

# Congruency and Time Perception: Investigating the Role of Congruent and Incongruent Stimuli

A Project submitted for partial fulfillment of the

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MASTERS OF ARTS

IN

PSYCHOLOGY



SUBMITTED BY:

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UNDER THE SUPERVISION AND GUIDANCE OF

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**CERTIFICATE**

This is to certify that the thesis entitled, “Congruency and Time Perception: Investigating the Role of Congruent and Incongruent Stimuli” is being submitted in partial fulfillment of requirements for the award of the degree of Masters of Arts in Psychology, presented in the Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala is a bonafide work carried out under the supervision of Dr. Anuj Kumar Shukla, Assistant Professor, Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala and that no part of this project has been submitted for the award of any other degree.



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



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### CANDIDATE'S DECLARATION

I hereby declare that the work presented in this thesis entitled, "Congruency and Time Perception: Investigating the Role of Congruent and Incongruent Stimuli" submitted in partial fulfillment of requirements for the award of the degree of Masters of Arts in Psychology, presented in the Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala is an authentic record of my work carried out under the supervision and guidance of Dr. Anuj Kumar Shukla, Assistant Professor, Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala and refers other researchers work which are duly listed in the reference section.

The matter embodied in this thesis has not formed the basis for awarding of any other degree at this or any other university.



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



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## **Declaration**

I, Vivek Rana (862102021), a student of M.A. Psychology (2021-2023), Student at Thapar school of Liberal Arts and Sciences, Patiala, have completed the thesis entitled “Congruency and Time Perception: Investigating the Role of Congruent and Incongruent Stimuli”

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Only one person never crafts a vital task, but the commitment of various individuals in their distinctive ways makes this achievable.

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Sincerely,

Vivek Rana (Thapar School of Liberal Arts And Social Sciences)

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## ABSTRACT

Previous studies on time perception have indicated that subjective time experience can be influenced by various factors, including emotion, color, and magnitude of stimuli. However, these factors are typically presented in a clear and unambiguous manner. Consequently, it remains unclear how an ambiguous stimulus might impact an individual's subjective perception of time. To address this gap, we employed two classical paradigms, namely the Color-Word and Face-Word Stroop stimuli, to manipulate the stimulus signals and create congruent or incongruent conditions. Participants were instructed to judge the duration of the presented stimuli under congruent or incongruent conditions using the temporal bisection paradigm. The participants' responses were recorded as either long or short, and the point of subjective equality (PSE) was estimated for both congruent and incongruent conditions in each experiment.

To examine whether temporal processing differed between the congruent and incongruent conditions, we conducted paired sample t-tests on the PSE values. The results of the t-tests revealed a statistically significant difference in temporal processing between the two conditions. Specifically, the incongruent conditions were consistently overestimated compared to the congruent conditions, regardless of whether Color-Word or Face-Word stimuli were used.

These findings can be explained by the attentional gate model of time perception. According to this model, allocating more attention to temporal information leads to temporal overestimation, while diverting attention to non-temporal information results in temporal underestimation. In our study, we propose that the incongruent stimuli require more attention, leading to an overestimation of time compared to the congruent stimuli. This interpretation will be further explored and discussed in relation to other relevant studies.

Overall, our research contributes to a better understanding of how stimulus congruity or incongruity influences subjective time perception. It highlights the role of attention in temporal processing and provides empirical support for the attentional gate model.

## CHAPTER-1

### INTRODUCTION & LITERATURE REVIEW

Time constitutes a fundamental aspect of human existence, facilitating the organization of our daily routines, future plans, and event sequencing. Nevertheless, time does not possess an objective nature comparable to measurable quantities like length, mass, and temperature. Instead, time represents a subjective concept that exhibits variability across individuals, influenced by factors such as age, attention, emotions, and environment. Time perception encompasses the subjective interpretation of the passage of time. It involves intricate cognitive processes that integrate sensory input, attention, memory, and decision-making. The ability to perceive time accurately holds significant importance in daily life as it enables individuals to anticipate and respond to events in their environment.

Furthermore, time perception plays a crucial role in various cognitive activities, including decision-making, planning, and learning. Notably, young children often exhibit less precise time perception compared to adults, while individuals with specific neurological disorders may experience distortions in their perception of time. Droit-Volet & Wearden, (2001) studied Temporal bisection in children the performance of temporal bisection in children aged 5 to 11 years were studied. The results showed that younger children had less exact time perception than older children and adults. Younger children tended to overestimate short durations and underestimate long durations, indicating difficulty detecting time intervals appropriately. Another study on time perception among children conducted by Zélanti & Droit-Volet, (2011) titled Cognitive abilities explaining age-related changes in time perception of short and long durations, the impact of cognitive abilities on time perception in children aged 5 to 8 years was investigated in this study. According to the findings, children's time perception abilities increased with age, which was partly attributable to the development of cognitive processes such as attention and working memory. However, even in older children, time perception was less

precise compared to adults. A study by Barkley et al., (2001) on Time perception and reproduction in young adults with attention deficit hyperactivity disorder found that individuals with ADHD tend to have difficulties accurately estimating time intervals and reproducing time durations. Another study by Carroll et al. (2008), titled Temporal processing dysfunction in Schizophrenia, examined time perception in individuals with Schizophrenia. The study found that individuals with Schizophrenia may have impaired perception of time intervals and difficulties integrating temporal information. Researchers have also investigated time perception in individuals with Autism Spectrum Disorder (ASD). Allman et al., (2011) conducted a study titled "Time Perception in autism spectrum disorder" and found that individuals with ASD may experience difficulties perceiving and reproducing time intervals accurately.

Wearden, Allan, and Gibbon (1991) were the first to utilize the temporal bisection task on humans, although a simpler version had already been used on people in 1968 (Bovet, 1968). Church and Deluty (1977) initially used it on rats to examine temporal discrimination. In the task, subjects are required to compare temporal stimuli to two reference stimuli, "long" and "short," held in memory. The actual stimuli are often either a tone or a light that is displayed for a while. Typically, individuals initially receive pre-training on reference stimuli before being exposed to intermediate probe stimuli. Participants in the temporal bisection task are typically given a sequence of stimuli that vary in duration. They are told to identify each stimulus as "short" or "long" depending on their subjective perception of its duration. Typically, the work comprises two reference durations: a short (e.g., 200 milliseconds) and a long (e.g., 1000 milliseconds). The stimuli shown to participants span a time span between the two reference points. The primary goal of the temporal bisection task is to find the point of subjective equality (PSE), which reflects the time participants perceive a stimulus as equally likely to be classified as short or long. This refers to the participant's subjective midpoint between the two reference durations.

