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# Journal of Experimental Child Psychology

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## Equivalent auditory distraction in children and adults



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### ARTICLE INFO

#### Article history:

Received 22 March 2017

Revised 13 February 2018

#### Keywords:

Development

Selective attention

Aging

Cross-modal distraction

Working memory

Irrelevant sound effect

### ABSTRACT

There is an ongoing debate about whether children have more problems ignoring auditory distractors than adults. This is an important empirical question with direct implications for theories making predictions about the development of selective attention. In two experiments, the disruptive effect of to-be-ignored speech on short-term memory performance of third graders, fourth graders, fifth graders, younger adults, and older adults was examined. Three auditory conditions were compared: (a) steady state sequences in which the same distractor was repeated, (b) changing state sequences in which different distractors were presented, and (c) auditory deviant sequences in which a deviant distractor was presented in a sequence of repeated distractors. According to the attentional resource view, children should exhibit larger disruption by changing and deviant sounds due to their poorer attentional control abilities compared with adults. The duplex-mechanism account proposes that the auditory deviant effect is under attentional control, whereas the changing state effect is not, and thus predicts that children should be more susceptible to auditory deviants than adults but equally disrupted by changing state sequences. According to the renewed view of age-related distraction, there should be no age differences in cross-modal auditory distraction because some of the irrelevant auditory information can be filtered out early in the processing stream. Children and adults were equally disrupted by changing and deviant speech sounds regardless of whether task difficulty was equated between age groups or not. These results are consistent with the renewed view of age-related distraction.

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## Introduction

The amount of information that can be held in working memory is limited and increases until early adulthood (e.g., Fry & Hale, 1996). The presentation of irrelevant auditory information reduces working memory performance dramatically both in adults (Colle & Welsh, 1976; Salamé & Baddeley, 1982) and in children (Elliott, 2002; Klatt, Lachmann, Schlittmeier, & Hellbrück, 2010). Whether children are more vulnerable to auditory distraction than adults is subject to current debate (Elliott et al., 2016; Schwarz et al., 2015). This question has important consequences for theories making predictions about the development of selective attention and is also of practical relevance for the acoustic design of learning environments. Although it has been proposed that children are particularly susceptible to attentional capture (Hughes, 2014; Meinhardt-Injac et al., 2015; Schwarz et al., 2015), it has not yet been tested whether there are developmental differences in the disruption of serial recall by auditory deviant stimuli. The current experiments were designed to close this empirical gap.

To study the effects of auditory distraction on short-term memory performance, serial recall is used as the standard paradigm. In this task, a list of random digits is presented and participants are asked to recall the digits in the order of their presentation. Serial recall performance is markedly impaired when task-irrelevant sounds are played (Colle & Welsh, 1976; Parmentier & Beaman, 2015; Röer, Bell, & Buchner, 2015; Salamé & Baddeley, 1982; Schlittmeier, Weißgerber, Kerber, Fastl, & Hellbrück, 2012; Wöstmann & Obleser, 2016). In the current study, we contrasted two types of auditory distraction: (a) the disruptive effect of changing distractor items (e.g., “a, b, c, d, e, f, g, h”) and (b) the destructive effect of auditory deviants (e.g., “a, a, a, a, b, a, a”). Disruption is typically measured relative to a steady state control condition (Hughes, Vachon, & Jones, 2007; Röer, Bell, Marsh, & Buchner, 2015; Sörqvist, 2010) in which the same distractor item is presented repeatedly (e.g., “a, a, a, a, a, a, a, a”). This is what we did in the current study as well. The changing state effect is defined as the increase in disruption by changing state sequences relative to steady state sequences (cf. Hughes, Vachon, & Jones, 2005; Jones, Madden, & Miles, 1992). The auditory deviant effect is defined as the increase in disruption by auditory deviant sequences relative to steady state sequences (cf. Hughes et al., 2005; Vachon, Hughes, & Jones, 2012).

Theoretically and empirically, the question of whether children should be particularly susceptible to the disruptive effect of changing and deviant speech sounds has not been finally resolved. We first turn to theories that make predictions about the development of selective attention. We subsequently give a short overview of the existing literature comparing auditory distraction in children and adults.

The attentional resource view (Dempster, 1992, 1993) is based on the idea that the areas of the brain that take longest to mature during childhood are the first to show signs of brain aging. According to this “last in, first out” hypothesis of cognitive development, children and older adults should show worse performance than younger adults. Specifically, it has been proposed that both children and older adults have less well-functioning inhibitory attention mechanisms compared with younger adults, leading to increased disruption by task-irrelevant information. Due to this inefficiency, both children and older adults should be less able to ignore task-irrelevant background sounds than younger adults.

However, it has also been argued that developmental differences in the efficiency with which auditory distractors can be ignored should depend on the specific type of auditory distraction. Central to the duplex-mechanism account (Hughes, 2014) is the assumption that disruption by changing state sounds and disruption by auditory deviants are differentially affected by cognitive control processes. According to this theory, there are two distinct forms of auditory distraction. Changing state sounds disrupt serial recall because the irrelevant order information in the distractor sequence is processed preattentively and interferes with the relevant order information in the item sequence. Auditory deviant sounds disrupt serial recall because they violate a recent auditory regularity, which produces attentional capture and draws processing resources away from the focal task. The changing state effect occurs automatically and cannot be controlled, whereas the auditory deviant effect is under attentional control (Hughes, Hurlstone, Marsh, Vachon, & Jones, 2013). It has been proposed that larger irrelevant speech effects in children as compared with adults (Elliott, 2002; Elliott & Briganti, 2012)

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