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REVIEW

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Do You See What I Am Saying? Changing Education: Recognizing the Role of Visual Perception in Reading Development

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Abstract: Researchers, educators, and parents have struggled to understand why some learn to read with ease while others face hardship. This review chronicles early theories of reading development, presents emerging research that explores additional factors that are believed to influence reading skill, and then suggests an agenda for future research to inform instructional methods in reading education. A thorough search of the literature was conducted to present perspectives on reading development that highlight critical yet overlooked factors that contribute to reading mastery. The research was compiled, reviewed, and presented in this article to elucidate the findings. Emerging research has identified several areas in which visual perception is essential to reading skills development. Researchers found that visual memory predicts word recognition. Inter-letter spacing and increased spacing between words have been found to improve reading speed. Visual attention is associated with reading accuracy. It is incumbent upon researchers and educators to better understand all the components of reading, so we may help students achieve their reading outcomes. Arguably, the conceptualization of reading assessment and reading intervention should be broadened by considering additional component skills that may impede reading success. Research highlights the importance of visual perception in recognizing letters and words. However, the role of visual perception in reading development has been mostly overlooked in language-based educational curricula. Visual perception should be explored further through research and practice to support students who struggle with reading and do not respond to traditional language-based reading instruction.

Keywords: reading, education, visual perception, schools, reading deficits

1. Introduction

Reading development and reading disabilities have been topics of significant concern since the implementation of formal education in the twentieth century [1]. Researchers, educators, and parents have struggled to understand why some learn to read with ease while others face hardship. In the United States, the average spending per student exceeds $15,000 [2]. However, despite extensive efforts and resources devoted to improving literacy in the United States, American students continue to struggle with reading mastery [3]. In 2014, only one-third of fourth-grade public school students scored at or above reading proficiency on national standardized tests.[1] Fourth-grade students' reading scores on these standardized reading tests remained stagnant for over a decade. In fact, the most recent reading assessment results revealed even lower scores in over half of the states in this country [4]. Given these poor results, one might question whether current methods of reading instruction are meeting students' needs. Perhaps reading relies on areas of functioning that are currently neglected in existing instructional methods.

This article is organized in the following manner: The literature review will recount the historical evolution of reading theories and then present novel research that explores alternative influences on reading proficiency. A discussion of the research will follow, where an agenda for future research in reading opportunities for changes in education that are informed by this research and concrete examples of activities that may be incorporated into reading instruction are offered.

2. Literature Review

2.1. Early theories of reading development

2.1.1. Reading as a visual task

By 1918, all US states passed compulsory education laws, requiring all children to attend school until 14 years of age [5]. Since then, reading has been an urgent topic of interest. Early researchers employed the Gestalt theory of learning, which theorizes that a whole image imbues greater meaning than the sum of its parts [6]. This theory lent itself to "whole word" reading instruction techniques in which the reader would be taught a word as a whole and was then taught to analyze its parts [7]. Other theorists believed that images were an integral part of learning words as the perception of the visual stimuli would be embedded in memory for later use during reading and learning tasks [8]. These theorists were pioneers in operationalizing reading instruction. However,

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[1] Grace Kena et al., "The Condition of Education 2015," 2015, National Center for Education Statistics, https://nces.ed.gov/pubs2015/2015144.pdf

their approach marginalized the importance of speech perceptions, as well as the essential interplay of both visual and auditory inputs that are essential to the contextualization of words and word meanings [9].

2.1.2. Language basis for reading

By the 1950s, researchers began to acknowledge that reading instruction was not limited to word recognition but that it was a means of communicating information that demanded an understanding of the content being read. This philosophy led to the incorporation of language processing in learning to read. Since then, many studies have explored the role of language in reading development [10–12].

The vast body of research that studies reading is known as the science of reading [13, 14]. Initially, the National Reading Panel reviewed the plethora of research and concluded that the most essential components of successful reading development include phonemic awareness, phonics, vocabulary, fluency, and comprehension.[2] These components are also known as "The Big Five" and continue to be the cornerstone of reading curricula [15]. Vaughn and Fletcher [15] also assert that systematic and explicit instruction is the most effective way to teach reading. Elementary schools' reading curricula were adapted to begin teaching students the simplest skill of letter-to-sound correspondence, progress toward teaching word recognition and vocabulary, advance to the complex skill of deriving meaning from text, and finally master the ability to draw inferences [16]. In practice, students are expected to apply their acquired reading skills to comprehend texts and accumulate knowledge in their core curriculum by the end of the third grade [17]. As a result, many reading curricula were developed from the report's findings, and many continue to be used today [3].