To explain how we perceive time, several theories have been presented. The internal clock model suggests that our perception of time is based on an internal pacemaker or clock that generates regular pulses. According to this model, the subjective experience of time is determined by the accumulation of these pulses. The basic idea is that we estimate time by comparing the number of pulses that have elapsed during an interval with a reference memory of the rate at which the clock ticks. The internal clock model proposes that the pacemaker emits pulses that are integrated by an accumulator. The accumulation process continues until the duration of the event matches the remembered duration stored in memory. The accumulated pulses are then translated into a subjective perception of time. This model explains various phenomena, such as the time dilation effect (where time appears to slow down during intense or novel experiences) and the time estimation errors (where individuals tend to overestimate or underestimate durations). It also accounts for the fact that time seems to pass more quickly in familiar or monotonous situations compared to a novel or engaging situations. Another theory that proposes how we perceive time is the attentional gate model proposed by Zakay and Block's (1997), which proposes that the processing of temporal information depends on the opening and closing of an attentional gate. When the gate is open, attentional resources are allocated to the processing of temporal information, leading to a more accurate perception of time. Conversely, when the gate is closed, attentional resources are diverted to other cognitive processes, resulting in a less accurate perception of time. This model explains why time can appear to pass more quickly when we are engaged in a highly absorbing task or when we are in a state of flow. In these situations, attention is focused on the task at hand, and the attentional gate is effectively closed, leading to a reduced allocation of attentional resources to time processing. As a result, our subjective experience is that time flies. External theories assert that external elements such as the physical qualities of stimuli, context, and social norms influence time perception.

Several methods for measuring time perception have been developed. These methods can be

alienated into two groups: direct and indirect. Direct methods involve asking people to estimate the length of the stimulus using verbal or nonverbal answers. The verbal estimating test, for example, asks participants to estimate the duration of a stimulus using words like "seconds," "minutes," or "hours." In the production task, participants are requested to complete a task in a specific time frame, such as 30 seconds. The reproduction task requires participants to reproduce the duration of a stimulus. The physiological or neurological correlates of time perception are measured using indirect approaches. Electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and transcranial magnetic stimulation (TMS) are examples of these techniques.

Time perception has been a subject of extensive research in psychology. One area of investigation focuses on the effects of congruency and incongruency between different types of stimuli, such as visual and auditory inputs, on our perception of time. This phenomenon has been explored through various studies, with some finding that congruent stimuli lead to underestimation of time, while others report no effect or even overestimation of time in incongruent stimuli. The attentional gate model and the internal clock model provide explanations for these observations.

Fraisse (1963) conducted one of the early investigations into the effects of congruent and incongruent stimuli on time perception. The study revealed that individuals were more accurate at perceiving the longer interval when presented with congruent stimuli, suggesting that similarity between stimuli may enhance time perception. Subsequent research yielded mixed results, with some studies supporting the notion that congruent stimuli improve time perception (Droit-Volet & Meck, 2007), while others found no effect (O'Boyle & Fraisse, 1975). Additionally, some studies have suggested that incongruent stimuli can improve time perception in certain contexts (Grondin, 2010). The attentional gate model (Block & Zakay, 1997) provides theoretical frameworks to explain these findings.

Similarly, Yarrow et al., (2001) examined audiovisual stimuli and found that temporal congruency influenced participants' perception of time, with congruent stimuli being perceived as longer than incongruent stimuli.

According to the literature, congruent and incongruent stimuli can considerably impact time perception. Many researchers conclude incongruent stimuli are perceived for longer periods of time than congruent stimuli. One study that investigated this overestimation effect is the "Stroop task" study conducted by MacLeod and MacDonald (2000). MacLeod and MacDonald found that participants took longer and made more errors in naming the ink color of incongruent words compared to congruent words. However, interestingly, they also found that participants overestimated the number of incongruent trials they encountered. In other words, they believed they experienced more incongruent trials than they actually did. The researchers suggested that this overestimation of incongruent information could be attributed to the cognitive effort required to process and resolve the conflict between the word's meaning and the ink color. This heightened cognitive effort might have led participants to perceive the incongruent trials as more frequent or salient than they were in reality. This is called the "congruity effect" or the "incongruity advantage." One reason for this effect is that incongruent stimuli necessitate more cognitive processing and attentional resources to resolve the conflict between competing or incompatible information, resulting in a longer perceptual processing time. Congruent stimuli, on the other hand, are processed more rapidly and efficiently since they are compatible with our expectations and prior knowledge. Overall, the duration of perception of congruent or incongruent stimuli can be influenced by a number of factors, including the nature and complexity of the stimuli, task demands, and individual differences in cognitive and attentional ability.

To investigate the effect of different stimuli on time perception, two experiments were conducted in the study. The first experiment involved participants judging the duration of congruent or incongruent “COLOR-WORDS”, determining whether they were closer to short or long. The second experiment employed a "FACE-WORD" task, where participants had to respond to congruent and incongruent stimuli consisting of a picture of a male with the word "female" written over it, representing incongruent information. The rationale behind the study was to explore whether the congruence or incongruence between stimuli and the task at hand influences our subjective experience of time. By comparing the results of both experiments, we aimed to gain insights into the mechanisms underlying time perception and how they are influenced by different types of stimuli.

The overall goal of the present thesis was to assess whether there would be any difference in perceived durations between congruent and incongruent stimuli. We predicted that there would be no difference between congruent and incongruent trials. We also hypothesized that if there is a difference between congruent and incongruent trials, incongruent trials will be overestimated compared to congruent trials. This prediction was based on the attentional gate model, which suggests that incongruent information requires more attention and result in an earlier and longer opening of the attentional gate. Consequently, the accumulator would collect a greater number of pulses, leading to time overestimation.

## CHAPTER 2

### **STUDY-1: TIME PERCEPTION IN CONGRUENT AND INCONGRUENT COLORED-WORD STROOP TASK**

Time perception is an essential component of human cognition that allows people to organize and make sense of their temporal experiences. Researchers have long been fascinated by the principles underlying time perception, and countless experiments have been done to investigate how various elements influence our experience of time. The congruency of stimuli provided during timed tasks is one such element that has attracted a lot of attention in recent years.

