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Time Perception after Emotional Induction

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Abstract

Current literature establishes trends where valent stimuli can create a subjective experience of retrospective or prospective time. The purpose of this study is to examine the consequences of estimating time that has passed as a result of valence mood induction. Time seems to pass more slowly when we are not in a pleasant state. What if a self-induced mood could change our perception of time that has passed? To answer this question, our study required participants to write about specific memories about incidents of joy or sadness, or about the classroom around them for a control condition. There was no significant change in mood for the positive emotion group and a marginal change in mood for the negative emotion group. There were no significant interactions between time and group. Using recall of an episodic memory was not an effective emotional induction technique.

Time Perception after Emotional Induction

A simple way to define time perception is that it is the experience of how slowly or quickly time passes for an individual in a given situation. Many people are familiar with the expression "time flies when you are having fun" and trends in current literature suggest that temporal experiences are an integral part of sensory perception just like vision, hearing, olfaction, gustation, and taction (Grondin, 2010). Visual and auditory perceptions can be manipulated, and so can our ability to estimate the length of a given interval of time.

We can interpret an interval of time to pass more slowly or quickly than it actually is based on changes in environmental stimuli, attention, and emotion. Time perception is a function of attention and working memory. The frequency of time-monitoring behaviors indicates that the intentional allocation of attention to temporal cues can be linked to high levels of executive functioning (McFarland & Glisky, 2009).

Our ability to attend to visual or auditory stimuli in the environment depends on attentional processes. Attention as it relates to time perception is maintained through monitoring behaviors like glancing at a clock (McFarland & Glisky, 2009). For example, by comparing a group of high-functioning young adults to a group of older adults with executive functioning deficits, McFarland and Grisky (2009) found that those in the high-functioning group increased their monitoring behaviors as the target time interval neared its end. Those in the low-functioning group did not increase their monitoring behaviors, indicating that poor executive control over attention makes time pass more quickly than for those who were attending near the end of the time interval.

Measuring and Manipulating Perceived Time

There are two main paradigms in which time estimation is measured in experimental settings. The first is the retrospective time paradigm where participants make comparative judgments about the duration of an interval after it had occurred. The second paradigm is the prospective paradigm in which participants are asked to produce a given time interval without any reference time occurring first (Angrilli, Cherubini, Pavese, & Manfredini, 1997).

According to Grondin (2010), there are four methods of investigation that are commonly used to investigate retrospective and prospective time perception. These methods are Verbal Estimation, Reproduction, Production, and Method of Comparison. Verbal estimation requires participants to specifically name how many seconds, minutes, etc. passed during their exposure to the time interval. The method of reproduction requires participants to first experience a time interval and then try to recreate it themselves. This is typically done by pressing a trigger release button for the specified duration, which is recorded by computer. Production is very similar to reproduction with the exception that the participant does not experience the time interval, but instead is given direct instruction to create the target interval. Using the method of comparison gives experimenters the ability to assess participants' judgments of how short or long two consecutive time intervals are relative to one another (Grondin, 2010).

In most experiments concerning time perception, visual or auditory stimuli are used as markers for target intervals. The use of visual stimuli uses either blinking or static images of simple shapes that appear on a computer screen. A participant may be asked to give an estimation for how long the image appeared on the screen (McFarland & Glisky, 2009). Short mechanical tones are also used often as auditory markers for interval durations in time perception experiments.

Attention

Time perception is the amalgamation of attention, working memory, and temporal processing. Attention is a key player in time perception in the way that an individual does or does not attend to temporal information in a given context. In the case of short-term learning, the expectation of a stimulus marking the beginning or end of a time interval can create an expectation, and then cause the participant to experience time slowing down (Barnes & Jones, 2000).

To think about time perception and attention, let us compare the examples of a routine car ride versus finding a place for the first time. A routine car ride has a low cognitive demand because the route is familiar and does not require additional cognitive resources. In contrast, finding a place for the first time places moderate demands on attentional resources. The driver finding a new place is devoting attention to temporal information by monitoring the clock and stimulus information by expecting specific street signs to mark their next turn. Allocation of attentional resources to temporal information is enough to create a lengthening effect on perceived duration (Birngruber, Schröter, Schütt, & Ulrich, 2018; Matthews & Meck, 2016). A lack of cognitive or physical demand from the environment allows attention to be spent on temporal cues. Those temporal cues can be the time or even ticking of a clock, which can be easily monitored when there is no competition for attentional resources. Once the cognitive demand is increased by a change in the environment, temporal cues may not receive the same resources that vision, or hearing would.

