tested in an isolated room in the Behavioral and Experiment lab at TSLAS. They were seated 50 cm away from a 15.6-inch Laptop screen with a resolution of 1920×1080 and a refresh rate of 60Hz. The stimuli presentation and data recording were conducted using PsychoPy software for the main experiment.

3.3.1 EFeRT

The EFeRT paradigm was adopted to measure participants' willingness to exert effort for varying levels of rewards. This task is widely used in cognitive and affective neuroscience to examine motivational states under different emotional conditions. Participants were presented with a choice between a low-effort/low-reward task and a high-effort/high-reward task, following exposure to affective stimuli (image or word).

In this experiment, participants were well informed of the task choice in the instructions, *EASY TASK* and *HARD TASK*. For the *EASY TASK*, the participants were asked to press the Space-bar key 30 times in 7 seconds using the index finger of their dominant hand (depending on their dexterity). Whereas in the *HARD TASK*, the conditions were changed as the participants were asked to press the Space-bar key 100 times in 21 seconds using the pinky finger of their non-dominant hand.

In order to make the participants perform hard task and avoid bias towards low effort task, a condition was introduced that if the participants perform the *EASY TASK* repeatedly for 3 consecutive trials it would lead to immediate termination. This condition helped the participants to perform hard tasks as well and to avoid biases to low effort task.

3.3.2 Procedure

Participants were seated in a dark room in the lab. They were asked to fill the informed consent (Appendix-A) and the GRiPS questionnaire (Appendix-B). After these steps the instructions were given and queries were resolved beforehand.

The Experiment was built on PsychoPy-2024 2.3 builder. It consisted of 60 trials, divided into three equal parts for each Valence (Positive, negative and Neutral). A fixation cross was presented for 500ms followed by an Image or a Word Prime for 3000ms. After the priming, a subjective rating of Valence and Intensity was collected from the subject. The subject was then asked choose between doing an *EASY TASK* or a *HARD TASK* which they then had to perform. Followed by that, the next trial would begin (See Figure 2).

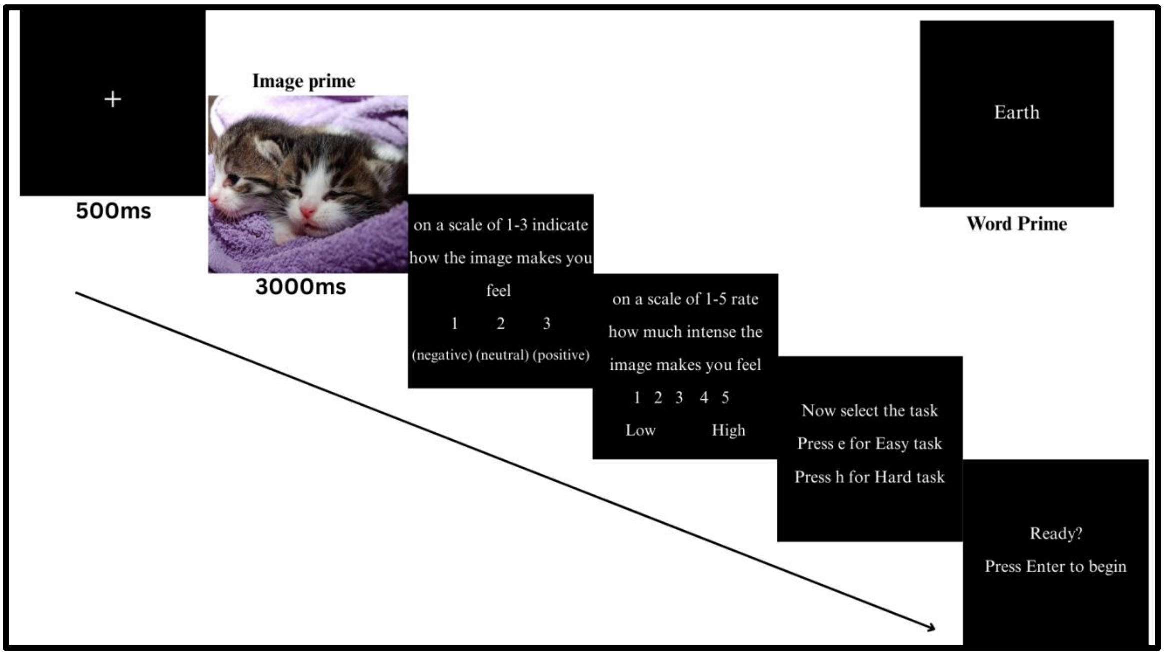

Figure 2: Illustration of Trial Structure for both Image and Word Prime.

