VISUAL-TEXT ALIGNMENT AND ITS IMPACT ON READING COMPREHENSION: A STUDY OF CONGRUENT AND INCONGRUENT IMAGERY

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Abstract

Printed and electronic texts are becoming increasingly multimodal, drawing greater attention to visual literacy. Relying on dual coding theory, which addresses the separate use of verbal and visual information systems, as well as the increasing importance of visual compactness, this study examines the relationship between images and written language. To investigate this, we designed a test for 120 randomly selected third graders. Divided into an experimental group and a control group with varied demographic characteristics, students responded to two types of tests. The control group was assessed with visually aligned tests, while the experimental group was assessed with tests where text and images did not match. The referential link between verbal and visual codes provided a platform for gathering data on how learners process and respond to visual and verbal stimuli. The test results of the two groups were analyzed using t-tests, which showed significant differences, highlighting higher achievements among students in the Control Group, who were assessed with tests where text and images were coherent. It is recommended that educators prioritize congruent visual-text materials to enhance reading comprehension outcomes.

Keywords: reading, reading comprehension, Congruent and Incongruent Imagery

Introduction

Numerous scholarly definitions converge on the characterization of reading as a multifaceted cognitive process involving the decoding of symbolic representations to construct meaning. Reading comprehension, as a complex cognitive operation, manifests as a cumulative outcome of interconnected competencies and skills. These include but are not limited to, grapheme-phoneme correspondence, lexical access, reading fluency, syntactic analysis, and semantic knowledge. This intricate interplay of skills establishes comprehension as a sophisticated index of overall reading proficiency.

Within the pedagogical context of emergent literacy, the acquisition of reading competency constitutes a primary educational objective. Consequently, instructional activities are predominantly focused on the development and refinement of reading skills—specifically, letter recognition, phonological synthesis, and intonation of words in a sentence (Ehri, 2005). However, while the fundamental purpose of reading remains the extraction of textual meaning (Johnson, 2024), contemporary perspectives extend the definition beyond mere understanding. Modern approaches to reading instruction emphasize critical thinking, inquiry-based learning, intertextual connections, and collaborative communication.

Reading comprehension arises from the synergistic interaction of multiple interdependent competencies, such as word recognition, reading fluency, syntactic processing, and vocabulary knowledge. This complex interrelationship positions comprehension as a refined indicator of overall reading aptitude. Nevertheless, isolated low comprehension scores offer limited diagnostic insight into specific underlying deficiencies, thereby hindering the precise identification of contributing factors to comprehension challenges (Parker, 2024).

A critical consideration is the potential interplay between mental imagery and reading comprehension. The capacity to generate mental representations may operate in parallel with, or be influenced by, accompanying visual aids within the textual material. Reading comprehension is facilitated by mental imagery, known as the "mind's eye," and can improve the quality of these mental models (Algozzine, & Douville, 2004; De Koning & van der Schoot, 2013). Furthermore, the inclusion of visual materials can leverage the so-called "multimedia effect", (Schüler et al., 2015) enriching comprehension, fostering conceptual connections, and clarifying relationships between ideas. Images also make it easier to understand the content of the reading as we are inherently more fluent in reading images due to seeing them more frequently (McCuaig, 2023).

Literature Review

Mental imagery

Mental imagery is characterized as a cognitive capacity arising from the processing of sensory stimuli in the absence of direct physical stimulation or perceptual input (Kosslyn, 1994). Mental imagery takes on a new importance as a fundamental underlying skill for cognition and learning (Suggate & Martzog, 2022). This emphasizes the proposition that mental images constitute quasi-perceptual representations of subjective experience. This perspective aligns with the conceptualization of West (2010), which posits that mental imagery facilitates the reactivation of pre-existing cognitive resources, identifying previously unperceived patterns and promoting a state of cognitive equilibrium between thought and action. This is analogous to the reported experiences of Einstein, who described his thought processes as predominantly visual, subsequently translating these visual representations into verbal and symbolic forms (West, 2010).