Many researchers who subscribe to language-based reading theories believe that deficits in phonological processing are the culprit of reading difficulties among children with average intelligence [18–20]. The phonological deficit theory, established by Snowling [12], is the foundation of reading recovery. This is a remedial reading curriculum that focuses on word–sound relationships [21]. This program continues to be used today [17].

2.1.3. Something is missing

Traditional language-based reading instructional methods are effective for some learners; however, statistics show that 66% of the students in the United States do not demonstrate reading proficiency [4]. According to the report prepared by Irwin et al. [22] for the National Center for Educational Statistics, the American students' reading performance has steadily worsened over time. Efforts to address this issue have been developed in the form of specialized programming utilizing targeted instruction to support struggling students. A widely held belief among many educators is that early identification of reading difficulties greatly enhances outcomes. The rationale is that reading relies on the development of multiple skills that progress from fundamental to more complex abilities [23]. Any deficit along this continuum will impact future reading development. Moreover, early detection of specific deficits in skills needed for reading is crucial to develop targeted instruction and ameliorate the need. Targeted instruction often requires educators to increase levels of support as the student's performance fails to meet grade-level expectations [24]. The premise for remedial instruction is that more intense instruction will yield better outcomes. However, poor scores achieved on standardized tests in the United States suggest that the effectiveness of this model is questionable [25].

Complementary methods of support, to be delivered concurrently with traditional reading instruction, should be considered as a strategy to address the discrepancy between current reading research and student achievement. Doing so will avoid a missed opportunity to better help these students achieve their reading outcomes. I propose that we re-examine the role of visual perceptual processing as an essential skill in reading. This notion does not suggest that we revisit reading as a visual task. Instead, we should acknowledge that the role of visual perceptual processing may have been marginalized in the science of reading.

The advent of functional magnetic resonance imaging has allowed researchers to identify the neural pathways involved in reading. Not surprisingly, the left lateral occipitotemporal sulcus, a site also known as the visual word form area, is consistently activated in subjects who engage in various reading and word recognition tasks [26, 27]. In fact, individuals with lesions in this area of the brain develop alexia, which is the inability to recognize words [28, 29]. Studies using imaging from this technology provide evidence that visual perceptual processing is integral to reading and, therefore, should not be marginalized. Reading education could then be enhanced and more effective in helping students achieve reading success.

2.2. Visual perception in reading: Emerging perspectives

Recently, researchers have begun to consider additional factors that contribute to reading difficulty, including the role of visual perceptual processing. Several approaches have been utilized to examine the role of visual perception in reading development and to explain barriers to reading achievement. The following studies are organized by their approach to highlight the strengths and weaknesses of the respective findings and to guide implications for future research. Interestingly, much of this research has been conducted in Europe. Perhaps the transparent orthographies of romance languages lend themselves to more feasible study designs than languages with greater orthographic opacity, such as English.

According to the International Dyslexia Association [30], developmental dyslexia is a neurobiological learning disability that is characterized by difficulty recognizing or accurately reading words despite average intelligence. The discrepancy between intelligence and performance is characterized as an unexpected reading difficulty [31]. According to Wagner and Lonigan [32], the distinction between poor readers and unexpected poor readers is difficult to operationalize. The studies presented in this literature review include participants who are described as typical readers, children who present themselves with reading challenges, and dyslexic children. It is unknown if the researchers who describe their participants as having dyslexia are diagnosed with developmental dyslexia or experience unexpected reading difficulty. Nevertheless, this review highlights research that explores the role of various visual processes in reading development among all learners.

2.2.1. Text modifications

Visual-spatial ability is a strong predictor of the reading readiness skill of phonemic awareness [33]. To explore how visual spatial perception influences more advanced reading proficiency, several researchers examined the effects of modifications to text on

[2]National Reading Panel, "*Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups*," 2000, https://www.nichd.nih.gov/publications/pubs/nrp/report

reading performance [34–39]. These include changes to the font size, spacing between words, line length, and line spacing. The studies indicate that manipulation of the visual presentation of text greatly influences reading speed and accuracy.

