Impact of mood induction on temporal processing

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Abstract

The durations of negative events are overestimated when compared to the actual amount of time passed (Langer, et al, 1961; Meck, 1983). Similarly, emotionally valenced faces are temporally overestimated when compared to neutral ones (Droit-Volet, Bruno, & Niedenthal, 2004). In the current study, participants embodied emotion via mood induction prior to temporal estimation of neutrally valenced faces. Valenced mood induction led to overestimation of the duration of neutral faces. Results support the claim that embodiment of emotion can cause subjective temporal distortion.

Introduction

Several movies, advertisements, and societal icons portray the old adage, 'Time flies when you are having fun', but only recently did science begin investigating the legitimacy of this statement. Does subjective experience of duration really change when in emotionally valenced situations? Experiencing emotional events such as foot shocks (Meck, 1983) and approaching threatening stimuli (Langer, et al., 1961) results in overestimation of event duration, implying that subjective experience of time speeds up when participating in negative events. Simply put, negative situations produce the feeling of more time going by than has actually passed.

The current paper investigates the impact of emotions on temporal perception and the scalar theory of timing (Gibbon, 1977). Past research has found that humans overestimate the duration of emotionally valenced faces (Droit-Volet, Bruno, & Niedenthal, 2004), and the current study evaluates an embodied emotion premise for this subjective temporal bias. After mood induction, participants evaluated the duration of neutrally valenced faces. We hypothesized that participants in valenced moods would overestimate the duration of these neutral events, supporting the impact of embodied emotions on subjective temporal perception.

The Scalar Theory of Timing

A predominant theory of timing is the scalar timing theory (Gibbon, 1977) which comprises two fundamental properties: (1) the internal clock is, on average, accurate in estimating stimulus durations, and (2) the greater the mean duration of time has passed, the larger the variability of the internal clock's estimation. Three stages are outlined in scalar timing theory: (1) the clock stage, (2) the memory stage, and (3) the decision stage. During the clock stage, a pacemaker emits pulses that are stored in an accumulator, with more pulses representing longer durations. The accumulator is opened or closed with a mode switch, allowing specific events to be separated for temporal estimation. Once event timing is complete, the contents of the accumulator are stored for later use in the decision stage in working memory, where they are compared to previously experienced durations stored in long-term memory. The decision stage allows for appraisal of relative values in order to make an assessment of time.

In this scalar model of timing, an attentional system—which can allocate differential resources to incoming stimuli based on perceived importance—is added to the modal switch of the clock phase, helping explain erroneous time estimation. While scalar timing theory posits that the internal clock is generally accurate, over and under-estimation of time does occur. For example, previous research suggests

that attentional distraction can either delay the mode switch closing or prematurely open it, resulting in a net loss of pacemaker pulses. This loss results in an underestimation of time (Buhusi & Meck, 2006; Coull, et al., 2004; Lejeune, 1998; Macar, 2002; Meck & MacDonald, 2007).

Effects of Emotion on Attention and Timing

Emotional salience can significantly impact attentional priority, with highly emotional stimuli directing both conscious and unconscious attention away from neutral stimuli (Taylor & Fragopanagos, 2005). Emotional stimuli have been shown to: (a) be detected faster and more accurately than neutral stimuli, regardless of the number of distracters (Ohman, Flykt, & Esteves, 2001), (b) remain more detectable within an attentional blink paradigm, even persisting past the point at which neutral stimuli become minimally detected (Anderson & Phelps, 2001), and (c) capture automatic attention earlier than neutral stimuli when measured by event-related potentials (Carretie et al., 2004). Furthermore, affective priming's impact on emotional judgment (Murphy & Zajonc, 1993) and amygdala activation of backwards-masked emotional stimuli (Whalen, et al., 1998) also demonstrate how both detected and undetected emotional stimuli impact cognitive and neural processes involved with attention.

Recent findings have provided substantial evidence that emotions also impact temporal processing by causing overestimation of the duration of emotional: (a) events (Langer, et al., 1961; Meck, 1983; Stetson, Fiesta, & Eagleman, 2007), (b) faces (Droit-Volet, Brunot, & Niedenthal, 2004, Gil, Niedenthal, & Droit-Volet, 2007), and (c) other stimuli (Angrilli, et al., 1997; Noulhiane, et al., 2007). When experiencing stressful events, such as foot shocks (Meck, 1983), approaching threatening stimuli (Langer, et al., 1961), and forcing eye contact with an angry face (Schiff & Thayer, 1970), higher arousal level is hypothesized to increase the pacemaker's speed, thereby impacting the number of pulses acquired in the accumulator. In addition, a significant interaction between emotional valence and arousal has been found, with the duration of high arousal, negative stimuli being overestimated when compared to high arousal, positive stimuli (Angrilli, et al., 1997). The relationship is reversed when low arousal stimuli are presented, with the duration of negative stimuli being underestimated when compared to positive stimuli (Angrilli, et al., 1997). Finally, the durations of emotionally valenced faces (i.e. angry, happy, and sad) are significantly overestimated when compared to neutral faces in a duration bisection task (Droit-Volet, et al., 2004). These results are consistent with those of Schiff and Thayer (1970), who found that perceived duration of forced eye contact with an angry face was significantly longer than perceived duration of eye contact with a neutral face.