Exposure to emotionally-charged stimuli or contexts can alter perceived time duration. Typically, images or situations that elicit feelings of anger or fear and are also highly arousing tend to make time slow down (Angrilli et al., 1997; Lui, Penney, & Schirmer, 2011; Smith, McIver, Di Nella, & Crease, 2011). This can partially be accounted for by an evolutionary perspective, where emotions like fear serve to increase attention and receive information about potential threats in the environment. If we continue to think about this evolutionary function of fear, it becomes hard to separate emotions and attention, as we are almost always experiencing varying combinations of high or low arousal and positive or negative valence (Angrilli et al., 1997; Smith et al., 2011). For example, in a car accident, our attention is increased because our bodies suddenly find themselves in a threatening situation. Emotion accompanies attention as it creates a call to action to navigate through potentially dangerous situations To keep the body safe, the brain increases attention and we are able to perceive the experience with greater detail. Spikes in arousal create heightened attention, and increased arousal often happens within a context accompanied by an emotional state (Droit-Volet & Gil, 2009; Matthews & Meck, 2016). When it comes to time perception, it is important to think of emotion and attention creating the context to either alter or maintain accurate perception of a time interval.

Emotions/ Emotional Induction

Emotionally salient stimuli like photographs or music are stimuli which can be used to induce mood. In most studies, photographs shown to participants as part of emotional induction are classified as possessing a positive or negative valence; valence is the intrinsic ‘goodness’ or ‘badness’ of the image. Negative valence in combination with high levels of arousal results in durations to be perceived as longer than they actually are (Angrilli et al., 1997; Grondin, 2010). In most of the experiments, emphasis is placed on the arousal that accompanies the emotional state. For example, stimuli meant to induce a state of fear should produce high levels of arousal so as to initiate a fight-or-flight response. Mainly, researchers use fear or anger for emotional induction procedures because it is easy to observe the direct changes that the induction may produce in physiological measures like heart rate or skin conductance (Smith et al., 2011). Valence (emotion) and arousal come together to create manipulation of time. The most significant interaction seen in literature is demonstrated when negative valence and high arousal cause individuals to significantly underestimate a given duration, i.e. time slows down (Angrilli et al., 1997; Grondin, 2010; Smith et al., 2011). Our study aims to evaluate the effectiveness of an uncommon emotional induction method and will not be including measurements of arousal.

Fear is regulated by the amygdala, and this structure initiates the fight or flight response to alert us to danger. There is evidence to suggest that the amygdala is responsible for altering time perception by its role in coloring stimuli with emotional overtones before they can be fully processed by the frontal lobe (Smith et al., 2011). Fear has a high salience in experimental settings and is used repeatedly to demonstrate induction into an emotional state. Anger is another emotion which frequently penetrates current literature. This emotion is used because of its activation of the sympathetic nervous system, which produces shorter reaction times and longer perceived duration of time in experimental settings (Cohen, Eckhardt, & Schagat, 1998; Smith et al., 2011).

If emotions that dramatically increase our arousal make time pass slowly, then could more moderate emotions demonstrate the same effect? Emotions such as joy, sadness, anger, and can be induced through private thought (Kuera & Haviger, 2012). In the case of Kuera and Haviger's article, emotional induction was completed by having a participant imagine a scenario. The procedure included a description of a situation and asked participants to imagine their feelings and responses to it. The researchers found that participants experienced the most successful mood inductions with fear and anger but reported higher levels of emotional awareness. Higher levels of the emotional awareness protect against the rapid decay of emotions.

Experiences of anger and fear produced lower levels of emotional awareness and experienced rapid decay (Kuera & Haviger, 2012).

Luan Phan, Wager, Taylor, & Liberzon (2002) identified a part of the brain which is activated by the use of episodic memory and emotional states. This structure is called anterior cingulate cortex and involved in emotional processing and episodic memory. The ACC works in tandem with the frontal lobe where working memory is regulated (Luan Phan, Wager, Taylor, & Liberzon, 2002). Identifying a brain structure that serves dual functions of both emotional processing and episodic memory provides validation for choosing to use an episodic memory task to induce mood. Reflecting on an episodic memory for several minutes will take advantage of neural activation of a specific portion of the brain which involves both the limbic system and cortical areas responsible for emotional regulation and directing attention. Using joy and sadness as the target emotions induced through the recall of an episodic memory will hopefully protect against mood decay seen in studies using emotionally-charged images to create altered perception of time intervals. Based on findings that indicate that time slows down for negative emotional states (Angrilli et al., 1997; Grondin, 2010; Smith et al., 2011), we predict that negative emotions will continue to make time feel longer and that positive emotions will show an opposite tendency to make time feel shorter.

