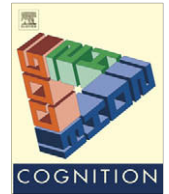




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## Interference by process, not content, determines semantic auditory distraction

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### ABSTRACT

Distraction by irrelevant background sound of visually-based cognitive tasks illustrates the vulnerability of attentional selectivity across modalities. Four experiments centred on auditory distraction during tests of memory for visually-presented semantic information. Meaningful irrelevant speech disrupted the free recall of semantic category-exemplars more than meaningless irrelevant sound (Experiment 1). This effect was exacerbated when the irrelevant speech was semantically related to the to-be-remembered material (Experiment 2). Importantly, however, these effects of meaningfulness and semantic relatedness were shown to arise only when instructions emphasized recall by category rather than by serial order (Experiments 3 and 4). The results favor a process-oriented, rather than a structural, approach to the breakdown of attentional selectivity and forgetting: performance is impaired by the similarity of process brought to bear on the relevant and irrelevant material, not the similarity in item content.

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### 1. Introduction

One of the most influential constructs in memory research is *interference*: the ease with which items are retrieved from memory is dictated, at least in part, by other stimuli or events that are similar in some way to the target (see, e.g., Anderson, 2003; Baddeley, 1986; McGeoch, 1942; Nairne, 1990; Nairne, 2002; Neath, 2000). The classical, structuralist, view has been that such interference-by-similarity-of-content directly causes forgetting, that is, forgetting is a passive side-effect of structural changes that result from the storing of new, similar, events in memory (Anderson, 1983; Cowan, 1999; McGeoch, 1942; Mensink & Raaijmakers, 1988; Oberauer & Lange, 2008; Oberauer, Lange, & Engle, 2004; Salamé & Baddeley, 1982). However, an alternative, more functional, view is that ‘forgetting’ (or the impairment of retrieval) reflects the legacy of dynamic and adaptive selective attention

processes (such as inhibition; e.g., Houghton & Tipper, 1994) that are designed to resolve conflict during the selection of candidates at retrieval (e.g., Anderson, 2003). Set within this quintessentially attentional approach to forgetting, the present article explores the nature of phenomena relating to impaired retrieval from memory due to distraction from irrelevant auditory events using the structuralist, interference-by-similarity-of-content, approach as a theoretical counterpoint.

One line of research in which a dynamic selective attention framework has been used to reconstrue putatively mnemonic phenomena is that concerned with the disruptive effects of to-be-ignored sound on visual-verbal serial recall whereby a list of around 6–8 verbal items (e.g., letters or digits) is to be recalled in strict serial order (the irrelevant sound effect—hereafter ISE—e.g., Colle & Welsh, 1976; Jones, Madden, & Miles, 1992; Jones & Tremblay, 2000; Salamé & Baddeley, 1982). The mere presence of background sound depresses serial recall appreciably, the weight of evidence favoring the view that the effect results from interference-by-process, and is not a passive side-effect of having similar items to remember and to ignore

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(Hughes & Jones, 2005; Jones & Tremblay, 2000). Specifically, this ‘classical’ ISE is thought to result from the obligatory, preattentive, seriation (or ordering) of sound sequences producing competition for the deliberate process of seriating the to-be-remembered items. Here we examine whether the principle of interference-by-process can be extended to a setting in which the focal memory task involves not serial processing but semantic retrieval strategies: Does the concurrence of similar semantic processing (rather than serial processing) applied to relevant and irrelevant material now dictate the form and degree of distraction? What little evidence there is seems to suggest that the structural accounts seem perfectly adequate in this context, that is, disruption from irrelevant sound in semantic memory seems amenable to a classical, and arguably simpler, ‘interference-by-content’, explanation (Beaman, 2004; Neely & LeCompte, 1999) rendering the ‘interference-by-process’ account rather paradigm-bound to serial short-term memory. The goals of the present series were to revisit the empirical signature of auditory distraction in the context of episodic short-term memory tasks that tap semantic memory processes (particularly given the paucity of studies on the issue) to establish the degree to which it is distinct from that found in serial recall, and to examine thereafter how such distinct phenomena might be reconciled with a dynamic process-oriented approach to interference.