Together, these findings suggest that emotional stimuli, events, and faces impact the speed of the pacemaker invoked by scalar timing theory. Other research suggests that the impact of emotional faces on temporal processing may also involve embodied cognition of perceived emotion.

Embodiment of Emotion

Viewing emotional events, stimuli and faces similarly affect temporal processing, but a remaining question is whether the experience (embodiment) of emotions affects temporal estimates of neutrally valenced stimuli. Studies suggest that embodiment of emotions occurs when exposed to valenced faces (Chambon et al., 2008; Effron, et al., 2006). Embodiment of other groups' physiological behavior has been demonstrated by Bargh, et al (1996) with participants: (a) walking slower when exposed to elderly stereotype words in a word search, and (b) being more likely to interrupt when exposed to rude stereotype words. Similarly, Chambon, et al. (2008) hypothesized slowing down of the internal clock speed when exposed to elderly faces versus younger faces. Effron, et al. (2006) investigated if an embodied cognition approach could specifically explain the impact of emotional facial stimuli on temporal processing; indeed, inhibiting imitation of viewed facial expressions (by having participants hold a pen between their lips) eliminated any overestimation of the duration of valenced faces. These results suggest that imitation of facial

expression may influence timing processes, though additional evidence for the role of embodied emotion on temporal processing is needed.

The current study will thus further investigate the role of embodied cognition through evaluation of the implication set forth by Effron, et al. (2006). If perceived mood is embodied, and as such impacts temporal perception, similar effects should be seen when mood is induced and neutral stimuli are evaluated as when valenced stimuli are evaluated in a neutral mood. Induction of positive, negative and neutral moods was utilized to determine whether emotionally valenced mood leads to duration overestimation of neutral faces similar to the effect seen when timing valenced stimuli. If overestimation of neutral facial stimuli were found for those in a positive and negative mood, compared to participants in a neutral mood, results would indicate that subjective temporal distortion could occur via embodiment of emotion. The current study also evaluated the influence of emotion on the scalar timing theory, specifically the impact of emotional arousal and attention prioritization. Differences in point of subjective equality between moods revealed a bias shift, seen in previous literature, implicating an increase in pacemaker speed during emotionally arousing situations. Furthermore, attentional prioritization of any emotional stimuli used in previous studies was decreased through the use of neutral stimuli in this study, thereby allowing for the exclusive analysis of embodied emotional arousal on temporal perception.

Methods

Participants

Participants consisted of 32 undergraduates (males: n = 14, females: n = 18 in psychology classes at Utah State University (neutral mood: n = 12, positive mood: n = 7, negative mood, n = 13). Participants received course credit for participating.

Material: Apparatus and Stimuli

All participants were asked to complete a computer-based bisection task taking approximately 30 minutes. The experiment was run on a Dell Optiplex 755 computer with a 21

inch monitor in a dimly lit room. Participants sat approximately 45 cm from the display. The task stimuli were presented and data were recorded using E-prime, and participants made all responses using a keyboard. The stimulus presented for the practice trials was a white oval (9 x 10 cm) similar to that used by Droit-Volet, et al. (2004). One photo of a female face with a neutral expression, which had been coded using the Facial Action Coding System (Tracy, et.al., 2009), was used for the testing trials (44x .32 cm).

Procedure

Before the bisection task, a mood induction procedure was run in which each participant was presented with a series of either positive (n = 25), negative (n = 24), or neutral (n = 35) Velten statements (Velten, 1968) that progressed automatically on the computer screen over the course of 8 minutes. Participants were instructed to "read each and think about them as if you were experiencing them." This procedure has been used to induce both positive and negative moods in many previous studies (Jennings, et al., 2000; Sinclair, et al., 1994; Strickland, et al.1974).

Immediately following the mood induction, participants completed a temporal bisection task similar to the one used in Droit-Volet et al. (2004) with two trial phases: (1) practice, and (2) testing. Participants pressed the space bar to initiate each trial. In the practice phase, a white oval was presented for the longest (1600 ms) and shortest (400 ms) durations. Participants had to press the 'd' key if the duration was closer to 400 ms or the 'k' key if the duration was closer to 1600 ms. Each stimulus was presented 8 times, for a total of 16 trials. Accuracy feedback was given after each trial; positive feedback consisted of 'Correct!' displayed visually for 1500ms, while negative feedback consisted of 'Incorrect' displayed visually for 1500ms. Participants were then instructed to press the spacebar to begin the next trial. In the testing phase, participants were presented with a neutral face rather than a white oval as the stimulus to be timed, and feedback was eliminated. This face was presented for 18 trials each at each of 7 durations in random order, including the shortest and longest durations from the training phase and various

intermediate durations (400, 600, 800, 1000, 1200, 1400, and 1600 ms) for a total of 126 trials.