Researchers have specifically explored how the congruency of temporal information with other contextual information, such as semantic meaning, impacts our experience of time. This line of inquiry has led to the study of time perception in word congruent and incongruent activities. Word congruent and incongruent tasks involve presenting temporal information alongside words that match or mismatch the temporal context. Typically, participants are prompted to judge the duration of each word stimulus during the task. The main focus is on whether the semantic congruency or incongruency of the word changes the participants' experience of time. According to the theory, Congruent words lead to more accurate time judgments or shorter perceived durations, whereas incongruent words lead to less accurate time judgments or longer perceived durations. The words are normally presented in a randomized order during the trial to avoid any order effects. To measure participants' time perception over different time scales, the duration of the stimuli can be modified to include both short and long intervals.

To measure whether Congruent and incongruent information affect with person's perception of time, we presented the subjects with both congruent and incongruent words in a single trial that was "RED" written in "RED" (Congruent stimuli) and "RED" written in "Grey." (Incongruent stimuli) and similarly with the word grey. We predicted an Overestimation of time when the information presented was incongruent (e.g., "GREY" written in "RED") compared to when it

was congruent (e.g., “GREY” written in “GREY”)

## **2.2 METHODOLOGY**

### **2.2.1 Sample:**

The research study included a sample of 28 young adults. The sample consisted of participants between the age range of 18 years to around 26 years.

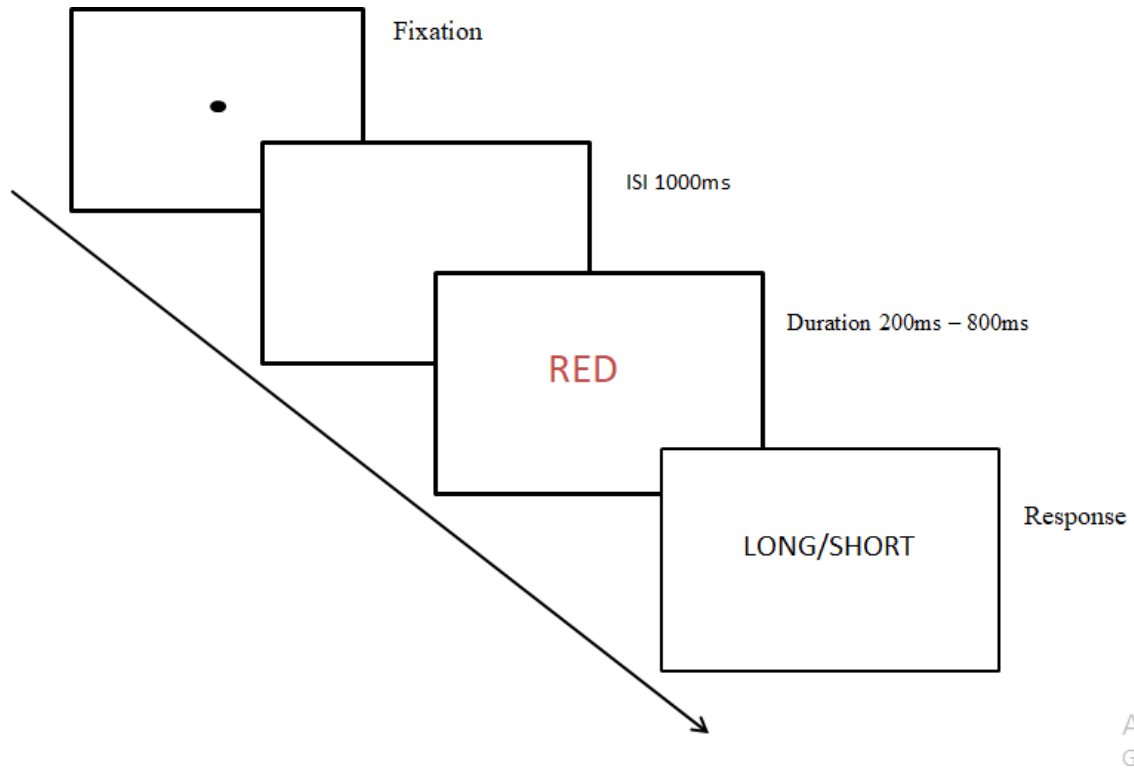
### **2.2.2 Design:**

A within-subject design was used to see the differences in the reaction time. The independent variable was Congruent and incongruent words (i.e., Red written in red and red written in grey), and the dependent variable was the reaction time.

### **2.2.3 Stimuli and apparatus:**

OpenSesame software was used to present and control the stimulus on a 17” CRT monitor (1600×1200 resolution ) running at a refresh rate of 100 Hz. Participants were seated in a dimly lit room at a distance from the monitor. Experiments Each trial began with a central fixation Dot (black, 1°) on a white background until the participant pressed an arbitrary key followed by congruent or incongruent word information. On each trial, the words Red and grey were presented in a random number, each containing a variable number of congruent and incongruent information on a white background. The words were presented in a varied duration of about 200ms to 800ms. The testing phase consisted of 224 trials.

**Figure 1: Illustration of Testing Phase**



*Figure-1: The trials started with a fixation cross, followed by congruent/incongruent information of durations varying from 200-800 ms. The participants were required to judge the duration of the word presented on the screen and were asked to respond in terms of short/ long.*

#### **2.2.4 Procedure:**

The participants were instructed to sit comfortably in a well-lit, noise-free psychology lab. Informed Consent was taken from the participants, wherein they were briefed about the experiment and were assured that they were free to withdraw from the experiment whenever they wished to. Instructions were displayed on the screen and simultaneously read aloud. Before starting the experiments, the lights were turned off so the participant could pay more attention to the task. Participants were instructed to take off any device and smartwatch that could be used to

Measure time. The participants were told that the experiment consisted of three phases training, feedback, and testing. In the training phase, participants were presented with “XXX” with two anchor Durations that were Short and Long and were told to look at the durations and experience the long and short durations. At this stage, they were not required to make any response. After sitting through the training phase, participants were presented with a feedback phase in which they were again presented with “XXX” on the computer screen in which they had to respond short or long for the following stimuli. Participants were told to press “S” on the keyboard if they perceived the word duration on the screen for a shorter time and press “L” if they perceived the word duration on the screen for a longer period of time. Participants were given feedback on whether their judgment was correct or incorrect in the feedback phase. After finishing the training and feedback phase, participants were presented with the testing phase. Participants were instructed that each word presented would be followed by a white screen to which they had to respond. After responding, a black dot would appear on the screen depicting that they now had to press the “spacebar” key for the next word to come up. Participants were presented with words written in different colors. Participants were presented with Red written in “red” and “grey” and Grey written in “grey” and “red.” They were told to respond to the following stimuli according to their perceived duration. Participants were told to press “S” on the keyboard if they perceived the word duration as closer to short and press “L” if they perceived the word duration as closer to long. Each trial’s response or reaction time was recorded for each subject. Following the completion of the data, statistical analysis was carried out using Microsoft Excel and JASP.

