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The cognitive locus of distraction by acoustic novelty in the cross-modal oddball task

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Abstract

Unexpected stimuli are often able to distract us away from a task at hand. The present study seeks to explore some of the mechanisms underpinning this phenomenon. Studies of involuntary attention capture using the oddball task have repeatedly shown that infrequent auditory changes in a series of otherwise repeating sounds trigger an automatic response to the novel or deviant stimulus. This attention capture has been shown to disrupt participants' behavioral performance in a primary task, even when distractors and targets are asynchronous and presented in distinct sensory modalities. This distraction effect is generally considered as a by-product of the capture of attention by the novel or deviant stimulus, but the exact cognitive locus of this effect and the interplay between attention capture and target processing has remained relatively ignored. The present study reports three behavioral experiments using a cross-modal oddball task to examine whether the distraction triggered by auditory novelty affects the processing of the target stimuli. Our results showed that variations in the demands placed on the visual analysis (Experiment 1) or categorical processing of the target (Experiment 2) did not impact on distraction. Instead, the cancellation of distraction by the presentation of an irrelevant visual stimulus presented immediately before the visual target (Experiment 3) suggested

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that distraction originated in the shifts of attention occurring between attention capture and the onset of the target processing. Possible accounts of these shifts are discussed.

Keywords: Novelty detection; Attention capture; Oddball task; Auditory distraction; Electrophysiology

1. Introduction

While efficient everyday functioning often requires the ability to selectively attend to some stimuli, it is equally important to maintain a certain degree of distractibility by task-irrelevant but otherwise potentially relevant events. Detecting an event violating the regularity of previous stimuli can for example warn of an imminent danger (e.g., an unexpected change in an aircraft engine's noise may signal a malfunction). In some circumstances, the propensity of transient environmental changes to capture our attention can have dramatic effects. For example, a report by the US National Transportation Safety Board examining 37 major accidents of US carriers from 1978 to 1990 revealed that nearly half these accidents involved lapses of attention associated with interruptions, distractions, or preoccupation with one task to the exclusion of another (Dornheim, 2000).

The distractive value of task-extraneous sound has been demonstrated in a variety of settings. For example, past research has shown that continuous irrelevant changing sounds can impair, for example, order memory (e.g., Jones, Alford, Bridges, Tremblay, & Macken, 1999; Jones, Farrand, Stuart, & Morris, 1995; Jones & Macken, 1993; Jones, Madden, & Miles, 1992; Tremblay, Macken, & Jones, 2001) and various office tasks (Banbury & Berry, 1997, 1998). Single auditory stimuli can also disrupt cognition by capturing attention away from ongoing cognitive processes, as shown in serial memory (Hughes, Vachon, & Jones, 2005; Lange, 2005), arithmetic (Woodhead, 1964), visual comparison (Woodhead, 1959), or motor pursuit tasks (Jones & Broadbent, 1991; May & Rice, 1971).

The present study examines the distraction occurring when stimuli in our environment deviate from the events expected by our cognitive system. As will become clear in the next pages, such distraction relates to core aspects of cognition, such as its tendency to build mental models of events to help deal with upcoming stimuli, and its propensity to orient attention towards events violating such models. The present study sought to examine the distraction yielded by such orientation responses. Specifically, it investigated whether attention-grabbing distractors impair ongoing cognitive performance due to competition for attentional resources or due to dynamic shifts of attention to and from distractors.

It is well established that infrequent auditory changes (so called oddball stimuli) in a train of repetitive stimuli capture attention in an obligatory fashion. From an electrophysiological standpoint, the brain response to auditory novelty is characterized by three specific responses, even when novel sounds are unrelated to the participants' task. These responses, referred to as the 'distraction potential' (Escera & Corral, 2003) are: the mismatch negativity (MMN) and the enhancement of N1 generators