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How much does emotional valence of action outcomes affect temporal binding?

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ABSTRACT

Temporal binding refers to the compression of the perceived time interval between voluntary actions and their sensory consequences. Research suggests that the emotional content of an action outcome can modulate the effects of temporal binding. We attempted to conceptually replicate these findings using a time interval estimation task and different emotionally-valenced action outcomes (Experiments 1 and 2) than used in previous research. Contrary to previous findings, we found no evidence that temporal binding was affected by the emotional valence of action outcomes. After validating our stimuli for equivalence of perceived emotional valence and arousal (Experiment 3), in Experiment 4 we directly replicated Yoshie and Haggard's (2013) original experiment using sound vocalizations as action outcomes and failed to detect a significant effect of emotion on temporal binding. These studies suggest that the emotional valence of action outcomes exerts little influence on temporal binding. The potential implications of these findings are discussed.

1. Introduction

Temporal binding refers to the compression of the perceived time interval between voluntary actions and their sensory consequences (Haggard, Clark, & Kalogeras, 2002). More specifically, an outcome (e.g., a tone) is experienced earlier when it is triggered by a voluntary action compared to when it occurs in isolation or is triggered by an involuntary movement. Similarly, actions that trigger an event are experienced later than actions with no discernible outcome (see Moore & Obhi, 2012, for a review). For example, Haggard et al. (2002) examined judgements of the onset time of both a voluntary action and a resulting tone using the Libet clock method (Libet, Gleason, Wright, & Pearl, 1983), where one estimates the time of onset of an action or outcome via the position of a rotating clock-hand around a clock-face. These judgements were compared to those made when only the action was performed (i.e., with no outcome) and when a sound was heard in isolation (i.e., without a prior cause). Haggard et al. found that the perceived time of an action was later when the action produced a tone compared to when there was no outcome. Moreover, the perceived time of a sound was earlier when the sound had been produced by an action compared to when it was heard in isolation. In other words, temporal binding means that the time interval between an action and its outcome becomes perceptually compressed when we think there is a causal relationship between action and outcome. Temporal binding has also been observed with methods other than the Libet task, such as verbal or numerical estimates of the interval between action and outcome (Buehner & Humphreys, 2009; Humphreys & Buehner, 2010). Temporal binding has been shown to occur for both self- and other-generated actions (Moore, Teufel,

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Subramaniam, Davis, & Fletcher, 2013; Poonian & Cunnington, 2013) and may be a general phenomenon linking causally related events (Buehner, 2012).

To date, researchers have mostly investigated the conditions required for temporal binding and the mechanisms that underpin it (Hughes, Desantis, & Waszak, 2013), and they have done so using experimental tasks that often involve basic actions, such as a button press, producing sensory feedback, such as an auditory tone (David, Newen, & Vogeley, 2008; Sato & Yasuda, 2005). These temporal binding tasks arguably lack any real-world complexity with which humans perform goal-directed actions to produce meaningful outcomes in everyday life (Moretto, Walsh, & Haggard, 2011). Researchers have started to examine the generalizability of temporal binding effects to stimuli beyond simple and arbitrary outcomes, such as priming social cues (Aarts et al., 2012), authorship of action cues (Desantis, Weiss, Schütz-Bosbach, & Waszak, 2012), leader-follower cues (Pfister, Obhi, Rieger, & Wenke, 2015) and economic and pain cues (Caspar, Christensen, Cleeremans, & Haggard, 2016). For example, Aarts et al. (2012) found that, when primed with a positive picture (taken from the International Affective Picture System; Lang, Bradley, & Cuthbert, 1999) that indicated a reward, temporal binding during the Libet clock task increased compared to neutral primes. Takahata et al. (2012) trained participants to associate two tones with either financial gain or loss. Using the Libet task, they found that the temporal interval between judgements of onsets for actions and outcomes of financial loss was significantly larger than for judgements of financial gain. In other words, negative outcomes reduced the effect of temporal binding. This points towards the possibility that the effect of valence on temporal binding might be driven by self-serving biases, where one is more inclined to associate positive events with the self compared to negative events (Mezulis, Abramson, Hyde, & Hankin, 2004; Miller & Ross, 1975).