## 2.3 RESULTS

The participants provided responses indicating whether they perceived the stimuli as long or short, and this data was collected for analysis. Using the collected data, we calculated the Point of Subjective Equality (PSE) for each condition of the task. The PSE is a point on a psychometric plot where 50% of the times participants perceived the duration be longer and shorter. The PSE was estimated using a MATLAB toolbox called Psignifit-4. The estimated PSE values were then utilized for subsequent statistical analysis to examine the effects of the experimental conditions.

To meet the study's objectives, the obtained data were subjected to various statistical analyses. Descriptive Statistics and Paired sample T-test was done. Paired sample T-test was used because the same participants performed both congruent and incongruent trials. The paired sample T-test came out to be significant.

***Table - 1 Descriptive Statistics for Congruent and Incongruent Trials.***

	PSE_Congruent	PSE_Incongruent
Valid	28	28
Missing	0	0
Mean	0.585	0.564
Std. Deviation	0.063	0.076
Minimum	0.454	0.394
Maximum	0.681	0.685

The above table clearly shows the mean and standard deviation for the variables under study. The mean and standard deviation for congruent trials was computed to be 0.585s and 0.063s, respectively, and the mean and standard deviation for incongruent trials were computed to be 0.564s and 0.076s, respectively.

**Table-2: Shows the paired T-test of Both Congruent and Incongruent trials administered on participants.**

Measure 1	Measure 2	t	df	p	Mean Difference	SE Difference	Cohen's d	SE Cohen's d
PSE_Congruent	- PSE_Incongruent	2.435	27	0.022	0.021	0.009	0.460	0.125

Note. Student's t-test.

A Paired samples t-test was conducted. The results indicate significant difference with the mean difference (0.021) between the mean value of PSE\_Congruent and PSE\_Incongruent. [ $t(27) = 2.435, p=.022, \text{Cohen's } d=0.46$ ].

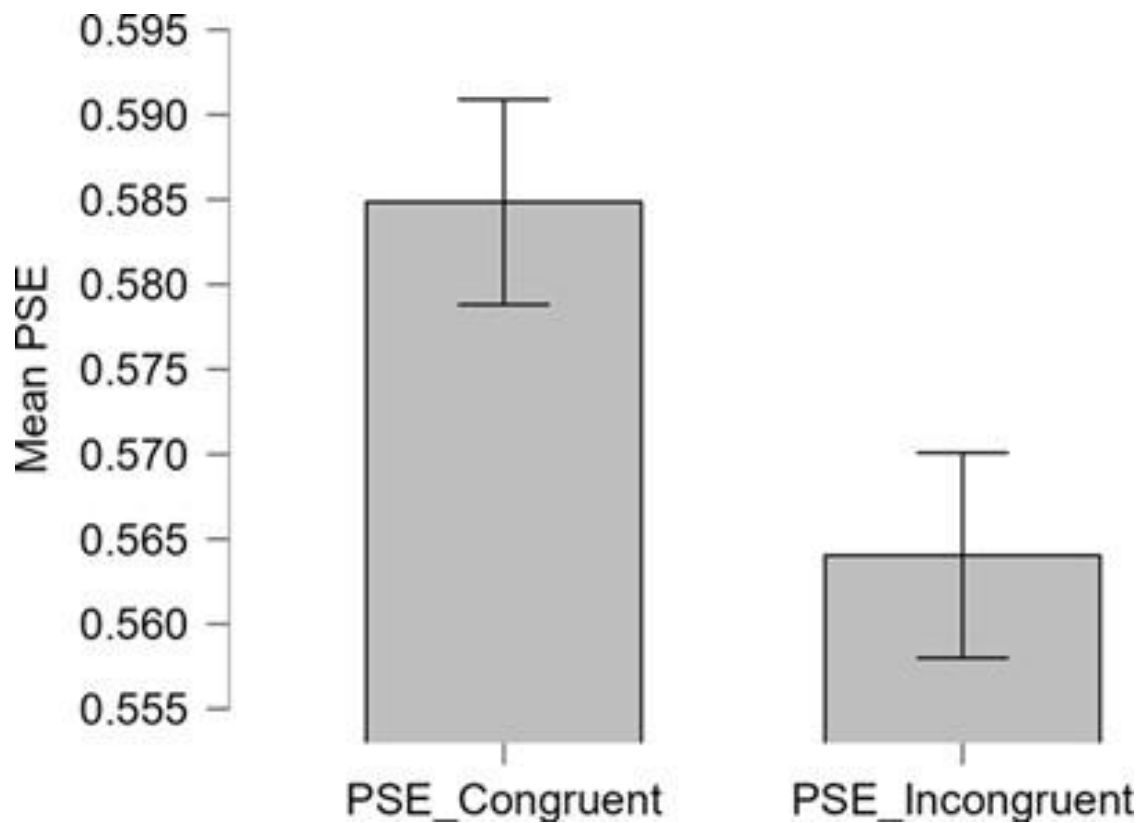


Figure 1: Shows difference in mean value of congruent and incongruent trials.

## 2.4 DISCUSSION

In the present study, we investigated whether the perceived duration of a visual stimulus is affected by its color. The aim of the present study was to assess whether there will be any difference in perceived durations between congruent and incongruent trials of words in different colors. We hypothesized there would be no difference in congruent and incongruent trials. We also hypothesized that if there is a difference between congruent and incongruent trials, then incongruent trials will be overestimated as compared to congruent trials. Much research have indeed indicated that the perceived duration of a visual stimulus can be influenced by its color. A study by Kanai, R., Paffen, C. L., Hogendoorn, H., & Verstraten, F. A. (2006) titled Time dilation in dynamic visual display where participants were presented with visual stimuli of different colors and asked to estimate their durations. The researchers found that stimuli with longer wavelengths (such as red) were perceived as lasting longer compared to stimuli with shorter wavelengths (such as blue). In a study conducted by Cicchini, G. M., Mikellidou, et al. (2017) investigated the effect of color on serial dependence, a phenomenon where perception of a current stimulus is biased by previous stimuli. The researchers found that color played a significant role in serial dependence, with color-dependent biases influencing the perceived duration of subsequent stimuli.

