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The effect of rapid automatized naming ability in elementary school on reading comprehension: the mediating role of sustained attention

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Abstract

The purpose of this study is to test the effect of sustained attention's mediating role on the impact of rapid automatized naming ability on reading comprehension. The participants in the study consisted of 56 third-grade elementary school students. Of the participants, 53.57% were female (n=30) and 46.43% were male (n=26). The age range of the students, who are from the same school and similar socioeconomic backgrounds, varies between 8.24 and 8.77 ($\bar{x}$=8.41, SD= 0.19). The native language of all students participating in the study is Turkish. A structural equation model was used to analyze the data obtained in the study. SPSS 24 was used for the necessary analyses in the study, namely correlation and Sobel z-test, while SmartPLS 4 was used for the mediation test and the equality model. The results of the study show that there is a significant relationship between the sub-dimensions of rapid automatized naming (object, color, letter), reading comprehension, and sustained attention, while there is no significant relationship between reading comprehension and number naming. Another result of the study is that rapid automatized naming has a direct (β=-.19, t=3.22, p<.05) and indirect (β=-.18) effect on reading comprehension. The direct relationship between rapid automatized naming and reading comprehension was found to be significant when the mediating variable was not included in the model. However, when the mediating variable of sustained attention was added to the model, this direct effect became insignificant. Therefore, it was concluded that sustained attention complately mediated this effect.

Keywords

Rapid automatized naming
Reading comprehension
Sustained attention
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Introduction

Reading comprehension (RC) is a skill that can be influenced by many cognitive, social, and emotional factors. Therefore, understanding the variables that affect RC or are related to RC is quite important. In the international literature, rapid automatized naming (RAN) and sustained attention (SA) are among the variables examined in this relationship, which has been studied for a long time.

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Studies in this field show that RAN and its subtasks are critically important for reading comprehension. Both RAN tasks and reading comprehension require sustained attention to perform well. In other words, it is thought that the role of SA needs to be understood. Therefore, this study focuses on discovering the effect of RAN on RC and how SA mediates this effect.

Reading is a mental activity in which the perspectives, events, and meanings in a written text are examined. In this process, the reader aims to achieve understanding by evaluating the author's intended purposes and relationships (Veeravagu et al., 2010). Ultimately, the main purpose of reading is understanding (Akyol, 2019). There are many mental components that are thought to be effective on RC. It is stated that RAN is related to RC (Van den Bos et al., 2002; Weng et al., 2016) and even that RAN is a strong predictor of RC (Altani et al., 2017; Bakır, 2007; Georgiou et al., 2009; Karadağ et al., 2019; Kirby et al., 2003). RAN may be a determinant of the amount and duration of information acquired during reading in working memory (Demirtaş, 2017; Norton & Wolf, 2012). Since working memory plays a critical role in information processing, students with weak RAN skills may experience difficulties in comprehension even if they pronounce the words correctly (Li et al., 2011).

Both reading and RAN tasks require continuous focus and coordination, making SA crucial for both skills (Saydam, 2020). SA provides the cognitive resources that enable focusing on the text in reading and on stimuli in RAN tasks (Karadağ et al., 2019). A review of the literature reveals studies examining the relationship between RAN and RC (Arnell et al., 2009; Karadağ et al., 2019; Tighe & Schatschneider, 2016). However, it can be said that the main focus is on the direct relationship between reading ability and RAN or on the predictive power of RAN on reading (Furnes & Samuelsson, 2011; Landerl et al., 2019; Li et al., 2009; Ozernov-Palchic et al., 2017; Taub & Szente, 2012; Wolf & Denckla, 2005). RAN skills enhance our perception of RC through their contribution to reading fluency (Norton & Wolf, 2012). The relationship between RAN and RC may be related to the shared cognitive resources used (Georgiou et al., 2008). Therefore, understanding the relationships between RAN, RC, and SA and the roles in these relationships will strengthen our perception of reading comprehension education.

RAN is defined as the ability to quickly recall visual symbols from long-term memory (Albayrak, 2023; de Jong, 2011; Warmington & Hulme, 2012; Wolf & Denckla, 2005). The RAN test consists of a series of tasks involving objects, colors, letters, and numbers that are assumed to be well recognized by the child. The child is presented with objects, colors, letters, and numbers in a mixed order, and the time taken to name them is calculated and evaluated (Araújo et al., 2015; Norton & Wolf, 2012). According to Karadağ et al. (2019), reading and RAN are based on the principle of naming images in sequence. The researchers explain this as a newly literate individual sounding out letters, while an individual who has not yet learned to read sounds out images (Karadağ et al., 2019). Consequently, it is known that it is possible to predict RC through RAN, which activates mental processes similar to reading (Karadağ et al., 2019; Tighe & Schatschneider, 2016).

Due to the continuous nature of its tasks, RAN requires the effective use of attention resources because of its impact on both speed and the automaticity of recall. Therefore, it has been suggested that attention may play a critical role in directing higher-level mental processes such as comprehension skills (Samuels, 2006). According to the literature, the effect of RAN on RC has been frequently investigated (Smallwood et al., 2008; Varizo et al., 2022). However, considering that RAN and RC tasks are actions requiring SA, it can be said that the attention variable has been overlooked in the studies conducted.

