EFFECTS OF EMOTIONAL STATES ON TIME PERCEPTION

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INTRODUCTION

Temporal information processing plays a fundamental role in human life for the representation of the external environment. In parallel, human beings are continually engaged in emotionally driven behaviour in everyday life. Consequently, we are almost always subjected to a multitude of modulus-specific stimuli which directly influence our interactions with the environment and our own thought processes. Of all the modalities, **audition** and **visualization** play major roles in guiding and determining our mental states and cognitive processes. In recent years, there has been a major focus on understanding how time perception by humans is influenced by affective states. Real life situations are as follows:

- When we are sad or grieving, it seems that time has slowed down. Each moment seems like an eternity, and events following the sadness-inducing stimulus seem long-drawn.
- During examination seasons, feelings of stress make the passage of time to be perceived as very fast. One hour seems nothing, and intellectual cognition seems to take forever.
- Pleasant music is often played at waiting places like airports and office receptions. This is done with the intention of inducing a pleasant feeling, so that waiting people do not perceive time passed as long as it actually has been.
- Film segments/ Images depicting horror are perceived to play longer.

Time has been evaluated by researchers to be split into two agencies; that of '**absolute time**' and '**perceived time'**. While absolute time is directly measured by counting passages of scientifically defined temporal units (seconds), perceived time (or relative time) is a subjective phenomenon. What one person perceives as an hour might not be an hour for another person. The timescape of a coma-ridden individual would not necessarily be identical to that of a person working long hours in the office. Similarly, it has been anticipated that emotional states of the individual have a certain, if not decisive role, in the subjective quantification of time.

It is important to note that '**emotion**' can be defined in multiple ways:

- Schachter and Singer (1962) defined emotion as "a state of physiological arousal and of cognition appropriate to this state of arousal." This definition distinguishes between physiological arousal, which can be termed *activation,* and mental arousal, characterized by the subjective experienced intensity of emotions.
- Oatley and Jenkins (1996) stated that "the core of an emotion is readiness to act and the prompting of plans. An emotion is usually caused by a person consciously

or unconsciously evaluating an event as relevant to a concern (a goal) that is important."

MOTIVATION

The recent research performed in order to understand how modalities influence cognition, and in particular time perception, peaked my interest in the subject. We were especially intrigued by the possibility of exploring for agents which can cause significant shifts in 'perceived time'. Inspirations relevant from real life were the phenomenon of temporal perceptual manipulation in deep meditation, 'expansion' of time by highly productive individuals as practised in their effective time management, and the effects of emotional turbulence on work productivity (through various psychological states including possible changes in perceived time). While these examples pertain to events in everyday life, much research has not been undertaken in the past to study how emotional states may quantitatively influence perception of time. And because affective states have been suggested to be heavily influenced by the environmental stimuli (obtained through modalities), we focussed on studies done in this particular domain.

GOAL

In this project, we intend to first recreate the experimental procedures employed by Sylvie Droit-Volet et al. in their studies on influence of auditory stimulus on time perception in normal subjects. We would like to analyse the effects of tuning various parameters of the stimulus (mode, pitch, tone, timbre, tempo, scale, etc.) in emotionally modulated samples.

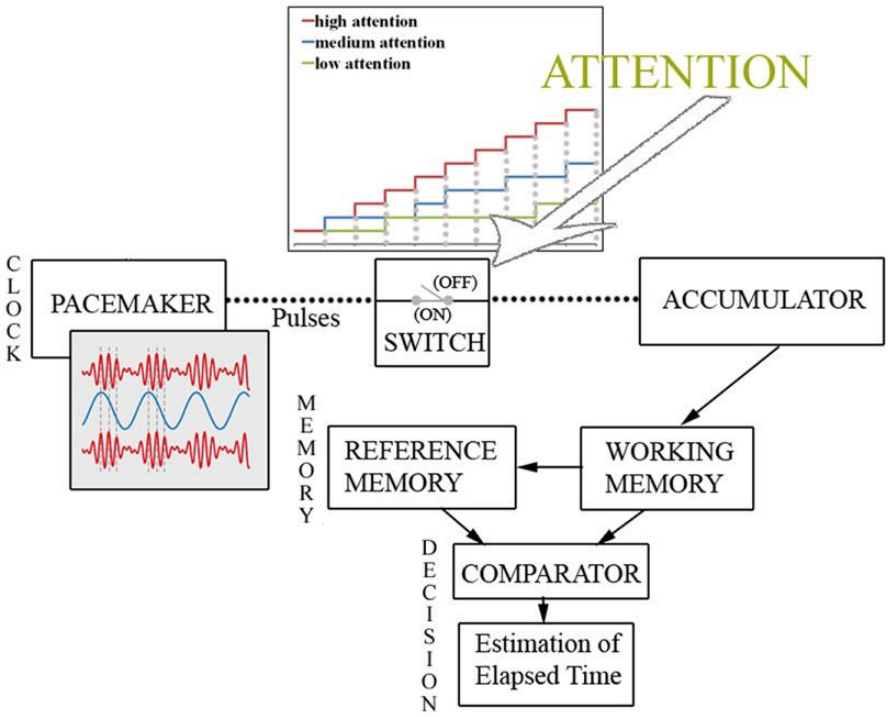
We also propose a novel experiment with auditory stimulus, wherein we seek to understand the mood-induced aftereffects and their implications on non-affective tasks like basic numerical analysis, puzzle solving, etc.

