Research Collection: On Theoretical Advancement in Auditory Distraction Research

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Introduction

One challenge in daily life is to remain focused on the array of environmental stimuli that are relevant to one's current goal while simultaneously ignoring that which is irrelevant. For example, to satisfy the goal of efficiently reading this text you must focus on the shapes that make up the words on this page whilst ignoring the computer fan or sounds outside. The selective attention system, however, must be dynamic and flexible: While there is a need to continue focusing on information relevant to one's task, there is also a need to simultaneously process other environmental information. Attention must not be too rigidly focused, else a potentially important change in the environment, that conveys information more important than our immediate goals, would be incapable of wresting our attention. For example, if a smoke alarm were to sound while you are reading this, it is important that your attention can be readily switched toward it since this new goal should be prioritized by the cognitive system. The selective attention system must therefore be permeable. However, this openness of the cognitive system to the processing of task-irrelevant stimuli, whilst indispensable, can bring about undesired distraction: The performance of a focal task can be disrupted by the processing of task-irrelevant stimuli. Such distraction can occur regardless of whether the task-irrelevant stimulus requires a response. The effects of openness are particularly apparent in relation to irrelevant auditory stimuli whereby unwanted distraction is a price we pay for a dynamic and flexible cognitive system that permits the simultaneous focus on task-irrelevant information and the gleaning of information from task-irrelevant sources. We are therefore often at the mercy of our auditory environments. Such distractibility is underscored by the nature of our hearing. Unlike vision in which the eyelids can be closed or one can avert their gaze to prevent processing of unwanted stimuli, there are no equivalent means by which this can be achieved with audition. Hearing is always "on" and registering sound even in conditions of darkness.

In terms of the underpinnings of distraction, a monolithic view is often presented. For example, the Merrian-Webster dictionary's definition of "distraction" is:

"something that distracts: an object that directs one's attention away from something else".

Further, the Cambridge dictionary defines "distraction" as:

"something that prevents someone from giving their attention to something else"

These definitions arguably epitomize many lay people's view that distraction is something that happens when an object/stimulus either causes the disengagement of attention from a focal task towards the object/stimulus responsible for producing the distraction or prevents someone from attending to a focal task. The underlying assumption of this view is that distraction can only occur via a single mechanism (diversion of attention). In many ways such a parsimonious explanation is attractive; after all, the more assumptions one must make about the occurrence of an effect, the more unlikely the explanation (Occam's Razor). However, over the last 25 years or so, a lively and active debate has centered on whether there exists a variety of different auditory distraction effects that can be dissociated through empirical manipulations and behavioral and psychophysiological measures.

For example, it has been found that some types of irrelevant sound (e.g., changing-state sound such as speech or varying tones) produce distraction only in tasks that require *serial-order processing* (e.g., serial recall from short-term memory), whereas other types of distractors such as isolated auditory deviants appear to be less task-specific (e.g., Beaman & Jones, 1997; Jones & Macken, 1993; Hughes et al., 2007). Further, the disruption

produced by phonological or semantic similarity between visual targets and auditory distracters is more pronounced with free, as compared to serial, recall requirements (Marsh et al., 2008a, b) wherein semantic and phonological cues can facilitate task performance. In addition, meaningful speech (that participants can comprehend) produces disruption relative to meaningless speech (incomprehensible to participants) in a reading task when requirement is to decide whether a read sentence is sensical, but not when deciding if it contains a nonsense character (Meng et al., 2020). Therefore, the match between the type of sound and the type of task appear to have a joint influence on the manifestation of distraction, leading to simple (e.g., changing-state sound being disruptive in task A, but not in task B, whereas an auditory deviant disrupts both tasks) or double dissociations (e.g., semantic properties affect task A, but not task B, whereas phonological properties affect task B, but not task A).

In addition, there is evidence suggesting that the distraction produced by changing-state sound (as compared to repeated sounds) is less susceptible to *cognitive control* than the distraction produced by auditory deviants. Specifically, enhanced demands for perceptual task-encoding (visually degrading the to-be-remembered stimuli), visual attention (i.e., preventing global processing by directing attention to local features), and inhibitory control (e.g., asking participants to recall the serial order of font colors of color words presented on the screen, which requires the inhibition of automatic reading processes) were found to eliminate the disruptive effect of auditory deviants, whereas the same manipulations did not affect the changing-state effect on serial short-term memory (e.g., Hughes et al., 2013; Marsh et al., 2020; Hughes & Marsh, 2020). Furthermore, it has been reported that the deviation effect, but not the changing-state effect is related to individual differences in *working-memory capacity* (Hughes et al., 2013; Sörqvist, 2010; Sörqvist et al., 2013) and there is some evidence that *foreknowledge* about the content of an impending auditory sequence reduces the deviation effect but not the changing-state effect (Hughes et al., 2013).