### 1.1. Irrelevant sound effect in serial recall

The debate between the structuralist and process-based standpoints can be observed in microcosm in a body of research showing that the presence of irrelevant, to-be-ignored, sound markedly increases forgetting in a (usually visually-presented) serial recall task (e.g., Colle & Welsh, 1976; Jones et al., 1992; Salamé & Baddeley, 1982). The conventional viewpoint, that forgetting can occur as a direct and passive consequence of the structural similarity between to-be-remembered and irrelevant episodes or stimuli (e.g., McGeoch, 1942), is evident in several theoretical accounts of the ISE that view it as a mere consequence of auditory stimuli gaining access to the same representational space as the to-be-remembered items (e.g., phonological store, Burgess & Hitch, 1992; Gathercole & Baddeley, 1993; Salamé & Baddeley, 1982; primary memory, Neath, 2000). Although these accounts differ in their detail of how interference arises, the important point for present purposes is that they are all examples of an interference-by-content approach: recall is impaired as a result of the similarity in identity (i.e., content) between to-be-remembered and to-be-ignored items.

Several strands of evidence converge to weaken the interference-by-content approach. First, non-speech sounds such as tones—which bear little or no resemblance to the to-be-remembered items—produce disruption similar in degree and kind to that from irrelevant speech (e.g., Jones & Macken, 1993; Neath & Surprenant, 2001). Second, the magnitude of disruption is unrelated to the degree of phonological similarity between to-be-remembered and to-be-ignored items (Jones & Macken, 1995; LeCompte & Shaibe, 1997; but see Hughes & Jones, 2005) thereby dis-

confirming the predictions of an early account based on the concept of a phonological store (Gathercole & Baddeley, 1993; Salamé & Baddeley, 1982). As a result of these findings, the phonological store account of the ISE has been modified and expressed computationally such that irrelevant speech disrupts a representation of order within the passive store rather than interfering with item representations (Norris, Baddeley, & Page, 2004; Page & Norris, 2003). However, problematic for any account that views irrelevant speech as disrupting the phonological store is recent evidence showing that rehearsal is a precondition for its expression (Jones, Macken, & Nicholls, 2004).

Third, the interference-by-content approach fails to acknowledge adequately the critical importance of the nature of focal task processing, the impairment of recall being chiefly determined by the co-existence of similar to-be-recalled and to-be-ignored items within a store. That is, they cannot account for why the ISE is only found if the focal task necessitates or tends to encourage a seriation process (e.g., serial rehearsal) and why the mere presence of similar content between the memory material and the sound is not sufficient (or necessary) for the effect (Beaman & Jones, 1997; Farley, Neath, Allbritton, & Surprenant, 2007; Henson, Hartley, Burgess, Hitch, & Flude, 2003; Hughes, Vachon, & Jones, 2007; Perham, Banbury, & Jones, 2007).

Whilst the preoccupation of the interference-by-content approach is with item identity, on the interference-by-process account, the key determinant of the disruption in serial recall is the extent to which both the irrelevant sound and the focal memory task share similar seriation (or ordering) processes (Jones, 1993; Jones & Tremblay, 2000). A key observation underpinning this account is the changing-state effect (e.g., Jones et al., 1992) whereby a sound sequence—regardless of whether it comprises speech or non-speech—that exhibits abrupt changes in acoustic properties (e.g., “*k v h q . . .*”, or a sequence of tones changing in frequency) is invariably more disruptive than a continuous or repeating stimulus (e.g., “*k k k k . . .*”, or a repeated tone). On the interference-by-process account it is assumed that the preattentive perception of acoustic changes between segmentable elements in the sound yields cues as to the order of those elements as a by-product of primitive, acoustic-based, perceptual organization processes (cf. Bregman, 1990). These irrelevant order cues compete for—and hence impair—the deliberate seriation process (serial rehearsal) supporting ordered recall of the to-be-remembered items (Hughes & Jones, 2005; Jones, 1993). In support of this view, the ability to encode the order of stimuli in an attended changing-state auditory sequence predicts the degree to which that sequence is disruptive when presented as irrelevant sound during serial recall (Macken, Phelps, & Jones, *in press*).

In sum, results based on research using the serial recall paradigm favor a dynamic process-based approach (Jones & Tremblay, 2000). However, the phenomenon of interference-by-process seems highly specific to a particular process (seriation) and little evidence is available with respect to whether such conflict occurs between other types of processes. In the present study, therefore, we addressed whether the phenomenon extends to auditory distraction in the context of a focal task that is likely to be

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