Our goal for this project is to understand if mood-inducing stimulus or emotionally charged states do indeed significantly affect time perception. If they do, we would be able to hypothesize if these could be generalized to daily scenarios, and if specific stimuli could indeed bring about the phenomenon of 'expansion of time' for increased human productivity. Finally, we would like to compare the results to analyse conformity with the various models of time perception, namely the 'Scalar Expectancy Theory' (F. Gibbon, R. Church, & W. Meck, 1984) and the 'Internal Clock Model'.

PREVIOUS RESEARCH

Major studies on the influence of emotional stimuli on time perception have been done by Sylvie Droit-Volet et al. [2][3]. The group performs a study done with auditory stimuli, and results state that while emotional stimuli do indeed have a controlling effect on how time is perceived, it is not decisive for all such stimuli. Specifically, Marion Noulhiane et al. [1] found that the arousal and valence of auditory stimuli can be modulated to observe differential errors in time quantification by subjects. Supporting evidence was found by Sylvie Droit-Volet et al. [2] when music was used as the emotional stimulus. However, in this latter study, it was observed that while tempo was a decisive factor in time perception, the emotional valence of the music had no effect independently. Another study by Sylvie Droit-Volet et al. [3] focused on film-induced mood. While previous studies looked at the time perception of emotional events themselves, this one focused on the effect of emotions *per se* on the subsequent time

judgement of a neutral, non-affective and non-temporally modulated event. The results state that film inducing horror in subjects does create a noticeable error in time quantification; however, the effect of neutral or sad films is negligible.
Treisman (1963) and Gibbon at al. (1984) had proposed a model of time perception called the 'internal clock model'. The model proposes an inherent and internal temporal processor exists in the human centre for time cognition. This processor, also called a timer, relies on four interrelated devices: a clock, a working memory store, a reference memory store, and a comparator. Details are provided in the description of the model [9].



The internal clock model
(Federika Piras, Fabrizio Piras, et al., Time dysperception perspective for acquired brain injury, 2014)

Other studies and articles mentioned in the references derive and comment on several observations made about the effect of affective states on time perception, and describe how various other aspects of cognition might aid or interfere in temporal processing centres.

EXPERIMENTATION PROTOCOL

The experimental setup for experiment 1 is adopted from work by Sylvie Droit-Volet et al. and Marion Noulhiane et al. We will be employing the freeware **PsychoPy** software [7] for delivery of the experiment dataset and recording of responses. A number of reinforcing measures and minute details of the experimental workflows are not being mentioned in the outline below, since these would be tailored to suit the experiment as it is being performed.

Experiment-1:
In this workflow, we will first create a comprehensive stimulus dataset of musical (similar to samples from the IADS database), and obtain the arousal, valence, and mood-induction ratings for the dataset samples from subjects. The ratings would be made based on the Brief Mood Introspective Scale (BMIS; Mayer and Gaschke, 1988) and the Self-Assessment Manikin (Hodes, Cook, & Lang. 1985). On obtaining the dataset and the statistical ratings for various parameters of the dataset samples, we will be using the dataset in subsequent experiments.

Experiment-2:
Through this experiment, we wish to see how emotional auditory stimuli (music / non-music) affect the perception of durations of the stimuli. The subjects will be subjected to a temporal bisection task regime, where they will first be trained with neutral stimuli (sample sound). The testing sample set would contain the rated samples from experiment-1. Differential time durations (10s-20s) will be used as stimulus durations, and the task of the subject would be to report (with a delay after the stimulus) the duration of the stimulus as perceived. Active counting methods will be discouraged (with appropriate measures as stated by Rattat and Droit-Volet, 2012). With the data obtained, we will computationally derive the variations in responses over differing time points. This data will help find the influence of base emotional states in time subjectivity.
Both verbal estimation of the durations and contrasted (with a neutral white sound) estimation would be obtained from the subjects. We expect interesting results from both these input methods.

Experiment-3:
This is a novel experiment design we have envisioned (**based on experiment design suggestions by Prof. Gianna Cassidy [10] (Glasgow Caledonian University) and her lab**) to determine if auditory stimulus induces emotional states in subjects such that their performance in non-affective tasks is influenced. In this workflow, we will test two phenomena – task (video game) performance and time perception. The subject will be asked to play any of three games:

- Temple Run 2 (Fixed rate of change in difficulty, time unbound)
- Fruit Ninja (Fixed difficulty, time bound)
- Paper Toss 2 (User-dependant difficulty, time unbound)

The three video games chosen are fairly famous, and subjects chosen for this experiment will be asked to rate themselves on expertise in these games. For normalizing the data obtained, we will ask the player to play the game in neutral (no stimulus) setting thrice. The scores obtained here will be used for normalization of the experiment scores.
The objective of this experiment is to determine how the affective state induced by sustained auditory stimulus generates variation in the player's **time perception of the gaming event**, and also the **performance of the player during the stimulus period**. We will ask the player to first estimate to their best accuracy the time duration for which they played the game in case of Games 1 and 3. We will then record the performance of the player based on the game rating systems targeting the score obtained, the errors performed, and the accuracy of the gameplay. In case of Game 2, only the performance of the player will be recorded.
The stimulus music will be chosen from the same set as the previous experiments; however, longer durations (>3min) of the music will be used. The player will be

provided with headphones, and will listen to the music while playing the game(s). We wish to see the effect of the following types of auditory stimuli:

1. Negative valence, low arousal [High tempo + Low tempo]
2. Positive valence, high arousal [High tempo + Low tempo]

These categories have been chosen specifically for their distinct ability to induce polar affective states. We hypothesize that performance would be variable while stimuli varying in arousal and valence are being played, but the major role will be that of tempo and note strength.

Finally, the results of all these experiments and their controls (and additional supporting experiments as required) will be systematically analysed to determine how they support/refute the proposed models of time perception and subjectivity.

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