Results

For the training phase, participants in all mood conditions demonstrated accuracy on the bisection task prior to starting the test trials (neutral = 91.67%, positive = 98.43%, negative = 93.75%). For the testing phase, the mean proportion of long responses was calculated for each stimulus duration and separated by mood condition (see Figure 1).

To evaluate any significant differences between groups, a non-linear regression analysis was performed [model: $Y=1/(1+[x/T50]^{-E})$] followed by a statistical comparison of the slopes (E) and subjective mid-point (T50) using a student's t-test. No significant differences between slope were found across groups. The following significant differences between subjective mid-point (T50)—the stimulus duration that the participant is equally like to categorize as 'short' or 'long'--were found: (a) those in a positive mood had a significantly lower T50 than those in a neutral mood (t (15) = -4.414; p <.01; positive: T50 = 893; neutral: T50 = 948.6), and (b) those in a negative mood had a significantly lower T 50 than those in a neutral mood (t (21) = -3.187; p <.01; negative: T50 = 904.8; neutral: T50 = 948.6). Thus, lower points of subjective equality were found in the positive and negative mood groups, as compared with the neutral mood group, supporting the premise that induction of valenced moods causes overestimation of the duration of neutral events.
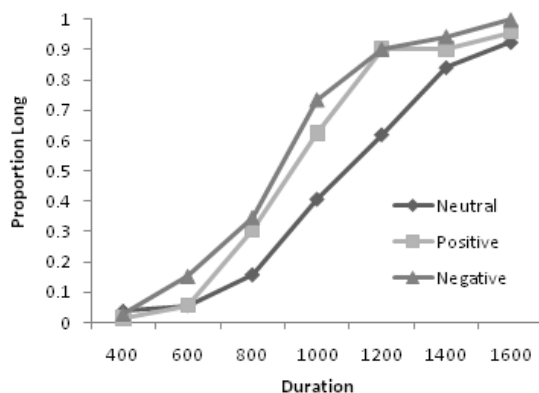

Figure 1. Proportion of 'long' responses for the duration of neutral facial stimuli for participants in neutral, positive, and negative moods.

As evidenced in Figure 1, this produces a leftward shift for the psychophysical functions of participants in valenced moods compared with neutral moods, and results in a bias to respond 'long'.

Discussion

The present findings replicate the effect of emotion on temporal perception found by Droit-Volet, et al. (2004) with emotionally valenced mood causing overestimation of neutral stimuli duration compared to duration estimation in neutral moods. The current use of mood induction, instead of emotional stimuli, supports the claims set forth by Effron et al. (2006) outlining the embodiment of perceived emotion significantly impacting temporal perception. The impact of experienced mood on temporal perception being identical to the impact of observed mood on temporal perception endorses the idea that embodying perceived emotion causes temporal bias when judging stimulus duration.

The current findings also speak to the influence of arousal on the scalar timing theory by illustrating a significant difference in point of subjective equality as well as no significant difference in sensitivity – slope- between groups. The use of neutrally valenced stimuli, as well as no slope differences between groups, indicates little if any impact of attentional demands on temporal perception. Furthermore, significant differences in point of subjective equality supports previous findings that arousal can impact pacemaker speed (Droit-Volet, et al., 2004; Gil & Droit-Volet, 2009). Positive and negative moods increase arousal levels, thereby causing faster pulse emission from the pacemaker and resulting in longer subjective judgment of time passed. Overall, in conjunction with previous research examining the effects of emotionally valenced stimuli on temporal perception, the current findings: (a) reveal the same impact via valenced mood induction on timing of neutral stimuli, and (b) suggest that

embodiment of emotions may distort temporal perception via increased arousal.

A body of research on depression and temporal perception suggests that the slowing of pacemaker speed in depressed individuals causes time to pass subjectively slower and underestimation of time (Blewett, 1992; Gil & Droit-Volet, 2009). There is a deceleration of general motor function in depression (Lemke, et al., 2000), however, manifested in reports of helplessness and resignation and not seen in non-depressed patients in a sad mood. This difference in motor function speed could account for the disparity in temporal perception in depressed and non-depressed patients. Regardless, differences in temporal perception between clinical populations with affective disorders (i.e. depression, bi-polar disorder) should be further addressed in future research.

Whether temporary valenced mood increases pacemaker speed or depression slows it, both support the idea that embodiment of emotions can drive temporal biases. When imitation of viewed facial expression is inhibited, for example, stimulus valence fails to impact temporal perception, suggesting that merely *perceiving* emotions in others is not sufficient to impact timing (Effron et al., 2006). The current finding that temporary mood induction produces the same effect on temporal perception as perceived mood further supports the claim that embodiment of emotions may play a mechanistic role in the influence of valence on timing.

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