Others, however, found that neither the changing-state effect nor the deviation effect was susceptible to the level of task engagement as induced through monetary incentives (Bell et al., 2021) and that both types of distraction were equally unrelated to working-memory capacity (Körner et al., 2017). Furthermore, there is some inconsistency in the evidence for a protecting effect of foreknowledge on auditory distraction, with some evidence suggesting that foreknowledge does not diminish the deviation effect (Bell et al., 2017). There is also some evidence to suggest that any attenuation of the disruptive effect of background speech by foreknowledge is related to the semantic/syntactic properties of speech rather than its acoustic changing-state properties (Hughes & Marsh, 2020) which suggests that these effects may be a sub-type of attentional diversion produced by the particular content of sound. Such stimulus-specific attentional capture can also be observed through the disruptive power of one's own name (Röer et al, 2013), valent words (Buchner et al., 2004; Marsh et al., 2018) taboo words (Röer et al., 2017), and one's own ring-tone (Roye et al., 2010). Taken together, there are studies suggesting that there may be two or more functionally distinct forms of auditory distraction while there is also evidence for a graded attentional account of distraction that does not make such a distinction (Bell et al., 2019).

The Aim of the Research Collection

There currently exists a tension within the literature on auditory distraction concerning the types of sound that produce distraction as well as whether the impact of certain distracters is mediated by task-parameters and factors relating to endogenous and exogenous control. For example a stable disposition for top-down control (e.g., as indexed by Working Memory Capacity; endogenous control) and an increase in top-down control as the result of contextual factors such as the difficulty of the task (e.g., task-engagement/task-induced differences in cognitive control; exogenous control) have both been shown to

ameliorate the disruptive effect of some types of distracter (Hughes et al., 2013; Marsh et al., 2017; but see Körner et al., 2017).

One aim of this Research Collection is to critically evaluate the notion that there are different varieties of auditory distraction characterized by behavioral and physiological signatures. We invited empirical studies and reviews that addressed the reliability or replicability of dissociation/double dissociations between different varieties of auditory distraction. From this approach, we hoped to see the emergence of a framework detailing under what conditions task-specific and non-task specific forms of distraction emerge. We also hoped that contributions to the special issue would lead to a more elaborated theoretical account that could deal with inconsistent findings that have emerged within the literature.

In addition to this, we welcomed submissions on topics exploring varieties of auditory distraction, including those that test the veracity of various proposed dissociations. These research topics included **task-parameters** (whether differences in auditory distraction emerge as a function of task properties; e.g., endogenous attentional control over exogenous attentional capture; visual-verbal or visuo-spatial serial recall), **type of sound** (steady or changing-state sound, aspecific or specific forms of auditory attentional diversion) and their differential susceptibility to cognitive control associated with **trait or dispositional factors** (e.g., working memory capacity, auditory selective attention). We also welcomed papers that focus on behavioral vs. psychophysiological indicators of auditory distraction including the event-related potential (ERP) method and pupillary responses.

Papers accepted for Research Collection will appear across multiple issues. Three articles appear in the current issue. The first paper in this initial trio is entitled “Distraction by auditory categorical deviations is unrelated to working memory capacity: Further evidence of a distinction between acoustic and categorical deviation effects”. Within this article Labonté et al. (2022) provide evidence that the disruption to performance of a focal task produced by

an unexpected acoustic change (acoustic deviation) in a task-irrelevant auditory background may be different from that produced by an unexpected semantic change (categorical deviation). They demonstrate that working memory capacity (WMC)—associated with a stable disposition for attentional control—is associated with disruption produced by an acoustic deviation but not that produced by a categorical deviation. The novel evidence that provide suggests that the categorical deviation effect, unlike the acoustic deviation effect, might not be underpinned by an attentional capture mechanism.

The second paper in the Research Collection appearing in this issue is entitled "Auditory distraction in the item-color binding task: Support for a general object-based binding account of the changing-state effect". In this article Bell et al. (2022) critically evaluate the notion that impaired of task performance produced by a sequence of changing as compared to non-changing (steady-state) sounds is dependent on serial order processing (e.g., serial rehearsal) within the focal task. Across two experiments, the authors demonstrate that changing sounds disrupt mnemonic binding between an item (e.g., a word) and the colored rectangle in which it was presented. Participants had greater difficulty assigning a word to a colour if the pairings had previously been presented in the presence of changing against steady-state sounds. Accuracy of performance on the color-binding task did not demonstrate serial-position curves akin to those of visual-verbal serial recall. Bell et al. (2022) reach the conclusion that the changing-state effect may represent disruption of a generalised item-to-context binding mechanism as compared to a disruption attributable to a clash of an automatic seriation process applied to sound and deliberate serial order processing applied to visual items through serial rehearsal (interference-by-process; Jones & Tremblay, 2000).

The final paper of the initial trio is entitled "The role of joint influence on the cross-modal Stroop effect: Investigating time course and asymmetry". In this article Medina et al. (2022) address the joint influence account (Francis et al., 2017) and the word production

architecture account (Roelofs, 2005) in the context of the cross-modal Stroop effect whereby typically naming of a color patch is disrupted more by a spoken color word as compared to a neutral word. Across three experiments, Medina et al. (2022) varied the time-course of targets and distracters and investigate the potential asymmetry of visual and auditory targets to determine the mechanism underpinning interference. They provide support for both the word production architecture account (Roelofs, 2005) and the joint influence account (Experiments 2 and 3) whereby target and distractor integration plays a primary role in the magnitude of cross-modal Stroop effects.

We wish to thank the co-editors of *Auditory Perception and Cognition*, Michael Hall and Michael Russell for supporting our conception and development of the Research Collection which is intended to bring together leading researchers within the field of auditory distraction who have made important advances within this area. We hope that the articles that follow over subsequent issues, like the trio appearing within the current issue, raise numerous exciting questions and future directions for research within the area of auditory distraction.

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