The absence of a validated, standardized mental imagery task with objective measures has indeed presented challenges to exploring the role of mental imagery in psychological processes (Suggate & Lenhard, 2022), particularly within the domains of reading and comprehension. A significant methodological challenge lies in the inherent difficulty of verifying and quantifying the fidelity of mental imagery generation during reading. Nevertheless, existing research (Boerma et al., 2016) support a positive correlation between mental imagery and reading comprehension, consistent with Paivio's dual-coding theory, which proposes that the integration of verbal and visual information enhances cognitive processing, resulting in improved comprehension and retention through the creation of a more elaborate and multi-sensory cognitive representation of textual information.

Existing scholarship on reading comprehension underscores the contribution of mental imagery to individual variations in reading proficiency. According to De Koning & van der Schoot (2013), students who are prone to reading are precisely those students who can create mental images in general while reading. Specifically, the ability to generate and integrate mental representations facilitates the comprehension of complex and abstract concepts within the text. Mental imagery encompasses a range of sensory modalities, including the visual, tactile, auditory, olfactory, gustatory, proprioceptive, and vestibular senses, reflecting the inherent link between imagery and perceptual processing (Andrade, 2023; De Neys, 2023).

Empirical evidence consistently demonstrates the significant impact of visual aids on reading comprehension, a phenomenon often referred to as the "multimedia effect." According to Schnotz (2014), pictures are external descriptive representations associated with descriptive representations using symbols of arbitrary structure, words. The reader's thinking model relies on the initial frame provided in the picture (Eitel & Scheiter, 2015) examined in research to explain sequencing effects when teaching pictures and text, which would benefit young readers

as the fusion of visual representations with text results in a richer mental representation of the story, and therefore improved understanding (Schüler et al., 2015). While textual information provides a more structured conceptual framework, visual elements facilitate the dynamic adaptation of mental models, offering flexible access to specific information for efficient cognitive processing (Eitel & Scheiter, 2015). Despite ongoing debate regarding optimal methods for integrating textual and visual information (Boerma et al., 2016), the dual-coding theory (Paivio, 2006) posits that, while processed independently, verbal and pictorial information remain interconnected within the cognitive system.

Reading Comprehension: The Influence of Associative Knowledge Networks

Analogous to semantic relationships, visual imagery contributes significantly to lexical meaning. Associative connections, particularly salient for words lacking concrete referents, points contribute to the meaning of the words. The complex skill of incorporating related verbal and nonverbal patterns in analyzing the meaning of concepts develops into associative cognitive ability.

While prevailing educational and cognitive research emphasizes the primacy of verbal representations in semantic processing, this study prioritizes the role of nonverbal variables. Cognitive theories of literacy posit that the identification of associative links facilitates knowledge construction. Therefore, a comprehensive understanding of reading necessitates an examination of the cognitive mechanisms underlying the evocation of mental imagery during reading. This process can affect not only later memory but also the actual meaning of the material as it is read (Denis, 1982). Empirical evidence demonstrates the intuitive linking of visual and verbal representations, facilitating the establishment of connections between verbal and nonverbal cognitive systems; this implicit process, guided by associative cognitive maps, significantly influences implicit memory retrieval.

Reading comprehension is a complex, goal-directed process characterized by dynamic interaction between reader and text. Goh and Tanmer's "simple view" of reading posits that comprehension emerges from the interplay of decoding and linguistic comprehension, highlighting comprehension as the fundamental objective of reading. Comprehension is defined as the extent to which a message is accurately processed. This understanding arises from the interplay between textual elements and the reader's pre-existing knowledge structures (Rayner et al., 2001). However, reading comprehension is further influenced by the reader's cognitive resources (attention, memory, critical analysis, inferencing, visualization), motivational factors (reading purpose, interest, self-efficacy), background knowledge (vocabulary, linguistic proficiency, content expertise, metacognitive strategies), and prior experience (Snow, 2002). The generation of mental imagery, analogous to a "movie in the mind," enhances engagement and improves memory encoding (Long et al., 1989). Furthermore, mental imagery facilitates various cognitive processes integral to comprehension, including inference generation, prediction, and schema utilization (Gambrell & Jawitz, 1993).