Yoshie and Haggard (2013) directly tested this idea by investigating whether temporal binding differed between outcomes that varied in terms of their intrinsic emotionality. They asked participants to make voluntary actions (a key-press) that produced auditory sounds that were either of positive or negative emotional vocalizations (e.g., laughter or disgust). Participants made temporal estimations of their actions and the ensuing sound via the Libet clock method. They found that positive sounds produced shorter estimations of onset-time between the action and sound compared to negative sounds (Experiment 1), with this effect being mostly driven by decreased binding to negative outcomes (Experiment 2).

Yoshie and Haggard's (2013) research provided promising evidence that negative emotional outcomes reduce temporal binding, which occurs presumably because people are less inclined to attribute negative outcomes to themselves. However, despite the potential importance of Yoshie and Haggard's (2013) findings, they have yet to be replicated using other temporal binding tasks and different emotionally-valenced action outcomes. Thus, answering Christensen, Yoshie, Di Costa, and Haggard's (2016) call for more research exploring the emotional modulation of temporal binding using alternative methods, the goal of the current research was to conceptually replicate Yoshie and Haggard's (2013) temporal binding effects using an interval estimation procedure (vs. the Libet task; Moore & Obhi, 2012) and images of faces conveying positive and negative emotions (vs. emotional vocalizations; experiments 1 and 2). Moreover, we conducted a separate study to validate the perceived valence of the face stimuli we used in Experiments 1 and 2 (Experiment 3), and we conducted a highly-powered direct replication of Yoshie and Haggard's first experiment (Experiment 4). On the basis of Yoshie and Haggard's findings, we expected that temporal binding would be smaller for negative outcomes (faces or vocalizations conveying negative emotions) than for positive outcomes (faces or vocalizations conveying positive emotions).

2. Experiment 1

We used an interval estimation procedure to gauge temporal binding (Ebert & Wegner, 2010; Engbert, Wohlschläger, & Haggard, 2008; Moore, Wegner, & Haggard, 2009). In this procedure, participants are asked to judge the time interval between an action and its sensory outcome (e.g., a button press and a sound). Using this procedure, Engbert et al. (2008) found that the interval between voluntary actions and visual, auditory, and somatic outcomes were compressed compared to the interval between passive actions and similar outcomes. For our task, participants were asked to press the space bar, which was followed by emotionally valenced action-outcomes—namely, emoticons depicting positive, neutral, or negative

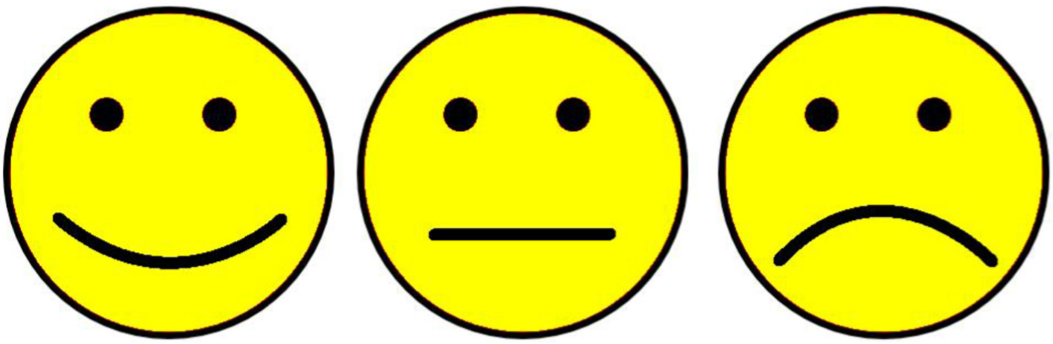

Fig. 1. Emoticons used in Experiment 1.