Day et al. [34] aim to explore the impact of fonts and letter spacing on reading speed and comprehension among third- to fifth-grade students. They presented an 11-passage narrative text reading assignment to 51 participants in eight different fonts (four each: serif and sans serif). The researchers found a significant increase in words per minute read when the text was presented in Roboto and Arial formats. Furthermore, the increased reading speed did not diminish the students' comprehension of the passages. The letter spacing between the letters and words was manipulated as well with narrow, normal, and wide distances to explore changes in reading speed, accuracy, or comprehension. They found no differences in the variables of interest because of the letter/word spacing manipulations. They conclude that the visual presentation of the text can be a useful tool in maximizing reading success. Although this study presents interesting findings, the premise for exploring the impact of letter spacing on reading comprehension relies on research conducted with dyslexic children. A limitation in this study is that the researchers recruited typically developing students with no known learning disabilities. A design that recruited dyslexic children as the target or comparison group would have yielded more compelling evidence for the utility of text modifications in reading.

Unlike Day et al. [34] and Katzir et al. [35], they manipulated the text in reading materials to find possible effects on reading comprehension in children without exploring reading speed. They explain that to comprehend text, one must visually recognize the words read. They challenged visual processing to see the effect on comprehension. The children were divided into two groups: second graders and fifth graders, totaling 100 subjects. The manipulations included decreasing the font size and increasing the line length of grade-level reading materials. The rationale was to invert the manipulations that have been shown to be effective in facilitating reading performance in previous studies [35, 37–39]. Katzir et al. [35] found that these manipulations significantly decreased the reading comprehension of the second graders but not of the fifth graders. They hypothesize that this discrepancy is due to the top-down effects employed by proficient readers during visual processing of words, as increased spacing between the letters may disrupt the proficient readers' ability to recognize a word as a unit. Early readers, however, are theorized to learn to read by decoding the visual stimuli and relying on the visual presentation of text to extract cues for processing. This interpretation seems to overlook an important factor. The students' language processing and visual perceptual skills were not assessed prior to conducting the study. As a result, the students' underlying skills in these two areas of functioning may have unknowingly impacted the reading comprehension scores. Therefore, the study findings may not be due to text modifications exclusively.

Christofalos et al. [40] examined the impact of eliminating spacing between words within a passage on reading comprehension. They found that eliminating spaces between words greatly increased reading time, prolonged eye saccades, and diminished inferencing capabilities among the participants. They concluded that reading success is strongly influenced by the visual presentation of text. In contrast, Perea et al. [37] explored the effects of increased inter-letter spacing on visual word recognition and reading by measuring changes in reading speed and accuracy. They hypothesized that slightly increased inter-letter spacing would improve reading speed and accuracy by enhancing oculomotor functions. These enhancements enhance the visual detection of letter position in words. The example that they cite is the ability to distinguish the difference between the words "causal" and "casual." In this study, four groups were tested: 24 typical adult readers, 24 typical fourth graders, 24 typical second graders, and 18 children (mean age 12.1 years: range 11–13) diagnosed with reading deficits. Unlike Katzir et al. [35], they found a slight improvement in skilled readers' performance (adults and children) with the application of increased inter-letter spacing. They attribute their results to the proficient readers' ability to divide words into syllables, minimizing the presumed effect of breaking up an image and inhibiting the perception of an entire word. The discrepancy between these two studies' findings may be due to a difference in the length of inter-letter spacing that was applied to the text in the respective studies. Significant improvements in reading speed and accuracy were found among children with reading deficits. Perea et al. appear to have considered not only the developmental aspects of reading development by examining the effects of increased inter-letter spacing on different age groups (which was overlooked by Katzir et al.), but they also consider the visual processing deficits in individuals with reading deficits.

Zorzi et al. [39] also examined the impact of inter-letter spacing on reading speed and accuracy in children with reading deficits, but they also increased the spacing between lines. They recruited 34 Italian children and 40 French children from dyslexia diagnostic centers. This is problematic in that the samples recruited from a particular treatment venue introduce bias to the experiment, as the subjects are likely to be like one another. Therefore, the applicability of the findings to the larger population is in question. Strangely, the researchers did not conduct the same experiment with each group; the Italian children read 24 modified passages (manipulated spacing between letters within words and lines of text), and the French children identified letters in quick succession. The researchers identified improvements in both groups' scores, but each of the two testing demands examined different aspects of visual processing. This discrepancy between task demands presents a limitation to the study. Repeating the study by measuring the response to text manipulation and performance during rapid letter recognition among Italian and French-speaking children would demonstrate more credible evidence of the value of these modifications in improving reading speed and accuracy in dyslexic children. Additionally, including a comparison group of typically developing children would have provided more robust support for the approach.