3.3.3 Statistical Analysis

For the data analysis, the subjective valence and intensity ratings, choice of task, success in task and Risk Propensity scores were collected. The experiment consisted of 60 trials, and the aforementioned scores were collected for each trial from all the participants were analyzed using R 4.4.3 and RStudio 2025.05.0+496 where LMM models for each dependent variable was conducted.

Chapter 4. Results

4.1 Valence of the Stimuli :

A linear mixed effects model was fitted to examine the effects of task type (word vs. image) and stimulus type (HN, HP, N, LP, LN) on valence ratings. Valence as outcome variable, and task type, stimulus type, and their interaction as fixed effects. The model included random intercepts and slops for task type by participant.

Table 4.1.1: Formulas indicating random slopes for Valence ratings

Formulas
VALENCE ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)
VALENCE ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)
VALENCE ~ STIMULUS_TYPE * STIM + (1 | NAME)

A Type III ANOVA using Satterthwaite's method indicated significant main effect of task type: *F (1, 64.2) = 68.68, p < .001*. The results indicate that overall, valence was reported higher for image (Mean = 2.074) in comparison to words (Mean = 2.2186). A significant main effect of stimulus type was also observed, *F (4, 7072.0) = 1139.92, p < .001*.

Table 4.1.2: *Type III Analysis of Variance Table with Satterthwaite's method*

	Sum Sq	Mean Sq	NumDF	DenDF	F value	p value
STIMULUS_TYPE	25.41	25.41	1	64.2	68.6803	<.001
STIM	1687.12	421.78	4	7072.0	1139.9240	<.001
STIMULUS_TYPE* STIM	14.57	3.64	4	7072.0	9.8426	<.001

Post hoc comparisons (with STIM_HN as the reference level) showed that all stimulus types differed significantly from each other (all *p's* < .001), confirming the distinct emotional impact of each stimulus category. The two way interaction between task type and stimulus type was also observed to be significant, F (4, 7072.0) = 9.84, $p < .001$. These results suggest that both the type of task (WORD vs. IMAGE) and the type of stimulus significantly influenced valence ratings. Furthermore, the effect of stimulus type on valence ratings varied depending on the task.

Table 4.1.3: Post hoc comparisons of stimuli

Stimulus	Contrast	Estimates	SE	df	T.ratio	p.value
HN	IMAGE-WORD	-0.2883	0.0376	753	-7.674	<.0001
HP	IMAGE-WORD	-0.1433	0.0376	753	-3.815	0.0001
LN	IMAGE-WORD	-0.1450	0.0376	753	-3.859	0.0001
LP	IMAGE-WORD	-0.2150	0.0376	753	-5.722	<.0001
N	IMAGE-WORD	-0.0375	0.0282	251	-1.330	0.1848

Random effects due to participants indicated variability in baseline valence ratings (τ_{00} = 0.018, SD = 0.13) and in the effect of task type (τ_{11} = 0.011, SD = 0.10).

The negative correlation between intercept and slope (r = –.60) suggests that participants with higher overall valence ratings exhibited smaller effects of task type. The residual variance (σ^2 = 0.370, SD = 0.61) reflects meaningful within-participant variability not explained by the fixed effects.

4.2 Intensity of the Stimuli:

A linear mixed effects model (lme) was fitted to examine the effects of task type (word vs. image) and stimulus type (HN, HP, N, LP, LN) on the subjective intensity ratings. Intensity as outcome variable, and task type, stimulus type, and their interaction as fixed effects. The model included random intercepts and slops for task type by participant.

