Mind the gap: Increased inter-letter spacing as a means of improving reading performance

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A B S T R A C T

The effects of text display, specifically within-word spacing, on children's reading at different developmental levels has barely been investigated. This study explored the influence of manipulating inter-letter spacing on reading performance (accuracy and rate) of beginner Hebrew readers compared with older readers and of low-achieving readers compared with age-matched high-achieving readers. A computer-based isolated word reading task was performed by 132 first and third graders. Words were displayed under two spacing conditions: standard spacing (100%) and increased spacing (150%). Words were balanced for length and frequency across conditions. Results indicated that increased spacing contributed to reading accuracy without affecting reading rate. Interestingly, all first graders benefitted from the spaced condition. This effect was found only in long words but not in short words. Among third graders, only low-achieving readers gained in accuracy from the spaced condition. The theoretical and clinical effects of the findings are discussed.

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Introduction

Most work on reading acquisition challenges has focused on the different skills that a child must master such as phonological awareness, decoding, and reading fluency. Less work has focused on the possible role of text display properties such as font size, line length, and even spacing within

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words in reading success in young children (Diemand-Yauman, Oppenheimer, & Vaughan, 2011; Katzir, Hershko, & Halamish, 2013).

Nearly all printed material intended for children is based on the text dimensions most frequently used rather than on empirical data. However, the typographical properties of these orthographic symbols are crucial for determining print readability (Woods, Davis, & Scharff, 2005). Consequently, the common and prevalent text properties might not be optimal for many readers (Montani, Facoetti, & Zorzi, 2014). Findings of studies concerning the adaptation of different text typographies to young readers' developing skills may shed some light on our theoretical understanding of young readers' processing of written words. The practical and instructional contribution of studying the influence of manipulating the physical properties of text display is undisputed, with the purpose of improving the accessibility of reading materials for young readers.

The current study focused on one text modification that might mediate the process of reading acquisition: altering the visuospatial feature of inter-letter spacing (e.g., compare reading to r e a d i n g). More specifically, we aimed to examine, through a developmental lens, whether increasing inter-letter spacing affects word recognition accuracy and rate among first- and third-grade Hebrew readers. Importantly, we also sought to investigate whether there are differences in the hypothesized effect of increased inter-letter spacing among high-achieving readers compared with low-achieving readers of the same age.

Efficient reading builds on a range of linguistic, auditory, and visual skills (Vellutino, Fletcher, Snowling, & Scanlon, 2004). When reading a word, a child is required to retrieve learned relationships between sequences of visual orthographic symbols and the relevant phonological units (Bosse & Valdois, 2009). Whereas most work on reading difficulties has focused on challenges concerning the linguistic aspects of word reading such as phonological awareness (Share, 1995), over the years work has also been done on the potential role of visual processing in reading acquisition as well as of visual deficits in explaining reading difficulties (Jones, Branigan, & Kelly, 2008; Morgan, 1896; Stein & Walsh, 1997; Vellutino et al., 2004). For instance, longitudinal studies have shown that visual attention and perception tasks in kindergarten (serial search, spatial cueing facilitation, block design, and matching letter-like forms) are predictors of future word and text reading ability in first and second grade (Bosse, Tainturier, & Valdois, 2007; Brunswick, Martin, & Rippon, 2012; Franceschini, Gori, Ruffino, Pedrolli, & Facoetti, 2012).

Several studies have proposed another universal visual phenomenon that affects the processing of objects and letters and, as a consequence, makes reading a more difficult task. This phenomenon is known as the *visual crowding effect* (Bouma & Legein, 1977; Martelli, Di Filippo, Spinelli, & Zoccolotti, 2009; Spinelli, De Luca, Judica, & Zoccolotti, 2002).

The general visual crowding effect

In real life, most objects do not appear in isolation but rather appear surrounded by other objects, as a tree is surrounded by a forest. Visual crowding occurs when an object becomes more difficult to identify when surrounded by other objects than when presented in isolation (Pelli, 2008; Pelli et al., 2007; Whitney & Levi, 2011). The interference generated by these flanking objects (i.e., the forest) on identification of the target object (the target tree) occurs in both the central vision and peripheral vision of young readers (Bouma, 1973; Jeon, Hamid, Maurer, & Lewis, 2010; Martelli et al., 2009). Identification of objects begins with feature detection and then proceeds to integration of features. Whereas low-level masking tasks tap detection of objects, crowding appears to interfere with mid-level integration. In typical crowding conditions, the target object is detected but identification is hampered because the object is experienced as jumbled with its neighbors (Pelli, Palomares, & Majaj, 2004). Parkes, Lund, Angelucci, Solomon, and Morgan (2001) showed that crowding causes greater interference when the target is similar to the distractors. For example, in the case of letters, crowding will impede the integration of serial letters into words. Literature shows that crowding affects the recognition of simple objects, such as bars, and complex objects, such as letters, faces, and words (e.g., Pelli, 2008; Pelli & Tillman, 2008; Whitney & Levi, 2011).