Methods

Participants

Participants in the research are third-grade students from 8 different primary schools (urban and rural settlements) in the western part of the Northern Republic of Macedonia. A total of 120 students are involved. To address the research limitations, specifically the exclusion of other relevant factors influencing reading comprehension, the tests of students reported by teachers as having learning difficulties were excluded from the sample. These excluded tests belonged

to the Control Group. Therefore, this study analyzed 115 tests, including 55 from the Control Group and 60 from the Experimental Group.

Reading materials and reading comprehension test

The results of the research are based on the children's story which is accompanied by illustrations. To observe whether students rely on reading comprehension in images, or focus more on the verbal (written) part, two types of tests were designed. The test text that tested the reading comprehension of the control group was designed so that there was a match between the images and the text, while the text on which the experimental group would operate was designed so that the text and images did not match completely. After the text was accompanied by images, there were multiple-choice questions with three possibilities about the story the children read and an open question. The reading comprehension results were assessed based on factual questions, while the six-question questionnaire required students to make connections between the facts in the text and summarize their understanding. We emphasize that the test was piloted with 50 students as a sample to represent the diversity and range of the full set. Reliability analysis with Cronbach Alpha resulted from α=0.82.

Procedure

The students included in the research were randomly assigned, so we could not determine the gender distribution completely. Because the purpose of the research did not involve finding the difference regarding the social status of the students, the place where they live, reading comprehension levels, prior knowledge, individual learning styles, and other factors that would dictate reading comprehension, we did not care that the distribution of the two types of texts is intentional. Therefore, this can be considered as a limitation of this research. The testing session in which the researcher and the teacher of the same class participated was completed for about 30 minutes, out of a possible 40 minutes. The teacher in charge of the class was requested so that the students could feel the daily routine. To minimize the influence of a teacher's emphasis on developing visualization and other reading comprehension strategies, the two types of texts were distributed in parallel within the classroom, ensuring that students were unaware of their assignment to the Control or Experimental Group. We tried to maintain proportionality when distributing the two types of texts.

The version of the text dedicated to the experimental group was read by a total of 60 students, of which 28 were male (46.7%) and 32 were female (53.4%). The version of the text dedicated to the control group was read by all 60 students, but 5 tests of the students involved in the testing were excluded from further analysis (four students with special needs and one with dyslexia). Then, in the control group, tests of 55 students were analyzed, of which 32 were males (58.18%) and 23 were females (41.82%).

The students were briefly presented in front of the pages of the story that should be read so that we naturally showed with gestures that they could find text and images in them. All this happened so as not to overemphasize the request that their focus should be on colored images, but that reading should be as natural as possible and according to the students' attitudes towards reading.

After reading, students were asked to hand in the texts. After we ensured that the students had read all the pages of the text and were sure they wanted to submit the text, they were given the open-ended test to complete. It was emphasized that if they wanted to withdraw from the test, they were free to do so, although none of them gave in and we did not feel that we pressured them.

Results

This study investigates the impact of visual-text alignment on students' reading comprehension. Specifically, it explores whether the congruence between images and text influences comprehension scores, and whether gender plays a role in this process. The two key research questions guiding this study are:

     1. Does visual-text alignment affect reading comprehension scores?

     2. Are there gender differences in reading comprehension scores for students with congruent and incongruent imagery?

In this study, we used two statistical tests to assess the impact of visual-text alignment and gender on students' reading comprehension. Independent Samples t-tests were conducted to compare the performance of the Control Group (congruent imagery) and the Experimental Group (incongruent imagery) on each question and the overall score. Additionally, a Two-Way ANOVA was used to examine the interaction between gender and group type in influencing reading comprehension.