Table 4.2.1: Formulas indicating random slopes for Intensity ratings

Formulas
INTENSITY ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)
INTENSITY ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)
INTENSITY ~ STIMULUS_TYPE * STIM + (1 | NAME)

A Type III ANOVA using Satterthwaite's method revealed significant main effect of stimulus, F (4, 7072.0) = 159.82, p < .001, while the main effect of task type was not significant, F(1, 64.2) = 1.60, p = .211. A significant interaction between task type and stimulus type was observed, F (4, 7072.0) = 20.33, p < .001 The results indicate that overall intensity ratings did not differ as a function of task type, however, the effect of stimulus type on intensity ratings was modulated by the task.

Table 4.2.2: *Type III Analysis of Variance Table with Satterthwaite's method*

	Sum Sq	Mean Sq	NumDF	DenDF	F value	p value
STIMULUS_TYPE	1.72	1.718	1	60.7	1.5993	0.2108
STIM	686.71	171.677	4	7072.0	159.8221	<.001
STIMULUS_TYPE* STIM	87.35	21.838	4	7072.0	20.3297	<.001

Post hoc pairwise comparisons using estimated marginal means indicated that for some stimuli (HN: mean = 3.483 , LN: mean = 3.182), images were rated as more intense than words, while for others , words (HP: mean = 3.823 , LP: mean = 3.564) were rated as more intense than images.

Table 4.2.3: Post hoc comparisons of stimuli

Stimulus	Contrast	Estimates	SE	df	T.ratio	p.value
HN	IMAGE-WORD	0.182	0.0794	212	2.289	0.0231
HP	IMAGE-WORD	-0.362	0.0794	212	-4.557	<.0001
LN	IMAGE-WORD	0.233	0.0794	212	2.940	0.0036

LP	IMAGE-WORD	-0.265	0.0794	212	-3.339	0.0010
N	IMAGE-WORD	-0.155	0.0671	109	-2.308	0.0229

4.3 Risk Propensity (RP)

A linear mixed effects model (lme) was fitted to examine the effects of task type and stimulus type on risk propensity (RP) ratings. The model included random intercepts and sloped for task type by participants.

Table 4.3.1: Formulas indicating random slopes for RP

Formulas
RP ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)
RP ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)
RP ~ STIMULUS_TYPE * STIM + (1 | NAME)

A Type III ANOVA using Satterthwaite's method indicated no significant main effect of any form with STIMULUS_TYPE random slope due to poor degree of freedom but in the other models (using STIMULUS random slope and intercept only) a significant main effect of task type was observed : $F\ (1,\ 7131) = 111.91,\ p < .001$, while the main effect of stimulus type and interaction between task type and stimulus yielded non significant results, $F(4,\ 7131) = 0.00,\ p=1.00$.

Table 4.3.2: *Type III Analysis of Variance Table with Satterthwaite's method*

	Sum Sq	Mean Sq	NumDF	DenDF	F value	p value
STIMULUS_TYPE	0.46296	0.46296	1	7131	111.91	<.001
STIM	0.000	0.000	4	7131	0.000	1
STIMULUS_TYPE* STIMULUS	0.000	0.000	4	7131	0.000	1

These findings suggest that, across all stimulus types, the task type (images or words) had a strong effect on the risk propensity, while the form of stimulus (HN, LN, N, LP, HP) and the interaction of the two had no significant contribution to variance of RP.

4.4 Choice

A binomial generalized linear mixed effects model was used to examine the effects of task type and stimulus type on choice outcomes (binary). The model included random intercepts and slopes for task type by participants.

Table 4.4.1: Formulas indicating random slopes for Choice ratings

Formulas
CHOICE ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)
CHOICE ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)
CHOICE ~ STIMULUS_TYPE * STIM + (1 | NAME)
CHOICE ~ RP + (1 | NAME)

Fixed effects for first model for choice analysis shows a significant interaction of STIMLN pr(>|z) = .0094 and STIMN pr(>|z) = 3.4e-06 when compared with STIMHN. While Task type and interactions are not significant, indicating that the effect of stimulus is similar for both image and word tasks.