The result of the current study indicates that there is a significant difference between the congruent and incongruent trials of words. It was found that Incongruent words were overestimated as compared to congruent words. Because according to the attentional gate model, incongruent trials require more attention compared to congruent trials; hence the switch will open earlier and remain open for a longer period of time, and the accumulator will collect more number of pulses leading to an overestimation of time. The switch operates in an "all-or-none" fashion and is governed by the temporal meaning assigned to stimuli. When a stimulus signaling the beginning of a relevant interval is perceived, the switch is opened, the counter is set at zero,

and the flow of signals can be counted. When a stimulus signaling the termination of a relevant interval is perceived, the switch is closed, preventing more pulses from entering the counter, and at the same time, the count is transferred to short-term memory. The findings have implications for our understanding of how contextual information influences time perception. It suggests that the congruency between temporal information and semantic meaning can impact our subjective experience of time. The results support the notion that our perception of time is not solely determined by objective time intervals but is also influenced by cognitive factors, such as semantic congruency. Previous studies combining temporal and nontemporal tasks (dual-task method) have suggested that the time spent processing the target duration might be a key factor: The less time devoted by the subject to the temporal task, the shorter the judged duration. The current study's findings reveal that the notion proposed by the attentional gate model stands correct, i.e., people overestimate the duration of incongruent things and underestimate the duration of Congruent ones.

In summary, the purpose of this study was to examine the impact of color and semantic congruency on the perceived duration of visual stimuli. The results indicated a significant difference in temporal processing between congruent and incongruent trials, with incongruent trials being overestimated compared to congruent trials. These findings align with the attentional gate model, suggesting that incongruent trials require more attention, leading to an overestimation of time. The study's findings shed light on how contextual factors, such as semantic congruency and color, can influence our perception of time. They highlight that our subjective experience of time is not solely determined by objective time intervals but is also influenced by cognitive factors.

These results have important implications for understanding time perception and emphasize the role of cognitive processes in shaping our temporal experiences. Moving forward, it would be valuable to investigate the specific mechanisms underlying the influence of congruency and

color on time perception. Furthermore, exploring the impact of other contextual factors, such as emotional valence or spatial relationships, could further enhance our understanding of how different elements shape our perception of time. Additionally, future studies could examine the generalizability of these findings across diverse populations and age groups to explore potential variations in time perception.

## **CHAPTER-3**

### **STUDY-2: TIME PERCEPTION IN CONGRUENT AND INCONGRUENT FACE-WORD STROOP TASK**

Temporal perception refers to our ability to experience and estimate the duration of events or stimuli. Previous studies have shown that emotional faces can impact various cognitive functions, including attention, memory, and perception. Additionally, emotional signals, such as facial expressions and emotional language, can further regulate our emotional experiences. However, the specific effects of congruency or incongruency between facial expressions and emotional words on time perception remain an intriguing topic of investigation.

Visual stimuli, such as faces and words, have been found to influence our perception of time. For instance, studies have demonstrated that emotional faces can alter time perception. Emotional cues like fearful or angry faces tend to be perceived as lasting longer than neutral faces. Similarly, words or linguistic cues can also affect our perception of time. Positive or negative words, for example, can influence our impression of the duration of time. Negative words, such as threatening or unpleasant words, often make time feel longer, while positive words may lead to an underestimation of time.

Research by Ogden has shown that viewing beautiful faces can reduce the perceived duration of time. This effect can be explained by the fact that these facial emotions divert attention away from temporal processing. According to internal clock theories, the perception of time is determined by the number of temporal units (pulses) released and collected during the presentation of a stimulus. When attention is directed away from time processing, temporal units are lost, resulting in a shorter perceived duration. On the other hand, displays of anger or fear have a lengthening effect on time perception. This effect is attributed to an increase in arousal caused by the perception of anger and fear, which speeds up the internal clock mechanism responsible for representing time. The greater the number of temporal units accumulated, the

longer the stimulus duration is judged to be. Droit-Volet and Meck (2002) suggest that this time dilation effect arises from the speeding up of the internal clock mechanism, which allows individuals to quickly prepare for action. This effect has been observed in children as young as three years old, indicating its automatic nature. Interestingly, the subjective extension of time in response to facial expressions has been found to be less pronounced for the emotions of happiness and sadness compared to anger and fear.

To investigate the role of emotional congruency in temporal judgments, a temporal bisection task can be employed. This task is commonly used to measure temporal perception. It involves presenting participants with two reference durations, a short and a long one. Participants are then shown intermediate durations and asked to categorize them as closer to the short or long reference time. By analyzing participants' categorization responses, the point of subjective equality (PSE) can be calculated, which represents the length at which the stimulus is perceived as equally short and long.

The motivation behind the present study was to examine the influence of congruency between facial expressions and accompanying words on temporal perception. While previous research has shown that emotional stimuli, such as faces and words, can affect time perception, the specific effects of congruent and incongruent facial information on temporal judgments have not been extensively investigated. By conducting a temporal bisection task with congruent and incongruent face-word pairings, this study aims to contribute to our understanding of how the congruency or incongruency of emotional information influences our perception of time.

In the task, participants were presented with a short and a long standard duration represented by simple ovals during the training phase. They were then shown face-word pairings, which included faces of a man and a woman with corresponding words written over them (e.g., "male" or "female" written over the face of the female stimulus). Participants' task was to judge whether the duration of the stimuli was short or long. The congruency between the face and the word was

manipulated across trials, creating congruent (e.g., male face with the word "male") and incongruent (e.g., male face with the word "female") conditions. The hypothesis was that there would be no difference between congruent and incongruent information, and incongruent information would lead to an overestimation of time, while congruent information would result in an underestimation.

## **3.2 METHODOLOGY**

**3.2.1 Sample:** The research study included a sample of 15 young adults. The sample consisted of participants between the age range of 18 years to around 24 years.