Like the study conducted by Day et al. [34], Schneps et al. [38] incorporated technology to manipulate the visual presentation of text. They utilized e-readers as a tool to examine the effects of increased inter-letter spacing, shorter line length, and involvement of the hands (holding the device vs. a dock) on oculomotor function. The study measured reading efficiency in high school students who are diagnosed with developmental dyslexia. They tracked eye movements while reading modified and unmodified text to detect changes in reading speed. They found that increased inter-letter spacing and shorter lines produced a 27% increase in speed of accurate reading ability, an 11% reduction in the number of eye fixations (indicating that the eyes fixated directly onto target words to sustain line regard), and a reduction in inefficient eye movements. They also found that holding versus docking the e-reader produced different outcomes. Some students experienced a reduction in speed and accuracy while holding the device. The researchers suspect that the simultaneous demands of visual perceptual processing and motor coordination exhausted some students who may have limited visual attention span. The researchers introduced "visual attention span" later in the report, considering it as a factor in their discussion of the results. It would have been easier to appreciate the effects of text manipulation on eye movements and reading speed if this concept had been introduced earlier in the study.

Roemmich [41] also manipulated inter-letter spacing and measured the reading improvements among dyslexic children. According to Roehmmich [41], "Inter-letter spacing is also known as kerning and inter-word spacing is known as tracking. Kerning is measured using a fraction of an em space. An em space is a relative unit, equal in width to the size of your type. In 12-point type, an em space is 12 points wide; in 72-point type, it is 72 points." Following the presentation of text using variable em space, Roemmich found that .5 em space for both kerning and tracking increased reading speed and accuracy among the study participants. Other fractional variations did not produce the same results. This study may serve as a pilot for exploring specific modifications to text; however, the design lacks a comparison group of typical readers. This recruitment bias weakens the argument that these specific modifications are essential to support dyslexics' reading speed. Omitting a comparison group introduces the possibility that the modifications would help all readers.

2.2.2. Joint visual and auditory processing

Within the camp of language-based reading theories, the simple view of reading [42] theorizes that word recognition and comprehension are both necessary to learn to read. Conceivably, word recognition is dependent on the processing and integration of visual and auditory inputs. Several studies support this notion by demonstrating how the integration of visual and auditory inputs impacts reading development. Stein [43] has studied the role of visual processing in reading difficulty for decades. He highlights the interplay of both visual and phonological processing in reading development in his most recent review of current reading research. He explains that phonological processing is an undisputed skill necessary for reading development; therefore, struggling readers will almost always display some degree of difficulty with this area of functioning. However, poor performance with this skill does not mean that phonological processing is the cause of all reading difficulties. Instead, he proposes that, "assessing poor readers' visual and auditory temporal processing skills should enable dyslexia to be reliably distinguished from other causes of reading failure. . . ." This research highlights the importance of incorporating visual perception as a complementary function to language processing. The integration of both skills is essential to successful reading.

Ehri [44] suggests that orthographic mapping, the process of pairing letters with sounds for recognition of words, spelling of words, and possible support in remembering the meanings of those words, is essential to comprehension. The automaticity that results from established orthographic mapping allows the reader to quickly access the words' pronunciations and meanings for easier comprehension of texts. Additionally, the ability to successfully read irregular words, that is, reading words that cannot be decoded (i.e., light, could, the), relies heavily on one's ability to remember the visual representations along with the way the entire word sounds [45]. Automaticity in recognizing these words also facilitates comprehension of texts, as the reader quickly retrieves the words' meanings from their visual form. This is true for regular and irregular words. Warmington and Hulme [46] researched children's performance on paired verbal-visual learning tasks. They found positive correlations between these skills and reading ability, with rapid automatized naming (RAN) of letters being most highly correlated with reading proficiency. Moreover, weaknesses in RAN have repeatedly been found to affect decoding skills [47, 48]. Additionally, it is hypothesized that a cross-modal mapping of orthographic and phonemic units forms a pairing of associated learning that is necessary to recognize words. This is also known as sight-reading, a skill that fosters competent reading comprehension. Sigmund et al. [49] also found RAN, along with letter knowledge and phonological processing, to be strong predictors among typically developing children in kindergarten and first grade. This research also underscores the role of both visual perception and auditory processing in reading development.