Table 4.4.2: Fixed effects table for Model 1 CHOICE ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**	**p-value**
(Intercept)	-0.08912	0.09578	-0.930	0.3521	
STIMULUS_TYPEWORD	-0.09038	0.12888	-0.701	0.4831	
STIMHP	-0.11772	0.11771	-1.000	0.3173	
STIMLN	-0.30776	0.11850	-2.597	0.0094 **	p<.01
STIMLP	-0.21563	0.11805	-1.827	0.0678	
STIMN	-0.47849	0.10301	-4.645	3.4e-06 ***	p<.001
STIMULUS_TYPEWORD:STIMHP	0.07500	0.16760	0.447	0.6545	
STIMULUS_TYPEWORD:STIMLN	0.15015	0.16846	0.891	0.3728	
STIMULUS_TYPEWORD:STIMLP	0.16580	0.16786	0.988	0.3233	
STIMULUS_TYPEWORD:STIMN	0.11075	0.14657	0.756	0.4499	

From the random effects table of model 1 we can observe that variability due to participants in overall choice tendency was small (variance = 0.13, SD = 0.36). Variability in participants' responsiveness to task type (WORD vs. IMAGE) was also small (variance = 0.15, SD = 0.39). A weak negative correlation between random intercepts and slopes (r = −0.13) suggests that participants who made more choices overall tended to be slightly less influenced by task type.

Table 4.4.3: Random Effects for Model 1

Groups	Name	Variance	Std.Dev.	Corr
NAME	(Intercept)	0.1363	0.3692	
	STIMULUS_TYPE WORD	0.1558	0.3947	-0.13
Number of obs: 7200, groups: NAME, 60				

Fixed effects for second model for choice analysis shows a significant interaction of STIMLN pr(>|z) = .01487 and STIMN pr(>|z) = 0.001 when compared with STIMHN. This model isolates the effect of stimulus type and finds that some stimuli (e.g., LN, N) significantly reduce the likelihood of making the choice, confirming the main effect of affective content on decision-making.

Table 4.4.4: Fixed effects table for model 2 CHOICE ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)

	Estimate	Std. Error	z value	Pr(>|z|)	p-value
(Intercept)	-0.10032	0.12750	-0.787	0.43140	
STIMULUS_TYPEWORD	-0.09694	0.12224	-0.793	0.42776	
STIMHP	-0.12044	0.19374	-0.622	0.53419	
STIMLN	-0.31075	0.12759	-2.436	0.01487 *	p<.1
STIMLP	-0.22174	0.18779	-1.181	0.23770	
STIMN	-0.47665	0.14595	-3.266	0.00109 **	p<.01
STIMULUS_TYPEWORD:STIMULUSHP	0.08197	0.17303	0.474	0.63571	
STIMULUS_TYPEWORD:STIMULUSLN	0.16271	0.17191	0.946	0.34393	
STIMULUS_TYPEWORD:STIMULUSLP	0.17858	0.17251	1.035	0.30057	
STIMULUS_TYPEWORD:STIMULUSN	0.12693	0.14985	0.847	0.39697	

Random effect of this model show that there was considerable variability across participants in overall choice tendencies (variance = 0.52, SD = 0.72). Participant responses to different stimulus types also varied, with the greatest variability observed for STIMULUSHP (variance = 1.35, SD = 1.16) and STIMULUSLP (variance = 1.22, SD = 1.10), followed by STIMULUSN (variance = 0.60, SD = 0.77), and minimal variability for STIMULUSLN (variance = 0.08, SD = 0.29). Correlations between intercepts and slopes were strongly negative (e.g., $r = -0.81$ for STIMULUSHP), indicating that participants who were more likely to choose overall were generally less sensitive to specific stimulus types.

Table 4.4.5: Random effects for model 2

Groups	Name	Variance	Std.Dev.	Corr
NAME	(Intercept)	0.52467	0.7243	
	STIMULUSHP	1.34771	1.1609	-0.81
	STIMULUSLN	0.08413	0.2901	-0.79
	STIMULUSLP	1.21533	1.1024	-0.83
	STIMULUSN	0.59903	0.7740	-0.80
Number of obs: 7200, groups: NAME, 60				

Fixed effects for third model for choice analysis shows a significant interaction of STIMLN pr(>|z) = .00926 and STIMN pr(>|z) = 3.25e-06 and a marginally significant effect of STIMLP pr(>|z) = .06727 when compared with STIMHN. The results reaffirm that stimulus type (LN, N) reduces the odds of making the choice, while task type remains non-significant.