Table 1. Group Comparisons for Reading Comprehension and Overall Scores

Question	Group	N	M	SD	t	p
Q1	Experimental	60	.47	.503	-1.633	.105
	Control	55	.62	.490		
Q2	Experimental	60	.73	.446	-.838	.404
	Control	55	.80	.404		
Q3	Experimental	60	.77	.427	-.674	.501
	Control	55	.82	.389		
Q4	Experimental	60	.53	.503	-4.213	.000*
	Control	55	.87	.336		
Q5	Experimental	60	.77	.427	1.940	.055
	Control	55	.60	.494		
Q6	Experimental	60	.40	.494	-2.798	.006*
	Control	55	.65	.480		
Overall Score	Experimental	60	.61	.200	-3.061	.003*
	Control	55	.73	.206		

The results of the independent samples t-tests reveal a mixed pattern of significance across the reading comprehension test questions. For **Q4** (p = 0.000) and **Q6** (p = 0.006), there were significant differences favoring the Control Group, indicating that congruent visual-text alignment helped students better interpret the materials and make connections. This is consistent with the broader pattern shown in the **Overall Score** (p=0.003), where the Control Group significantly outperformed the Experimental Group, further supporting the role of congruent materials in reading comprehension.

While **Q5** showed a marginally significant effect (p = 0.055) in favor of the Experimental Group, other questions such as Q1, Q2, and Q3 did not reveal statistically significant differences (p > 0.05). This suggests that the effect of congruence may vary depending on the type of question, with more complex or integrative tasks (e.g., Q4 and Q6) being more sensitive to congruent visual-text alignment.

Table 2. Gender Differences in Reading Comprehension and Overall Score

Question	Gender	N	M	SD	t	p
Q1	Male	60	.47	.503	-.129	.897
	Female	55	.62	.490		
Q2	Male	60	.73	.446	.914	.362
	Female	55	.80	.404		
Q3	Male	60	.77	.427	-.674	.501
	Female	55	.82	.389		
Q4	Male	60	.53	.503	.913	.363
	Female	55	.87	.336		
Q5	Male	60	.77	.427	-.888	.376
	Female	55	.60	.494		
Q6	Male	60	.40	.494	-.856	.394
	Female	55	.65	.480		
Overall Score	Male	60	.61	.200	-.294	.769
	Female	55	.73	.206		

The results of the independent samples t-tests reveal no significant differences in performance between male and female students across all six reading comprehension questions and the overall score. The p-values for all comparisons exceed the 0.05 threshold, with the overall score showing $t = -0.294$, $p = 0.769$, indicating no meaningful gender-based differences in reading comprehension outcomes.

For individual questions, male and female students performed similarly. For example, in Q1 ($t = -0.129$, $p = 0.897$) and Q2 ($t = 0.914$, $p = 0.362$), the differences in mean scores were negligible. Even for questions requiring higher-order thinking, such as Q4 and Q6, there were no statistically significant differences, suggesting that both genders approach and interpret reading tasks in comparable ways.

These findings suggest that gender does not play a significant role in influencing reading comprehension in the context of the test. This result aligns with broader research indicating that when instructional materials are well-designed, gender differences in comprehension tend to diminish. Future research could investigate whether other factors, such as prior knowledge or cognitive styles, interact with gender to affect outcomes in more nuanced ways.

A Two-Way ANOVA test was conducted to examine the effects of visual-text alignment (group: control vs. experimental) and gender (male vs. female) on students' performance in a reading comprehension test. The test aimed to measure how congruence or incongruence between visuals and text affected students' ability to answer factual multiple-choice questions and summarize key ideas. The Control Group received reading materials where the visuals aligned with the text, while the Experimental Group worked with materials where the visuals and text were incongruent. The analysis also investigated whether gender influenced performance or interacted with the group effect.

Table 3. Summary of Two-Way ANOVA Results for Overall Reading Comprehension Scores

Effect	F	df	p-value	Partial Eta Squared	Interpretation
Gender	0.424	1, 111	0.516	0.004	No significant effect of gender on reading comprehension.
Group	9.515	1, 111	0.003**	0.079	Significant effect: Control group outperformed Experimental group.

	F	df	p	η²	Interpretation
Gender × Group Interaction	0.015	1, 111	0.903	0.000	No significant interaction between gender and group.
Levene's Test	0.313	3, 111	0.816	-	Homogeneity of variances assumption met.
Model R²	-	-	-	0.080 (Adj. 0.055)	Model explains 8% of variance in scores.