To further understand the importance of the synchronization of visual and auditory input in fluent reading and processing speed, Horowitz-Kraus et al. [50] explored the impact of functional connectivity between visual and auditory brain regions on reading fluency among typical and dyslexic readers. They found significantly enhanced performance among typical readers, as they demonstrated highly synchronous processing of visual and auditory inputs during reading tasks.

Upon examining the role of visual perception in reading development among typically developing children, Modlin [51] found statistically significant relationships between visual memory and both word recognition and phonological processing. Additional statistically significant relationships were found between visual spatial relations, form constancy, and sequential memory with phonological processing. These relationships align with developmental theories that propose the simultaneous emergence of these abilities, which are recruited and integrated for the acquisition of new skills, such as reading.

2.2.3. Visual memory

Modlin [51] hypothesized that visual perceptual processing skills are one component of word recognition in typically developing first graders. She tested 80 general education students using two widely used standardized instruments: the Test of Visual Perceptual Skills, 4th Ed [52], and subtests from the Kaufman Test of Educational Achievement, 3rd Ed [53], which relate to reading development, such as letter/word recognition and phonological processing. The study aimed to identify relationships between these skills to uncover potential visual perceptual components recruited in typical reading development. Analysis of the data utilizing a correlational design revealed a statistically significant relationship between visual memory and letter/word recognition. Replication of this study among diverse student populations may highlight the likely importance of visual memory in learning to read. This pilot study did not include children with known reading or learning disabilities. Therefore, the findings support a homogeneous group. Replication of this study with a heterogeneous group of students or with two groups consisting of typical students and students with reading difficulties would produce more significant insight into the elements of reading development.

Pickering et al. [54] found moderately strong relationships between visual memory and vocabulary development among children aged 2–12 years. They explored preferential neural streams for visual processing of various visual stimuli that were simultaneously recruited during vocabulary tasks. The ventral visual streams that process static visual inputs, such as color or shape, were more highly activated than dorsal visual streams that process dynamic visuo-spatial stimuli.

2.2.4. Visual discrimination

Yoo and Saunders [55] explored how visual discrimination skills predict early reading development. To do so, they recruited young children (3.5–5 years) with no exposure to reading education. The children were presented with novel materials, some imprinted with images of individual letters and others with 3-letter words. The accuracy of the children's ability to match the letters and 3-letter words was compared with their ability to discriminate between similar-looking letters. The children who were able to quickly match

individual letters were also able to group 3-letter words beginning with the same stimulus letter (i.e., mug, mop, mat). Furthermore, a generalization of the children's visual discrimination skills was demonstrated when the children were also able to distinguish similarly spelled untaught 3-letter words (i.e., rat, cat, sat) by identifying first letter differences among those words and the same letter endings. This study supports the notion that visual perception and visual discrimination, in particular, are critical components of the widely accepted alphabetic principle. The alphabetic principle is a system that explains the relationship between visual and language representations of letters, which is believed to be one of the building blocks of learning to read.

Tsai et al. [56] explored character reading proficiency among typically developing early readers and dyslexic children who had early exposure to picture books. They found that typically developing children demonstrated significantly improved visual temporal processing and enhanced character recognition as compared to dyslexic children.

2.2.5. Visual attention

Early researchers of the relationship between visual attention and reading can be traced to Franceschini et al. [36]. They assert that accurate identification of individual letters is critical to the development of letter-to-sound correspondence. Furthermore, they hypothesize that visual attention is a key function in deciphering the differences between individual letters that contribute to letter-to-sound correspondence. In their longitudinal study, a visual search task was used to measure visual attention. They asked pre-reading kindergartners to find specific letters embedded within an array of random letters. These same children's reading abilities were tested in first grade and then again in second grade. Each student's reading scores were compared to their visual search task scores to determine if visual search aptitude is a predictor of future reading ability. The researchers found that 60% of the second graders who scored one standard deviation below the mean in reading ability also scored poorly on the visual search task when they were tested in kindergarten. They concluded that visual search activities might be used as an approach to facilitate reading in children who are at risk of developing reading disability. Although the researchers considered the importance of letter-to-sound correspondence in reading development, they did not include these students' speech and language functioning in the design of the study. Analysis of the data, with language skills as a covariate, might have produced a more convincing conclusion.