Table 4.4.6: Fixed effect table for model 3 CHOICE ~ STIMULUS_TYPE * STIM + (1 | NAME)

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**	**p-value**
(Intercept)	-0.08896	0.09707	-0.917	0.35940	
STIMULUS_TYPEWORD	-0.09017	0.11773	-0.766	0.44373	
STIMHP	-0.11803	0.11783	-1.002	0.31647	
STIMLN	-0.30861	0.11860	-2.602	0.00926 **	p<.01
STIMLP	-0.21623	0.11817	-1.830	0.06727 .	p<.1
STIMN	-0.47986	0.10309	-4.655	3.25e-06 ***	p<.001
STIMULUS_TYPEWORD: STIMULUSHP	0.07620	0.16677	0.457	0.64771	
STIMULUS_TYPEWORD: STIMULUSLN	0.15424	0.16758	0.920	0.35737	
STIMULUS_TYPEWORD: STIMULUSLP	0.16741	0.16701	1.002	0.31615	
STIMULUS_TYPEWORD: STIMULUSN	0.11977	0.14578	0.822	0.41134	

From the Random effects table it can be concluded that there was a small degree of between-participant variability in overall choice behavior, as indicated by a random intercept variance of 0.15 (SD = 0.39). This suggests that participants differed modestly in their overall tendency to make a choice, independent of the predictors in the model.

Table 4.4.7: Random Effects for model 3

Groups	Name	Variance	Std.Dev.	Corr
NAME	**(Intercept)**	**0.1506**	**0.388**	
Number of obs: 7200, groups: NAME, 60				

Fixed effects table for the final model shows a non-significant interaction of Risk Propensity over the task choice.

Table 4.4.8.: Fixed effect table for model CHOICE ~ RP + (1 | NAME)

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.418907	0.202863	-2.065	0.0389
RP	0.002873	0.007665	0.375	0.7078

A Type III ANOVA indicated a significant main effect of stimulus type: $F(4) = 11.01$, $p < .001$. This suggests that the probability of making a particular choice differed depending on the stimulus type. However, there was no significant main effect of task type: $F(1) = 0.02$, $p = .88$ and no significant interaction between task type and stimulus type, $F(4) = 0.32$, $p = .86$. *Post hoc* comparisons using estimated marginal means showed that several stimulus types differed significantly from each other, confirming that specific stimuli categories were associated with choice probabilities. Although in contrast they were found to be insignificant.

There was no significant main effect of task type, $F(1) = 0.02$, $p = .88$ as well as no significant interaction between task type and stimulus type was observed, $F(4) = 0.32$, $p = .86$.

Table 4.4.9: *Type III Analysis of Variance Table*

	NumDF	Sum Sq	Mean Sq	F value	p value
STIMULUS_TYPE	1	0.22	0.225	0.0225	0.88
STIM	4	44.037	11.0092	11.0092	<.001
STIMULUS_TYPE* STIM	4	1.267	0.3167	0.3167	0.86

4.5 Success

A binomial generalized linear mixed effects model was fitted to examine the effects of task type and stimulus type on the success outcomes (coded as binary). Success was the outcome variable, with task type, stimulus type, and their interactions as fixed effects. The model included random intercepts and slopes for task type by participant.

Table 4.5.1: Formulas indicating random slopes for Success outcomes

Formulas
SUCCESS ~ STIMULUS_TYPE * STIM + (1 + STIMULUS_TYPE | NAME)
SUCCESS ~ STIMULUS_TYPE * STIM + (1 + STIM | NAME)
SUCCESS ~ STIMULUS_TYPE * STIM + (1 | NAME)

A Type III ANOVA revealed no significant main effect of stimulus type, $F(4) = 1.73$, $p > .05$ as well as the interaction of task type and stimulus. $F(4) = 0.86$, $p > .05$. Although a significant main effect of the task type was observed, $F(1) = 11.44$, $p < .001$. This suggests that the participant success rate was influenced by what kind of task they were made to perform instead of the type of stimulus presented

Table 4.5.2: *Type III Analysis of Variance Table*

	NumDF	Sum Sq	Mean Sq	F value	p value
STIMULUS_TYPE	1	11.4391	11.4391	11.4391	<.001
STIM	4	6.9333	1.7333	1.7333	>.05
STIMULUS_TYPE* STIM	4	3.4447	0.8612	0.8612	>.05

Post hoc pairwise analysis using the estimated marginal means confirmed the absence of significant differences between stimulus types or between the task type within each stimuli.