The results showed a significant main effect of group on overall reading comprehension scores, $F(1,111) = 9.515$, p = 0.003, $\eta^2 = 0.079$. Students in the Control Group (M = 0.73, SD = 0.206) outperformed those in the Experimental Group (M = 0.61, SD = 0.200). This result highlights the critical role of congruent imagery and text in facilitating comprehension. Gender did not significantly influence scores, $F(1,111) = 0.424$, p = 0.516, $\eta^2 = 0.004$, and no interaction between gender and group was observed, $F(1,111) = 0.015$, p = 0.903, $\eta^2 = 0.000$.

Levene's Test confirmed that the assumption of homogeneity of variance was met (p = 0.816), validating the reliability of the ANOVA test. The model accounted for 8% of the variance in test scores, highlighting that visual-text alignment is a moderately important factor influencing reading comprehension.

Discussion

The results of this study offer valuable insights into how visual-text congruence influences reading comprehension. The significant advantage of congruent visual-text materials observed in this research echoes findings by Huang (2019), who demonstrated that meaningful integration of visuals with textual content reduces cognitive load, thereby enhancing understanding. This perspective aligns with Clark and Lyons (2011), who emphasized the role of well-designed visuals in promoting effective learning across various subjects. Furthermore, the results corroborate Mayer's (2009) Cognitive Theory of Multimedia Learning, which underscores that meaningful alignment between verbal and visual elements facilitates deeper cognitive processing. These findings highlight the importance of ensuring congruence in instructional design to maximize comprehension and retention.

In contrast, other studies, such as those by Schmitt and Schmitt (2020) and Nadera (2001), advocate for a balanced approach. While visuals are crucial for engagement and understanding, they stress that reading strategies like skimming and scanning are equally important for developing independent comprehension skills. These researchers suggest that over-reliance on visuals without strategic reading practices may limit students' ability to extract deeper meanings from text alone. The gender-insensitive nature of the comprehension results aligns with the work of Rashidi and Piran (2011), who found that differences in reading performance often hinge more on instructional materials and strategies than on demographic factors. Similarly, the absence of significant gender effects in this study resonates with findings by Salehi et al. (2014), who observed that reading performance is more strongly influenced by task-specific elements than by gender. Lastly, the control group's success in the congruent visual-text condition aligns with the findings of Richards and Schmidt (2002), who emphasized the role of integrated reading and visual materials in fostering vocabulary acquisition and syntactic understanding. However, future studies could consider incorporating longitudinal designs and diverse demographics to explore whether these benefits persist across varied contexts.

Conclusion

This study explored the effect of visual-text congruence on reading comprehension and examined whether gender influenced this relationship. The results showed that the control group, exposed to congruent imagery, outperformed the experimental group, which engaged with texts paired with incongruent visuals. Specifically, the control group had an overall mean score of 0.73, while the experimental group had a mean score of 0.61. The data indicated that students in the control group performed significantly better on certain questions, such as Q4 (p = 0.000) and Q6 (p = 0.006), which supports the notion that the alignment between visual and textual elements influences comprehension. In response to the research questions, the study confirms that visual-text congruence does impact reading comprehension. However, the results revealed that the control group, which was exposed to congruent imagery, performed better overall, achieving a mean score of 0.73 compared to 0.61 for the experimental group, which engaged with incongruent imagery. This outcome was contrary to the initial hypothesis, suggesting that factors beyond visual-text congruence may influence students' comprehension. Gender did not significantly affect reading comprehension in this study, as both male and female students exhibited similar performance across the two groups. The findings suggest that educators may need to reconsider the impact of visual-text congruence, as other factors, such as the task design or student familiarity with the material, could also influence comprehension outcomes.

Limitations

The study has some limitations, including a small sample size, which may limit generalizability. It also did not consider factors like prior knowledge or cognitive abilities that could affect comprehension. Future research should address these factors with a larger, more diverse sample and examine the long-term effects of visual-text congruence on reading comprehension.

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