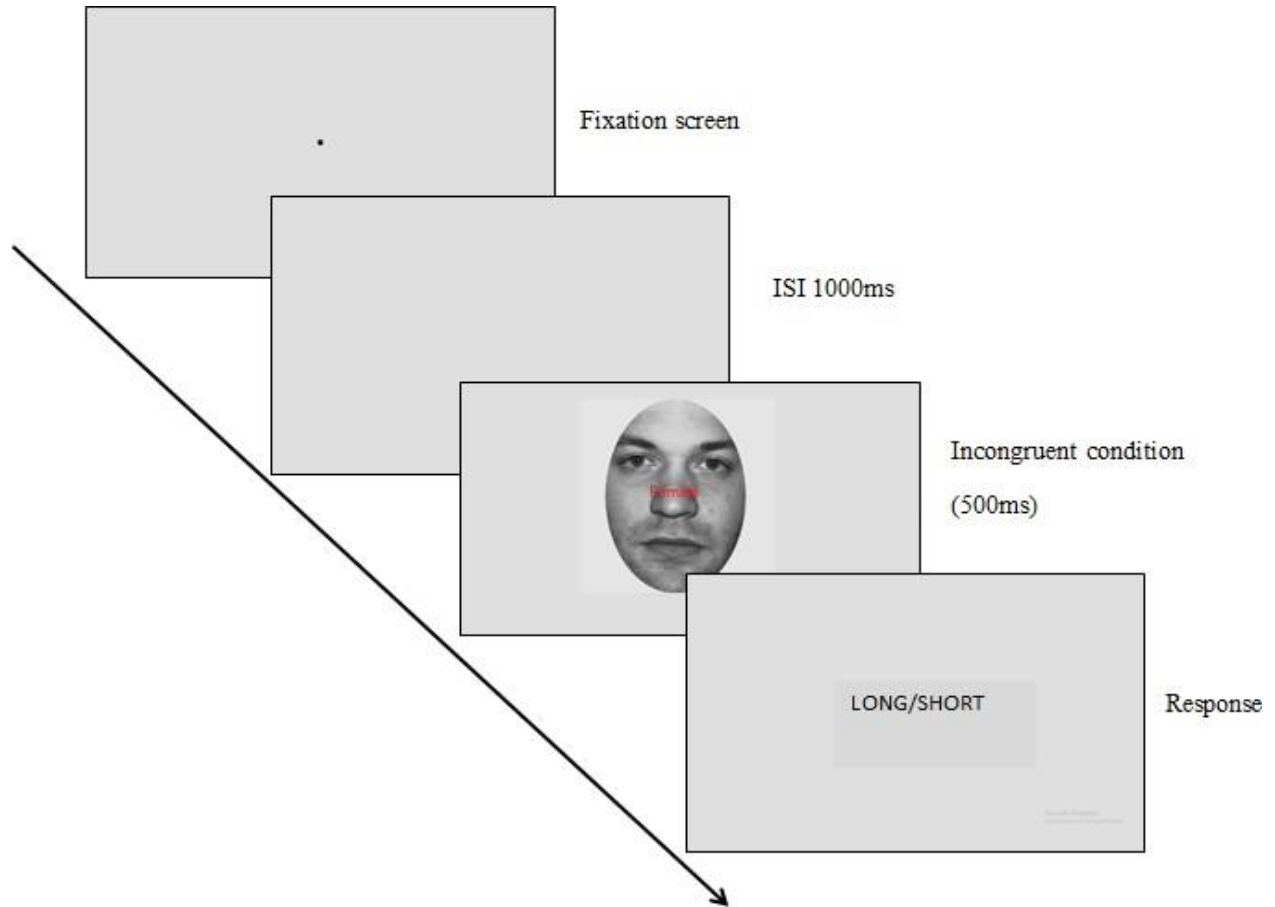
**3.2.2 Design:** A within-subject design was used to examine the differences in reaction time depending on the independent variable of congruent and incongruent word-picture pairings (For example, a picture of a male accompanied by the word "male" would represent a congruent pairing, while a picture of a male with the word "female" would represent an incongruent pairing.), with reaction time being the dependent variable examined.

**3.2.3 Stimuli and apparatus:** A temporal bisection task was created using OpenSeasme software and was also used to present and control the stimulus on a 17" CRT monitor (1600×1200 resolution). There were three phases training, feedback, and testing. Participants were seated in a dimly lit room at a distance from the monitor. Each trial in the testing phase began with a central fixation Dot (black, 1°) on a white background until the participant pressed an arbitrary key followed by congruent or incongruent "FACE-WORD" information running at a refresh rate of 100 Hz. The stimuli used in this experiment were face of a human male/female with male/female word written over it, which were congruent and incongruent in nature (picture of a male accompanied by the word "male" would represent a congruent pairing and incongruent if the word is "female"). On each trial, the FACE-WORD stimulus was presented in a random

number, each containing a variable number of congruent and incongruent information on a grey background. The stimulus was presented in a varied duration of about 200ms to 800ms. The testing phase consisted of 225 trials.



*Figure-1: The provided image illustrates an example of incongruent trials in a Face-Word Stroop Picture task. In these trials, a male neutral picture is combined with a female word overlaid on it. Participants were presented with these stimuli for different durations and were instructed to judge the duration of the presented Face-Word Stroop Pictures.*



**Figure-2 :** *The experimental trials began with the presentation of a fixation cross. Following the fixation cross, visual stimuli in the form of Face-Word pairs were presented to the participants. These pairs could be either congruent or incongruent in terms of the information conveyed. The stimuli were displayed for a total of 7 objective durations, ranging from 200 to 800 milliseconds. Participants were tasked with judging the duration of the stimulus presented on the screen and indicating whether it was perceived as short or long.*

### 3.2.4 Procedure:

The participants were instructed to sit comfortably in a well-lit, noise-free psychology lab. Informed Consent was taken from the participants, wherein they were briefed about the experiment and were assured that they were free to withdraw from the experiment whenever they wished to. Instructions were displayed on the screen and simultaneously read aloud. Before starting the experiments, the lights were turned off in order for the participant to pay more attention to the task. Participants were instructed to take off any device and smartwatch which could be used as a way to measure time. The participants were told that the experiment consisted of three phases training, feedback, and testing. In the training phase, subjects were presented with short and long durations. The durations were shown in terms of an OVAL. Participants were to experience the duration and understand what is long and what is short duration. In this phase, they were not supposed to make any responses. In the second phase, which was the feedback phase, participants were presented with the same OVAL figurine for short and long durations in random order. They had to judge whether the presented duration was short or long. They were required to press “S” on the keyboard if they felt the presented duration to be short and press “L” if they perceived the duration to be long. After every response, participants received feedback on whether their answer was correct or incorrect. The last phase was the testing phase, where the participants were presented with “Face-Word” for varied durations. Experiments Each trial began with a central fixation Dot (black, 1°) on a grey background until the participant pressed an arbitrary key followed by “Face-Word” pictures of varied durations (from 200ms to 800ms). Subjects then needed to judge whether the duration of the “Face-Word” was closer to short duration or closer to long duration. They were required to press “S” on the keyboard if they felt the presented duration to be short and press “L” if they perceived the duration to be long.