Chapter 5. Discussion

The current study investigated the influence of affect on decision using images and words across multiple dimensions including valence, intensity, choice, task success and the individual risk propensity. The findings reveal a pattern of emotional and cognitive processing differences between visual and semantic stimuli, offering valuable insights into the modality specific effects.

The results demonstrate a combined effect of task type (image or word task) and stimulus type (HN, LN, N, LP, HP) on the Valence ratings, with images generally receiving a higher valence rating compared to words. The results support the observation that "valence effects were most apparent when the individuals processed pictures" (Kensinger & Schacter, 2006). This heightened valence ratings to images may be attributed to the direct nature nature of images, leading to more immediate activation of emotional systems in comparison to words (Bruno et al., 2020).

Intensity analysis revealed a more complex pattern of observations on valence ratings. It was intriguing to observe that highly negative and low negative (HN and LN respectively) were rated more intense when presented as images, while positive stimuli (HP and LP) were rated more intense when presented as words. While some previous research has suggested a general processing advantage of images over words (Schlochtermeier et al., 2013; Bruno et al., 2020) generally, our findings suggest an advantage that may be dependent on the valence. These results align with newer perspectives suggesting that "both pictures and words elicit emotional responses with no general superiority for either stimulus modality, while emotional responses to pictures are modulated by perceptual stimulus features, such as picture complexity (Schlochtermeier et al., 2013). This pattern maybe explained by how negative information (for instance, threat detection) is often more visually striking and attention grabbing in image form, while positive words might gain from cultural, conceptual, and motivational associations that can be more detailed using language.

In regards to Risk Propensity, a significant main effect of task type was observed, without any effect of stimulus type or the interaction of task type and stimulus. These results can be interpreted as the format of stimulus presentation (images or Words) influences the risk perception regardless of the specific emotional content. This finding has an important implication in contexts of risk perception and decision making researches. A study on economic decision by shows that visual based presentation of risk information led to different risk taking behavior than verbal presentations, even though the underlying information was identical, which the authors attribute to differences in cognitive and affective processing routes triggered by the modality (Fang et al., 2007).

An in-depth analysis of the Choice preference in terms of effort exertion revealed a significant effect of stimulus type without the effect of task modality. This suggests that preference of choice or decision are guided by the affective and semantic quality of the stimulus presented whether it be positive, negative or neutral, it elicits a direct effect on what kind of task they want to perform. A review by Hou and Cai (2022), highlighted that emotional stimuli (regardless of which modality it is presented) enhance the working memory performances, with both affect heuristics (valence and arousal) enhancing the attention and memory processes. These findings indicate that affect tends to influence cognitive processing, leading to a better recall and selection in tasks involving emotional material (Hou &Cai, 2022).

However, when taking Success outcomes of the preferred task were taken in consideration, an opposite effect was observed with a significant effect of the task type over the stimulus type presented. What participants chose was influenced by the emotional content of the stimuli, however, their success in completing the tasks was determined by the modality of presentation rather than emotional content. This means that stimulus drives the preference formation and modality impacts the implementation. Factors such as cognitive load, perceptual clarity, and modality specific processing play a role in determining task performance.

Chapter 6. Conclusion

This study investigated the influence of affective states, using valence and arousal, on effortful decision making among young adults, with a particular focus on how these emotional states modulate willingness to exert effort for varying rewards. Utilizing a within-subjects experimental design and validated stimuli (images and words), the study systematically examined participant's choice between low effort/low reward and high effort/high reward tasks following exposure to positive, negative and neutral affective primes.