Valdois et al. [57] built upon Francheschini's work by continuing to study the role of visual attention in reading development. Their theory is based on findings from their study that found visual attention to be a strong predictor of reading fluency. They tested the visual attention skills of typically developing kindergartners and then tested those children's letter and word identification skills at the end of the first grade. Children who demonstrated strong visual attention to text in kindergarten performed significantly better on letter identification tasks than children with weaker visual attentional abilities. They proposed a teaching model that utilizes visual attentional skills to enhance reading acquisition skills among early readers.

3. Discussion

Despite extensive efforts and resources devoted to reading instruction in the United States, only one-third of fourth-grade public school students score at or above reading proficiency on national standardized tests. These poor results suggest that existing language-based reading instruction may be imperfect. It is incumbent upon researchers and educators to better understand all the components of reading, so we may help students achieve their reading outcomes. Arguably, the conceptualization of reading assessment and reading intervention should be broadened by considering additional component skills that may impede reading success.

Recently, emerging research has demonstrated that visual perception is necessary for letter and word recognition. Moreover, deficits in visual perceptual processing may be partly responsible for poor reading success. However, the role of visual perception in reading development has been mostly overlooked in language-based educational curricula. Incorporating visual perception as a complementary skill to existing language-based approaches will enhance letter-to-sound correspondence, sight word recognition, and decoding skills, which are foundational skills of reading development. Instructional curricula should maintain a language focus, as deriving meaning from text is the purpose of reading. The purpose of this review is to stress the importance of including visual perception in reading instruction.

Students who experience reading difficulty due to visual perceptual deficits but only receive language-based interventions are at risk offor falling fuarther behind in their reading achievements. For these children, the root cause is not being addressed. Missed identification of these deficits can negatively impact students' academic, social, and emotional development. Therefore, the role of visual perception should absolutely be explored further through research to better understand its role in reading development, and visual perceptual interventions and strategies should be incorporated into practice to support students who struggle with reading and do not respond to traditional language-based reading instruction.

4. Implications for Practice and Future Research

Future studies should explore the role of visual perception in reading development. Predictive designs that examine the influence of visual perceptual processing on word recognition and decoding would highlight the impact of these skills on reading development. Longitudinal studies that track students' reading success along with their visual perceptual abilities would demonstrate stronger evidence that visual perception is integral to reading and should be incorporated into reading education. Cross-cultural studies could reveal how visual perception impacts reading development in languages with varying degrees of orthographic opacity. The development of specific evidence-based visual perceptual and oculomotor exercises could be incorporated into reading instruction, and researchers may evaluate the effectiveness in improving reading outcomes. Intervention studies can be conducted to explore reading successes with the utilization of visual perceptual exercises.

Educational practices may be enhanced by incorporating aspects of visual perception into reading instruction. Reading curricula could be developed in the following ways:

1) Include visual memory tasks during instruction to increase letter identification, sight word reading, and word recognition. Examples include visual memory games with letters and words or recalling letter sequences from visually presented index cards.
2) Visual discrimination tasks may be used to complement reading instruction to visually identify similarities and differences among letters and words. Examples include highlighting the differences between "b," "d," "p," and "q," which may be formed in a similar fashion but differ spatially or by presenting similarly

spelled words side by side (i.e., "saw" and "say," "causal" and "causal") to learn how to better recognize and distinguish words.
3) Visual attention tasks may be incorporated into instruction to help readers focus on relevant text on the page and ignore extraneous information. Examples include finding target words embedded in a paragraph and pictures or by assembling word puzzles.
4) Visual perceptual skills may be assessed along with reading screenings to identify deficits in this area that may be contributing to difficulty in learning to read. Strategies that integrate visual perceptual processes into reading remediation may enhance the effectiveness of the techniques.
5) Additionally, the role of specialized support personnel on the school-based team, such as occupational therapists, should be considered as a resource for supporting students in achieving their reading outcomes. Occupational therapists' knowledge of visual perception and its impact on function can further enhance an educator's mission to help students successfully learn to read.

5. Conclusion

Reflecting upon the aforementioned studies, it seems undeniable that visual perception plays some role in reading. This notion is not in contrast to research that identifies reading as a language-based skill. Instead, it suggests that the role of visual perception is an overlooked component of reading, one which may hold the key to achieving better reading outcomes. Therefore, a re-conceptualization of reading development, in which both visual perception and language processing are equally essential, seems warranted.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by the author.

Conflicts of Interest

The author declares that she has no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Author Contribution Statement

Ellen Modlin: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing.

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