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Improvements in reading accuracy as a result of increased interletter spacing are not specific to children with dyslexia

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A B S T R A C T

Recently, increased interletter spacing (LS) has been studied as a way to enhance reading fluency. It is suggested that increased LS improves reading performance, especially in poor readers. Theoretically, these findings are well substantiated as a result of diminished crowding effects. Empirically, however, findings on LS are inconclusive. In two experiments, we examined whether effects of increased LS are specific to children with dyslexia and whether increased LS affects word or sentence processing. In the first experiment, 30 children with dyslexia and 30 controls (mean age = 9 years 11 months) read sentences in standard and increased LS conditions. In the second experiment, these sentences were read by an unselected sample of 189 readers (mean age = 9 years 3 months) in either a sentence or word-by-word reading condition. The first experiment showed that increased LS affected children with dyslexia and controls in similar ways. Participants made fewer errors in the increased LS condition than in the standard LS condition. Reading rates were not affected. There were no indications that the effect of LS was related to reading ability, not even for a subgroup of readers. Findings of the second experiment were similar. Increased LS resulted in fewer errors, not faster reading rates. This was found only when complete sentences were presented, not when sentences were read word by word. Three main

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conclusions can be drawn. First, increased LS appears to affect reading accuracy only. Second, the findings do not support claims that increased LS specifically affects poor readers. And third, the effect of LS seems to occur at the interword level. Theoretical and practical implications of these findings are discussed.

Introduction

Recently, increased interletter spacing (LS) has been studied as a way to enhance reading fluency. Zorzi et al. (2012), for example, showed that an increase in the space between two adjacent letters, and additional increases in the space between words and lines, fostered reading fluency, especially in readers with dyslexia. These improvements in reading performance in these poor readers are remarkable given that enhancing reading fluency for this group has proven to be difficult. The growth rate of reading speed in poor readers has been shown to be approximately half of that observed in typically developing peers (Tressoldi, Stella, & Faggella, 2001). As a result, the difference in reading speed between poor and average to good readers increases rapidly over time. Therefore, it is not surprising that the results of Zorzi et al. (2012) were picked up and praised by the research community (e.g., McCandliss, 2012). It was appreciated that an immediate increase in performance was achieved through relatively simple and ecologically valid methods. Furthermore, McCandliss (2012) mentioned that these results seem highly replicable. However, to date, few studies have managed to replicate that effects of increased LS are *specific* to individuals with dyslexia (e.g., Perea, Panadero, Moret-Tatay, & Gómez, 2012). A large number of studies found zero or negative effects of increased LS or found positive effects on speed or accuracy that were not specific to individuals with dyslexia; other groups of readers, such as skilled adult readers and young readers without dyslexia, sometimes also profit from an increase in LS (for an overview, see van den Boer & Hakvoort, 2015; see also Perea, Giner, Marcet, & Gomez, 2016; Sjoblom, Eaton, & Stagg, 2016). In the current article, we first describe the theoretical validation of the effects of increased LS and review the research findings on this topic. We then present two experiments that aimed to replicate and extend the results of Zorzi et al. (2012).

Theoretically, the potential effect of LS is substantiated with the literature on visual crowding. Although in most studies on LS crowding is not explicitly measured, LS can be considered one of several possible manipulations of crowding. LS is thought to reduce crowding, which is the negative effect in peripheral vision of surrounding visual elements on the recognition of an otherwise identifiable target (Bouma, 1970; Whitney & Levi, 2011). This crowding effect impedes the utility of peripheral vision for visual object recognition tasks (Millin, Arman, Chung, & Tjan, 2014; Whitney & Levi, 2011). Crowding appears to result from inappropriate feature integration in early visual processing but is also sensitive to top-down influences (Pelli & Tillman, 2008). Recognition is impaired when objects are closer together than the critical spacing, that is, the distance that is needed between target and flankers to allow for unimpaired recognition. This threshold eccentricity for accurate recognition appears to be a fundamental parameter of human vision and, thus, is the same for all objects (Pelli & Tillman, 2008). In terms of reading, visual crowding distorts the perception of peripherally presented letters that are surrounded by other letters and, consequently, has the potential to impede the reading process. The majority of visual word recognition processes occur while the word is fixated. The impact of visual crowding on these processes can be expected to be marginal because eccentricity is at a minimum (Slattery & Rayner, 2013). However, some reading processes, such as the processing of parafoveal preview information and the related saccade planning, are of a parafoveal nature (Marx, Hutzler, Schuster, & Hawelka, 2016; Schotter, Angele, & Rayner, 2012) and, thus, potentially subjected to visual crowding effects.

Notably, the effect of crowding, and more specifically the critical spacing, does appear to be sensitive to developmental processes and to differ across individuals. For example, crowding effects were