Hypothesis: We predict that having participants recall of a joyful episodic memory will make time feel faster and recalling a sad episodic memory will make time slow down compared to a neutral mood condition.

Method

Participants

Undergraduate students from Eastern Illinois University were recruited from the introductory psychology course and received partial course credit for their participation in the research. 60 students in total participated with n= 20 per emotional group. Students provided written informed consent prior to the start of the procedure as per the requirements of Eastern Illinois University's Internal Review Board (IRB). All procedures were conducted on campus. Data collected from these participants were used as part of an honors thesis completed for course credit. Demographic information was collected via survey for reporting purposes. Each participant completed the procedure one at a time with only the experimenter present in the room with them. Participants ranged from age 18-25 with 78.3% female, 20% male, and 1.7% non-binary students. There were no exclusionary criteria for participation in this experiment. 58.3% of participants were Caucasian, 28.3% were African-American, and 6.7% were Latino, 5% Asian, and 1.7% 'Other'.

Materials

Mood induction

We created our mood induction procedure based on the findings of Keura and Haviger (2012) who found that the emotions of joy and sadness are less likely to decay quickly. Their study focused on awareness of the emotion and found that participants who underwent emotional induction procedures with sadness or joy showed high rates of emotional awareness and low decay.

For our study, participants responded to one of three writing prompts as part of the mood induction portion of the procedure. Responses to the writing prompts were written on lined notebook paper. Participants were instructed to write an appropriate response to their assigned prompt until instructed to stop by the experimenter. Each writing prompt asked the participants to recall a specific memory in which they felt either joy or sadness. Specific questions were included in the prompts to stimulate participants' thinking while writing. Some of these include ('how did you know you felt joy/ sad?' 'what does joy/ sadness feel like to you?'). In the neutral condition, participants were asked to write about the last classroom they were in. The experimenter stopped the writing session after seven minutes. All writing prompts were given to or discarded immediately after the completion of an experiment session with any given participant.

We used the Positive and Negative Affect Schedule (PANAS) as a manipulation check for emotional induction. The PANAS is 20-item questionnaire with 10 positive and 10 negative mood adjectives. Instructions for the PANAS ask users to rate each mood adjective based on their feelings in the past week. Each mood adjective is scored using a scale with 1 being "very slightly or not at all" to 5 being "extremely" accurate for feelings over the course of the past week (Crawford & Henry, 2004). For the purposes of this project, the experimenter modified the PANAS format and participants were given both written and verbal instructions to fill out the questionnaire based on how they felt at that exact moment in time. For data analysis, a positive affect score is obtained by summing 10 items, as is the negative affect score. Scores on each subscale can range from 10 – 50 points (Crawford & Henry, 2004).

Time Estimates

The researcher asked participants to give a 'thumbs up' to indicate when they perceived a time interval of 42 seconds to have elapsed. Responses to estimates of Time 1 and Time 2 were recorded using a stopwatch. The researcher recorded the elapsed time in a data collection sheet.

Participants did not receive feedback on their time estimates.

Procedure

Prior to the writing exercise, participants were instructed to give a ‘thumbs up’ to indicate when 42 seconds had passed, and then were given the PANAS questionnaire. Participants were assigned to one of three mood induction conditions: joy, sadness, or a neutral condition. Assignment to each emotional induction condition was done in ascending order as participants completed the procedure. Immediately after the writing session ended, participants were again instructed to give a ‘thumbs up’ to indicate when 42 seconds had passed, and then were given the PANAS questionnaire.

Results

Mood Induction

Overall, positive mood on the PANAS before mood induction was high across participants and remained high after mood induction. Levels of joy did not seem to be raised by responding to the writing prompt, but instead resulted in lowered negative mood reported on the PANAS questionnaires. However, these trends did not result in a significant interaction between time (before/after) and group (joy/sadness/neutral) on positive emotion $F(2, 57) = 2.32$, $p = .107$ (see Figure 1).

Negative mood increased in the sadness group and decreased in the joy group, but did not produce a significant interaction between the time and group on negative mood $F(2, 57) = 2.97$, $p = .059$ (see Figure 2). Our neutral groups experienced a decline in positive mood but did not show an increase in negative mood. There were only mild changes in mood which indicate that the method of emotional induction was not as effective for creating a significant change in participants’ moods.

Time Estimates

A 2 X 3 mixed ANOVA with time (before/after) as the within-subjects factor and group (joy/sad/neutral) as the between-subjects factors did not indicate a significant interaction between time and group on the time estimates of 42 seconds, $F(2, 57) = 1.40, p = .255$ (see Figure 3). However, in all three groups, time estimate 1 was lower than time estimate 2, resulting in a significant main effect for time $F(1, 57) = 49.977, p = .000$. This trend shows that time was moving faster for participants before the emotion induction and slower after the induction.