The findings of this research provide compelling evidence that affective states significantly shape effort-based decision making. Rather than one modality having absolute superiority, our results suggest context-dependent advantages based on the specific dimension being measures and the emotional valence involved. However, our findings on intensity ratings suggests that complexity alone cannot fully explain modality differences, as words showed stronger effects for positive content. This suggests that symbolic processing may offer advantages in certain emotional contexts, particularly for positive information that maybe benefit from conceptual elaboration.

6.1 Implications:

These findings have important practical implications for fields like advertising, health communication, risk messaging and educational material designing. For instance, when communicating negative risk information, visual formats like images, videos or other forms may generate stronger intensity responses and potentially greater risk aversion. Conversely, positive messaging might be more effectively conveyed through verbal formats for certain purposes. The dissociation between effects on choice and success further suggests that message designers should consider whether their primary goal is to influence preference or to improve performance outcomes, as different modalities may be optimal for each purpose.

6.2 Limitation and Future Direction

Despite its contributions, this research is not without limitations. The sample was restricted to college-aged individuals, potentially limiting the generalizability of the findings. Additionally laboratory setting may not fully capture the complexity of real-world decision making. Future research should aim to replicate these results in more diverse populations and ecological contexts with a relatively increased sample size, and further investigate the roles of individual differences such as emotional sensitivity along with measuring the potential moderating effect of traits like verbal processing abilities and visual imagery capacity of the participants..

In conclusion, our findings contribute to a more nuances understanding of how words and images deferentially impact emotional processing and decision making, with important theoretical and practical implications for how information modality shapes our affective and cognitive responses.

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Appendix -A
INFORMED CONSENT

You are invited to participate in a research study. I, Ashman Marwaha, a student of M.A. Psychology from Thapar School of Liberal Arts & Sciences (TSLAS), Thapar Institute of Engineering and Technology, Patiala, is conducting this research as a part of my dissertation under the guidance of Dr. Richa Nigam (Professor, TSLAS, Patiala). This study aims to study the impact of Affect state on Decision-Making. By participating, you will be asked to provide some basic demographic information (e.g., name, age, contact details) and complete a short questionnaire assessing risk-taking tendencies. Followed by that, you will participate in the experiment.

CRITERIA FOR PARTICIPATION

College students aged 18-25 years who are physically and mentally healthy (no known illness), can speak and understand the English language and are residents of India. If you fulfil the above criteria, please feel free to participate in the study. There are no known risks and costs to you if you decide to participate in this study. The information you provide will solely be used to collect data for the study. The whole experiment will take about 20-30 minutes to complete. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits. Your participation in this study is voluntary. By completing the experiment, you voluntarily agree to participate. You are free to withdraw at any point in time from the study. No individual information will be disclosed should the data be published.

Kindly participate by accepting the following:
I have read the instructions and am willing to participate in the study
□ YES
□ NO

Name: ________________________________
Age: _________
Gender:_________
Email Id: ____
Contact Number:______________
Signature: _______
Date: __________________

If you have any questions about the study, please contact;
Ashman Marwaha (Masters Student, TSLAS) - amarwaha_ma23@thapar.edu
Dr. Richa Nigam (Faculty, TSLAS) – richa.nigam@thapar.edu

Appendix-B

General Risk Propensity Scale

Instructions

Below are some general statements that may or may not describe you. Please indicate the degree to which you disagree or agree with each statement.

Item	Strongly Disagree (1)	Disagree (2)	Neither (3)	Agree (4)	Strongly Agree (5)
1. Taking risks makes life more fun	☐	☐	☐	☐	☐
2. My friends would say that I'm a risk taker	☐	☐	☐	☐	☐
3. I enjoy taking risks in most aspects of my life	☐	☐	☐	☐	☐
4. I would take a risk even if it meant I might get hurt	☐	☐	☐	☐	☐
5. Taking risks is an important part of my life	☐	☐	☐	☐	☐
6. I commonly make risky decisions	☐	☐	☐	☐	☐
7. I am a believer of taking chances	☐	☐	☐	☐	☐
8. I am attracted, rather than scared, by risk	☐	☐	☐	☐	☐