This phase did not consist of any feedback for the responses made. There was no time limit to make a response. For each subject, the response or reaction time for each trial was recorded. Following the completion of the data, statistical analysis was carried out using Microsoft Excel and Jasp.

### 3.3 RESULTS:

The participants provided responses indicating whether they perceived the stimuli as long or short, and this data was collected for analysis. Using the collected data, we calculated the Point of Subjective Equality (PSE) for each condition of the task. The PSE is a point on a psychometric plot where 50% of the times participants perceived the duration be longer and shorter. The PSE was estimated using a MATLAB toolbox called Psignifit-4. The estimated PSE values were then utilized for subsequent statistical analysis to examine the effects of the experimental conditions.

*Table – 1 Descriptive Statistics for Congruent and Incongruent Trials.*

	PSE_Congruent	PSE_Incongruent
Valid	15	15
Missing	0	0
Mean	0.558	0.538
Std. Deviation	0.077	0.065
Minimum	0.425	0.421
Maximum	0.646	0.636

The above table clearly shows the mean and standard deviation for the variables under study. The mean and standard deviation for congruent trials was computed to be 0.558s and 0.077s, respectively, and the mean and standard deviation for incongruent trials were computed to be 0.538s and 0.065s, respectively.

**Table-2:** Shows the paired T-test of Both Congruent and Incongruent trials administered on participants.

Measure 1	Measure 2	t	df	p	Cohen's d	SE Cohen's d
PSE_Congruent	- PSE_Incongruent	1.962	14	0.035	0.507	0.144

Note. For all tests, the alternative hypothesis specifies that PSE\_Congruent is greater than PSE\_Incongruent.

Note. Student's t-test.

To investigate the difference between PSE\_Congruent and PSE\_Incongruent, a paired sample t-test was conducted. The resulting t-value was 1.962, which suggests that there is a moderate difference between the means of the paired samples. The calculated p-value was 0.035, showing that there was a statistically significant difference between the two measurements. A p-value of 0.035 suggests that there is evidence to reject the null hypothesis and accept the alternative hypothesis. The Cohen's d value obtained was 0.507, suggesting a moderate effect size. This indicates that there is a meaningful difference between the two measures, with PSE\_Incongruent showing a higher value than PSE\_Congruent. [t(14)=1.962, p=0.035]

**Figure-3** Shows the mean PSE's of Congruent and Incongruent trials.

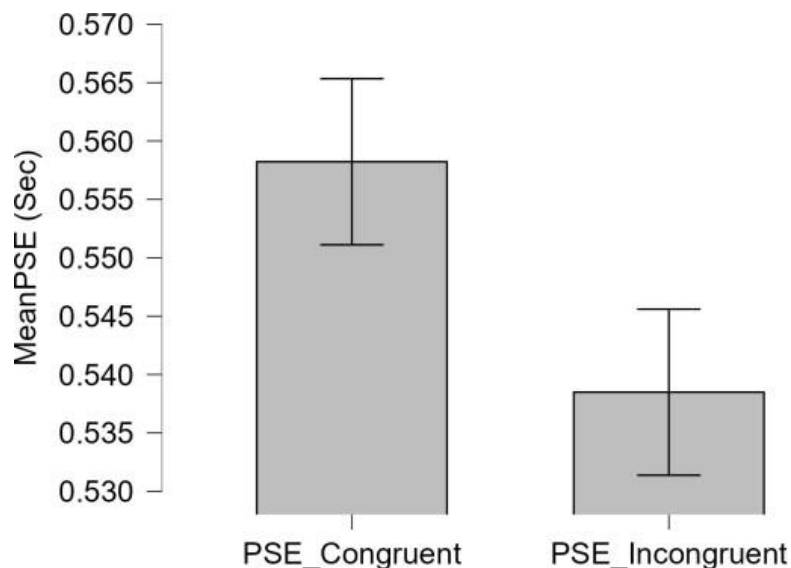


Figure 2: Shows difference in mean PSE value of Face-Word congruent and incongruent trials.

### **3.4 DISCUSSION:**

The aim of this study was to explore how the congruency between facial stimuli and accompanying words affects our perception of time using a temporal bisection task. The study employed a within-subject design and included 15 young adult participants. The results revealed a significant difference in temporal perception between congruent and incongruent trials. Previous research has already provided insights into the impact of pictorial stimuli, such as facial expressions and emotional words, on time perception, although these stimuli were studied separately. For instance, a study by Droit-Volet and Meck (2007) investigated the influence of emotional arousal on time perception and found that emotionally arousing stimuli tend to lead to an overestimation of time durations. Various theoretical models have been proposed to explain the mechanisms underlying time perception, including the internal clock model and the attentional-gate model. In the context of the attentional-gate model, the overestimation of time in the incongruent condition can be understood as incongruent emotional information capturing attention and disrupting temporal processing, which results in a perceived elongation of time. Previous studies have demonstrated that emotional cues, such as facial expressions and emotional language, have the ability to influence time perception. Negative emotions are known to dilate time, while positive emotions tend to shorten it. In the current study, the introduction of incongruent face-word pairings may have introduced conflicting signals, leading to an extended perception of time. Conversely, congruent pairings may have facilitated focused and efficient processing of the stimuli, resulting in a shortened perception of time. The findings of this study further emphasize the role of attention in temporal processing. In the case of congruent pairings, attention may be redirected away from temporal processing, leading to a loss of temporal units and an underestimation of time.

To conclude, the results of this study indicate that the congruency between facial stimuli and accompanying words has an influence on our perception of time. Incongruent face-word pairings lead to an overestimation of time, while congruent pairings result in an underestimation of time. These findings contribute to our understanding of the complex relationship between emotion and temporal perception and highlight the role of attention in shaping our subjective experience of time.

## **CHAPTER-4**

### **GENERAL DISCUSSION**

The aim of these studies was to examine the effects of congruent and incongruent information on perceived duration and temporal perception. Study 1 investigated the perceived duration of visual stimuli (coloured words) in congruent and incongruent trials, while Study 2 explored the effects of congruency between a face and the word written on it. Both studies provided valuable insights into the complex relationship between various factors and temporal perception.

