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Perceptual organization masquerading as phonological storage: Further support for a perceptual-gestural view of short-term memory

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Abstract

Three experiments examined whether the survival of the phonological similarity effect (PSE) under articulatory suppression for auditory but not visual to-be-serially recalled lists is a perceptual effect rather than an effect arising from the action of a bespoke phonological store. Using a list of 5 auditory items, a list length at which the expression of phonological storage should, ostensibly, be strong, the PSE under suppression was removed at recency by a suffix (Experiment 1) and removed throughout by a suffix combined with a prefix (Experiment 2). Finally, the PSE under suppression could be restored simply by decreasing the acoustic similarity between the prefix-and-suffix and the to-be-remembered list (Experiment 3). The results favour a perceptual-gestural view over a dedicated-system view of short-term 'memory.'

Keywords: Short-term memory; Serial recall; Auditory perceptual organization; Phonological store; Phonological similarity

Introduction

Most models of cognition view perceptual processes as being distinct from those responsible for the short-term retention of information. That is, short-term memory performance is usually explained by invoking a bespoke short-term memory system that is intrinsically post-perceptual and functionally divorced from 'earlier,' pre-categorical, perceptual processes (e.g., Atkinson & Shiffrin, 1968; Baddeley, 1986; Baddeley & Hitch, 1974; Broadbent, 1958; Cowan, 1995; but see Crowder, 1993). Indeed, the boundary between pre-categorical perceptual processes and post-categorical mnemonic processes is seen by some as "a fundamental division in cognitive architecture" (Pashler, 1998, p.33; but see Houghton, Macken, & Jones, 2003). However, there is now a growing body of evidence suggesting that many effects traditionally classed as short-term memory phenomena can be better and more parsimoniously understood by recourse to more "peripheral" processes of auditory perceptual organization and gestural skills (e.g., speech) that are co-opted opportunistically to meet the demands of the short-term 'memory' task (e.g., Hughes & Jones, 2005; Jones, Macken, & Harries, 1997; Jones, Macken, & Nicholls, 2004; Macken & Jones, 2003; Nicholls & Jones, 2002a, 2002b; Woodward, Macken, & Jones, 2005).

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The present article is concerned with revealing the perceptual contribution, more specifically from the auditory system, to phenomena hitherto ascribed to distinctly mnemonic processes. Specifically, we examine an interaction among three factors that has played a pivotal role in the shaping and sustaining of the idea of a short-term phonological store, a post-perceptual component of the cognitive architecture designed specifically for the temporary storage of abstract representations of verbal events (cf. the working memory model; Baddeley, 1986; Burgess & Hitch, 1999; Henson, 1998; Page & Norris, 1998). The interaction in question is that the phonological similarity effect (PSE; Conrad, 1964) survives under articulatory suppression when the mode of presentation is auditory but not when presentation is visual (Baddeley, Lewis, & Vallar, 1984; Jones et al., 2004; Murray, 1968; Peterson & Johnson, 1971). The proposition to be examined here is that this key interaction is due not to phonological storage but due entirely to acoustically based auditory perceptual organization. Although there is already some evidence supporting this perceptual organization account (Jones et al., 2004), the present article addresses the critical question of whether the account generalizes to a situation in which, ostensibly, the expression of phonological storage should be particularly strong, namely, when the to-be-remembered lists are relatively short (see, e.g., Baddeley, 2000b; Baddeley & Larsen, 2003; Salamé & Baddeley, 1986). We turn first to describe the currently dominant, phonological store-based, account of the interaction between phonological similarity, modality and articulatory suppression.

Phonological storage account

The phonological store retains representations of verbal events that are subject to loss due to decay unless revivified in some way. Phonological representations can be revived by the action of an *articulatory control process* which re-cycles representations through the store, the phenomenal realization of which is sub-vocal rote rehearsal (e.g., Baddeley, 1986, 2000a). The empirical signature of the action of the phonological store is the PSE: items that sound alike (e.g., "*b d g t c*") are serially recalled more poorly than dissimilar sounding items ("*f q r h y*"; Conrad, 1964; Conrad & Hull, 1964), even when presented visually. The phonological storage view is that this effect arises due to confusions between similar phonological representations when retrieving items from the phonological store, although the precise mechanism has not been detailed.

A further key assumption of the phonological store construct is that, for auditory input, entry into the phonological store is automatic and obligatory whereas for visual input there is a more deliberate, and hence optional, grapheme-to-phoneme conversion process involving the articulatory control process. This process not only allows for visual-verbal input to be converted into phonological form, it is also, as noted earlier, the vehicle by which the decay-prone representations within the store (regardless of their modality of origin) are revivified. Note, therefore, that the PSE found with auditory presentation and that found with visual presentation are both explained by recourse to the action of the same short-term phonological store. Indeed, '... the two effects are of roughly comparable magnitude and show an essentially similar pattern of performance across a range of manipulations' (Baddeley et al., 1984, p. 242).

An important logical consequence of the fact that the phonological store does not discriminate between input from external acoustic input and input from internal speech is that the representations with which the store deals—contrary to the interpretation of Wilson (2001)—can neither be acoustic nor articulatory but must, rather, be post-categorical, "central" representations that are functionally remote from more peripheral perceptual or motoric systems. Indeed, the use of the term *phonological* seems to have been deliberately adopted in favor of the terms *acoustic* or *articulatory* (see, e.g., Baddeley, 2002) to indicate the abstract nature of the phonological store's unit of currency. Thus, the phonological store's representations are, by definition, post-categorical, canonical representations of the sounds of a language. They are static linguistic representations that bear very little resemblance to the dynamic and context-sensitive pattern of acoustic energy conveyed by speech, the pattern of light conveyed by the written word, or the movement of the articulators during (covert or overt) speech production (see, e.g., Porter, 1987). According to the working memory model, then, the PSE is an impairment of short-term memory resulting from a similarity between abstract representations of linguistic units regardless of whether these linguistic representations have been abstracted from actual speech sounds or from the written word.

That auditory and visual input gain access to the phonological store by different means provides an explanation for the intricate interplay of three factors that is the central interest of the present article: modality of list presentation, articulatory suppression, and phonological similarity. Articulatory suppression serves to block entry of visual-verbal material into the phonological store whereas auditory-verbal material, in contrast, enjoys direct access and its recall is therefore relatively unimpaired by suppression. The key empirical signature of the action of the phonological store—the PSE—should therefore remain evident during articulatory suppression, but only with auditory material, which enjoys the direct access route, and not with visual material. And indeed, at a macroscopic level, the effect of the combination of these factors is entirely in line with the predictions (Baddeley et al., 1984; Jones et al., 2004; Murray,