Discussion

The lack of significant findings for this experiment prevent us from being able to draw any formal conclusions. Instead, we can make a note of the trends that we saw in the results. We can see that the expression ‘time flies when you are having fun’ was true for our participants in the joy condition. While all groups showed time estimates lower than 42 seconds at Time 1, only the joy condition showed underestimation at Time 2. Generally, findings for positive emotional states (like joy or excitation) show a lack of consensus about their significance. We do not see a clear evolutionary role that positive emotions play in the same way that fear is a function of survival after encountering a threatening stimulus (Lui et al., 2011; Matthews & Meck, 2016; Smith et al., 2011). In our study, there was not much difference between the neutral group and the sadness group in the time by group interactions. These findings do not reflect patterns observed in other literature where negative emotions produced stronger changes in perceived duration than positive ones did (Angrilli et al., 1997; Grondin, 2010; Lui et al., 2011; Smith et al., 2011).

In this study, we tried to use a different method of emotional induction which was not commonly used in other referenced articles about time perception. Other researchers found significant interactions between time estimation and high negative valence (Angrilli et al., 1997; Droit-Volet & Meck, 2007; Grondin, 2010; Smith et al., 2011). One thing each of these studies has in common is that researchers showed participants an inventory of images in order to induce an emotional state in conjunction with high or low arousal. Our study did not include manipulation of or testing for arousal. Instead, we rested on the assumption that writing a response to a prompt for seven minutes would produce measurable changes in mood. We were unable to produce an effective emotional manipulation, and therefore did not see significant results on the Time x Group interactions. Viewing time perception only from the lens of an emotional condition is not adequate to fully understand the experience of altered time perception.

Limitations and Future Directions

There were several limitations which we experienced in creating our study. One possible explanation for the lack of significant difference in mood scores could be due to the PANAS not being sensitive enough to detect slight changes in mood. Another explanation could be that the writing prompts may not have been strong enough to produce a discrete change in mood. In other procedures using emotional induction, picture inventories are used to create high levels of arousal in participants from looking at gruesome human and non-human images (Droit-Volet & Meck, 2007; Smith et al., 2011). As an informal observation, we noticed that many of the participants struggled to write for the full seven minutes. This is to be expected of the neutral conditions but came as a surprise that those in the sadness or joy conditions found it difficult to write about a memory of their choice for seven minutes.

Participants may have had a hard time writing for the entire seven minutes due to their expectancy of instructions to stop. Expectation of a stimulus or marker can alter time without an emotional induction procedure (Birngruber et al., 2018). This study used a prospective interval production task in which participants were explicitly told what the target interval was. Some participants engaged in counting or tapping methods to provide themselves with temporal cues. As we have seen in literature on attentional resources, when attention is not purposefully allocated to temporal cues, we see that time moves more quickly (Barnes & Jones, 2000). For future studies, it is important to create a manipulation which does not allow participants to attend to temporal cues. Unlike the prospective paradigm used in our study, the retrospective paradigm can be easily used to ask for time estimates without the interference of deliberate temporal monitoring.

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Appendix

Figure 1

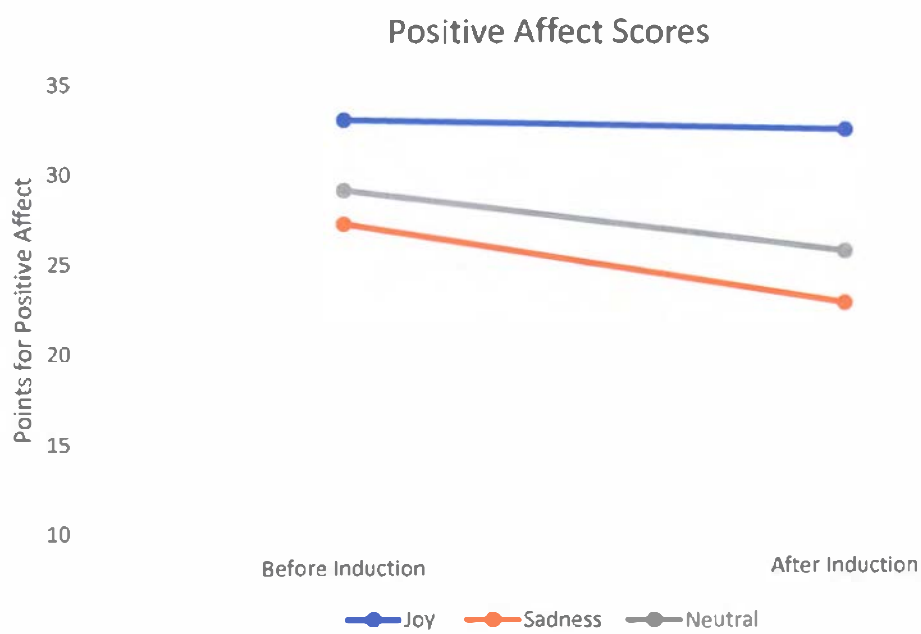
Positive Affect Scores
Points for Positive Affect
35
30
25
20
15
10
Before Induction
After Induction
Joy
Sadness
Neutral

