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The Link Between Temporal Attention and Emotion: A Playground for Psychology, Neuroscience, and Plausible Artificial Neural Networks

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Abstract. In this paper, we will address the endeavors of three disciplines, Psychology, Neuroscience, and Artificial Neural Network (ANN) modeling, in explaining how the mind perceives and attends information. More precisely, we will shed some light on the efforts to understand the allocation of attentional resources to the processing of emotional stimuli. This review aims at informing the three disciplines about converging points of their research and to provide a starting point for discussion.

Keywords: Attention, Emotion, Cognitive Science.

1 Introduction

In this paper, we address the endeavors of three disciplines, Psychology, Neuroscience, and Artificial Neural Network (ANN) modeling, in explaining how the mind perceives and attends information. More precisely, we address the efforts to understand the allocation of attentional resources to the processing of emotional stimuli. By bringing the three disciplines together, we aim at informing researchers about some of the recent advances in the other disciplines: whereas temporal attention and emotion are often studied separately, and with very disciplinary approaches, we argue that advances in one domain can help to refine the others. We further argue that the interplay between Psychology, Neuroscience, and ANN modeling lies in the constraints that each discipline can impose on the others, offering converging evidence towards one common goal. To focus our enterprise, we will address results from studies investigating the modulation of *temporal attention* by emotional stimuli. Temporal attention contrasts with other types of attention, like spatial attention, by setting the focus on the unfolding allocation of attentional resources to the processing of stimuli over time, and the underlying processing dynamics. Studies addressing temporal attention use experimental paradigms like Rapid Serial Visual Presentations (RSVP), for which it has been shown that emotional stimuli elicit particular patterns of response. Our paper is structured as follows. In the next section, we present the recent theoretical advances in emotion psychology with regards to

the modulation of temporal attention by emotion. The third section describes the brain mechanisms highlighted by neuroscience, pointing out the key areas of the brain involved in the cognitive functions of attention and emotion, and the brain mechanisms underlying their interaction. In the fourth section, we will briefly present some of the ANN modeling proposed to account for the modulation of temporal attention. We will conclude by highlighting some of the issues an interaction between Psychology, Neuroscience, and ANN modeling can help to resolve.

2 Psychological Perspectives on Pre-attentive Processes and Emotion

Psychology plays a major role in preparing the stage for the interplay between the disciplines. In this section, we will first describe the modulation of temporal attention by emotion, along with some of the behavioral results issued from experimental psychology. We will then introduce two sets of theories that have a special interest in describing the unfolding dynamics underlying the allocation of attentional resources to the processing of emotional stimuli.

2.1 The Modulation of Temporal Attention by Emotion

In a typical RSVP experiment, participants are presented with rapidly flowing images (presented at a frequency ± 10 Hz), one replacing the other at the same spatial location on the screen. Participants are asked to spot and perform tasks on one or more targets embedded within distracting images. Varying the time interval between two targets renders it possible to indirectly measure the amount of resources that is allocated to the processing of targets: results in a typical dual task experiment indeed show that the perception and processing of a first target (T1) hinders the perception and processing of a second target (T2) if it appears within 200-400 milliseconds after T1 (Figure 1). This phenomena has been rhetorically named an "Attentional Blink" (AB) [13]. Interestingly, emotional targets seem to benefit from a processing bias, alleviating the blink. If extensive research has been done on temporal attention, surprisingly little has been devoted to the modulation of temporal attention by emotion.

In an early study, Anderson and Phelps [1] showed that, not only did negative words alleviate the typical blink response compared to neutral words, but also that the amygdala was critical to benefit from the emotional significance of the words. These authors concluded that a critical function of the human amygdala is to enhance the perception of stimuli that have emotional significance. As we will discuss in the next section of the paper, the amygdala seems to play an important role in the interaction between attention and emotion. The modulation of the blink by the intrinsic significance of the targets has also been reported in a study showing that participants did not experience an AB for their own names but did for either other names or nouns [18]. Equivalent results have been reported when T2 targets were familiar faces compared to unfamiliar faces, the former