The overall objective of the research was to understand how the congruity or incongruity between different stimuli, such as visual words and faces, influences our perception of time. The studies conducted within this thesis shed light on the role of attention, cognitive processing, and emotional cues in temporal perception. The results also highlight the interplay between attention and temporal processing, emphasizing the need for further exploration of the underlying mechanisms. Overall, the findings suggest that incongruent trials lead to an overestimation of time, while congruent trials result in an underestimation of time.

In Study 1, the results indicated a significant difference between congruent and incongruent trials in terms of perceived duration of words. Specifically, incongruent words were overestimated compared to congruent words. These findings support the attentional gate model, which suggests that incongruent trials require more attention, leading to a longer estimation of duration. The switch mechanism, operating in an "all-or-none" fashion, was proposed as the underlying mechanism responsible for these effects. It suggests that when a stimulus signalling the beginning of a relevant interval is perceived, the switch opens, allowing pulses to accumulate and contribute to time estimation. Conversely, when a stimulus signalling the termination of a relevant interval is perceived, the switch closes, preventing further pulse accumulation. The results of the current study align with the notion that attentional demands influence temporal

perception and can lead to overestimation or underestimation of duration. A study by Thönes, Castell, Iffinger, et al. on Color and time perception: Evidence for temporal overestimation of blue stimuli. investigated whether participants overestimate the duration of red stimuli in comparison to blue stimuli, while controlling for differences in brightness and saturation. Surprisingly, our results show an overestimation of the duration of blue as compared to red stimuli (indicated by a shift of the point of subjective equality), even though the red stimuli were rated as being more arousing. Tewari, Makwana, & Srinivasan (2020) wanted to know whether Group congruent labeling leads to subjective expansion of time which emitted contrasting result. They found that Both the groups reproduced significantly longer durations when the sound clip was associated with the group congruent compared to the group incongruent festival contexts. The two groups however did not differ significantly in reproduced duration when the sound was attributed to a non-religious common (busy city street) context. These study show contrasting result from what we have got wherein incongruent stimuli was overestimated. We speculate that the present results are due to fundamental different in the stimuli used in the two studies. Also the task employed across these two different studies could also be the reason why the findings are different from the present study.

The second experiment focused on the influence of face-word congruency on temporal perception using a temporal bisection task. The results revealed a statistically significant difference between congruent and incongruent trials in terms of the point of subjective equality (PSE). Incongruent face-word pairings led to an overestimation of time, while congruent pairings resulted in an underestimation of time. These findings suggest that emotional cues, such as facial expressions and language, can influence temporal perception. Incongruent picture introduced conflicting signals and extended the perception of time, while congruent pairings facilitated focused and efficient processing, leading to a shortened perception of time. The role of attention in temporal processing was also highlighted, as congruent pairings redirected attention away

from temporal processing, resulting in an underestimation of time. Earlier study conducted by Noulhiane et al.,(2007) on how emotional auditory stimuli modulate time perception found that Negative sounds were judged to be longer than positive ones, indicating that negative stimuli generate a greater increase of activation. It is essential to note the limitations of second study where the sample size was small, with only 15 young people participating. This may restrict the findings' generalizability to larger groups.

The rationale behind the study was to explore whether the congruence or incongruence between stimuli and the task at hand influences our subjective experience of time. The present findings shed light on the role of attention in temporal processing. In both studies, incongruent trials required more attention due to the conflicting information presented. This increased attention allocation likely resulted in an elongation of perceived duration. In contrast, congruent trials directed attention away from temporal processing, leading to a loss of temporal units and an underestimation of time.

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## APPENDIX A

### CONSENT FORM FOR STUDY-1

#### CONSENT FORM

We are conducting the present study to understand how we perceive time. The experiment would be conducted in THREE phases: Training, feedback, and testing. In the training phase, you will be presented with “xxx”, and you are required to look at the duration and experience the long and the short duration. In the testing phase, you will be presented with “Color-words” and you need to judge the duration of the presented “color-words” in terms of LONG/SHORT.

- Participation in the study is completely voluntary.
- Data will be kept confidential and subjects identity will be protected.
- Subjects participation will take approximately 10-12 minutes.
- If you are still interested in participating and assisting with this research project, please fill out the consent form below. You can contact me at my Email [Vrana\\_ma21@thapar.edu](mailto:Vrana_ma21@thapar.edu) if you have questions, comments or concerns now or in the future about your participation in this study. Thank you for your time and consideration.

Signed:.....  
(Researcher)

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#### Subject demographic details

Name of the participant: \_\_\_\_\_

Date of birth: \_\_\_\_\_ Age: \_\_\_\_\_ Gender: \_\_\_\_\_

Education: \_\_\_\_\_

Address: \_\_\_\_\_

Contact Details: \_\_\_\_\_

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I, \_\_\_\_\_, give my consent for the participation in this Time perception experiment being conducted by Vivek Rana.

I understand that:

- My data will be used for research.
- My participation is voluntary.
- My information will be kept confidential.

I have read the information above and any questions i asked have been answered to my satisfaction. I give consent for my participation in this study.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

**APPENDIX B**  
**CONSENT FORM FOR STUDY-2**

**CONSENT FORM**

We are conducting the present study to understand how we perceive time. The experiment would be conducted in THREE phases: Training, feedback, and testing. In the testing phase, you will be presented with "FACE-WORD" and you need to judge the duration of the presented "FACE-WORD" in terms of LONG/SHORT.

- Participation in the study is completely voluntary.
- Data will be kept confidential and subject's identity will be protected.
- Subject's participation will take approximately 10-12 minutes.
- If you are still interested in participating and assisting with this research project, please fill out the consent form below. You can contact me at my Email [Vrana\\_ma21@thapar.edu](mailto:Vrana_ma21@thapar.edu) if you have questions, comments or concerns now or in the future about your participation in this study. Thank you for your time and consideration.

Signed:.....  
(Researcher)

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**Subject demographic details**

Name of the participant: \_\_\_\_\_

Date of birth: \_\_\_\_\_ Age: \_\_\_\_\_

Education: \_\_\_\_\_

Address: \_\_\_\_\_

Contact Details: \_\_\_\_\_

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I, \_\_\_\_\_, give my consent for the participation in this Time perception experiment being conducted by Vivek Rana.

I understand that:

- My data will be used for research.
- My participation is voluntary.
- My information will be kept confidential.

I have read the information above and any questions i asked have been answered to my satisfaction. I give consent for my participation in this study.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_