Table 1

Summary Table for Two-Way Analysis of Variance of the Effects of Mood Induction and Time on Positive Mood

Source	*SS*	*df*	*MS*	*F*	*p*	η_p^2
			Between Subjects			
Mood Induction	1307.517	2	653.758	3.807	.028	.118
Error	9787.575	57	171.712			
			Within Subjects			
Time	200.208	1	200.208	9.919	.003	.148
Mood Induction X Time Interaction	93.817	2	46.908	2.324	.107	.075
Error	1150.475	57	20.184			

Figure 2

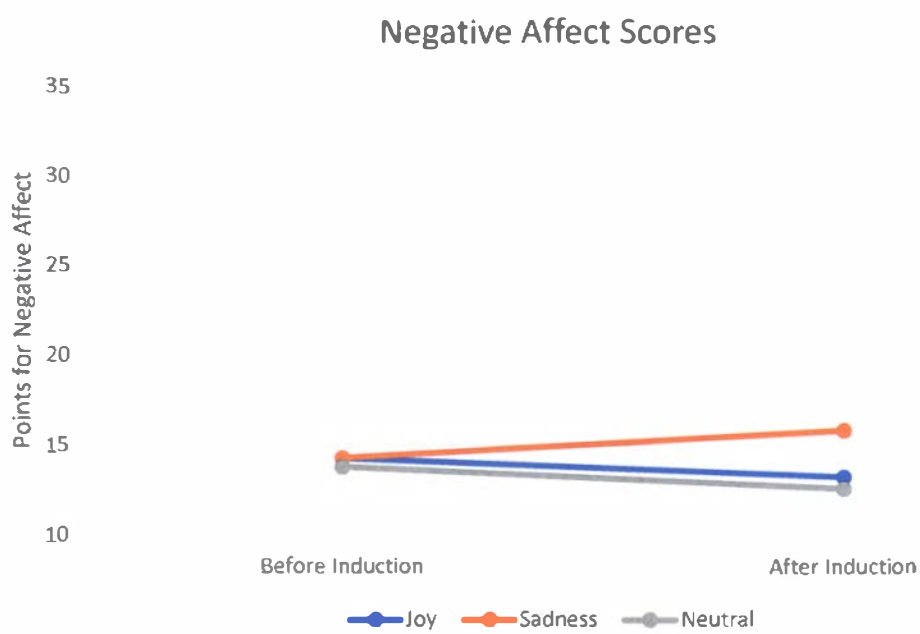
Negative Affect Scores
Points for Negative Affect
35
30
25
20
15
10
Before Induction
After Induction
Joy
Sadness
Neutral

Table 2

Summary Table for Two-Way Analysis of Variance of the Effects of Mood Induction and Time on Negative Mood

Source	*SS*	*df*	*MS*	*F*	*p*	η_p^2
			Between Subjects			
Mood Induction	90.050	2	45.025	.170	.844	.597
Error	15069.375	57	264.375			
			Within Subjects			
Time	1.633	1	1.633	.203	.654	.004
Mood Induction X Time Interaction	47.817	2	23.908	2.972	.059	.094
Error	458.550	57	8.045			

Figure 3


Time X Group
Time Estimation (in seconds)
44
42
40
38
36
34
32
30
Estimate Before Induction
Estimate After Induction
Joy
Sadness
Neutral

Table 3

Summary Table for Two-Way Analysis of Variance of the Effects of Mood Induction and Time on Time Estimation (in Seconds)

Source	*SS*	*df*	*MS*	*F*	*p*	η_p^2
			Between Subjects			
Mood Induction	90.050	2	45.025	.170	.844	.006
Error	15069.375	57	264.375			
			Within Subjects			
Time	1665.075	1	1665.075	49.977	.000	.467
Mood Induction X Time Interaction	93.350	2	46.675	1.401	.255	.047
Error	1899.075	57	33.31			