Attention is a cognitive resource that directs mental resources to various stimuli (Bizama & Chávez, 2023). While analyzing words during reading, individuals must constantly direct their attention to the written material in order to form mental representations of the meanings in the text (Alloway et al., 2014). Attention also enables the selection of correct information for reading comprehension. Therefore, it is vital for reading comprehension skills (Yıldız & Çetinkaya, 2017). When attention resources are mostly used for correct word pronunciation, problems arise in the formation of meaning (Torgesen et al., 2001). Therefore, it can be said that the continuity of attention plays a particularly important role in RC. Smallwood et al. (2008) also support this view, emphasizing that for

comprehension to occur, the individual must perceive stimuli and maintain focus on these stimuli throughout the process. Arrington et al. (2014) state that SA predicts RC. Other studies also show that SA plays an important role in the RC process (Alvarado, 2023; Öksüz & Akyol, 2023; Razza et al., 2012; Shelleby & Ogg, 2020; Stern & Shalev, 2013).

It is also necessary to understand the relationship between RAN and SA, which activate the same parts of the brain as RC. It has been suggested that RAN skills require many abilities, such as attention, memory, and motor skills (Georgiou et al., 2016; Wolf et al., 2000). In addition, the speed and accuracy of RAN tasks can be influenced by many variables (Wolf & Bowers, 1999). It is also stated that attention to the stimulus is essential in the RAN process (Karadağ et al., 2019). Individuals with developed RAN skills use fewer cognitive resources in word recognition and pronunciation. This enables the transfer of attention resources to different cognitive processes and, consequently, strengthens RC (Norton & Wolf, 2012). In this case, it can be said that SA is both a requirement and a result of the RAN process. It can be interpreted that SA has a kind of guiding function for both RC and RAN. Therefore, it is possible to say that SA acts as an mediating structure for the continuity of the process for both skills.

Current Study

When studies are examined, it is seen that the interaction between RAN and RC is frequently investigated (Karadağ et al., 2019). Connor (2016) emphasizes that reading comprehension occurs through a series of interactions between the knowledge structures possessed by the individual and certain cognitive structures. RAN refers to the rapid recall and vocalization of visual symbols (de Jong, 2011; Warmington & Hulme, 2012; Wolf & Denckla, 2005). This situation works similarly in reading (Abolafya, 2008). For meaning to be formed, visual symbols related to letters must be retrieved from memory and read. Some researchers indicate that the same regions of the brain become active in both tasks (Lervag & Hulme, 2009; Litt, 2010). Numerous studies in the field also confirm the relationship between RAN and RC (Araújo et al., 2015; Karadağ et al., 2019; Li et al., 2011). SA is quite important in tasks involving both skills (Smallwood et al., 2008).

Attention determines the selectivity of the inputs we perceive through our senses (Schunk, 2012). Attention is a skill that can be consciously directed and sustained (Bizama & Chavez, 2023). Sustainability of attention plays a decisive role in both RAN tasks (Georgiou et al., 2016) and RC tasks (Stern & Shalev, 2013). Research also shows that RAN (Araújo et al., 2015; Karadağ et al., 2019) and SA (Macdonald et al., 2021; Stern & Shalev, 2013) are important cognitive skills for RC.

Based on all this information, it is also very important to explain the model on which the study is structured. As in the current study, there are many models used to examine and explain cognitive functions in educational processes (see Baddeley, 2000; Mayer, 2005). The identified model focuses on the interaction between RAN and RC, while also explaining the role of SA. According to the model, SA mediates the relationship between RAN and RC, which is important for both. In other words, the model attempts to explain the function of SA, which is one of the determining factors of success in RAN and RC tasks. Considering its relationship with both RAN and RC skills, it is thought that important information regarding the mediating role of SA will be obtained and, therefore, this study will make a significant contribution to the field in terms of explaining the predictive relationship between RAN and RC skills. Accordingly, the aim of this study is to test the effect of SA's mediating role on the impact of RAN skills on RC skills. To this end, the hypotheses presented in Figure 1 are proposed:

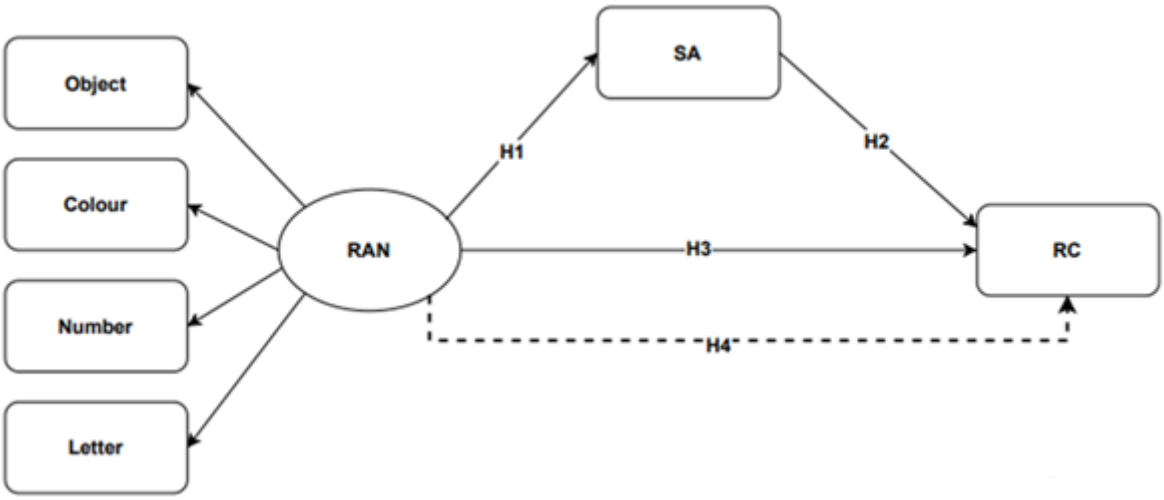

Figure 1. Theoretical Modeling of the Research

H1: Rapid automatized naming ability significantly predicts sustained attention ability.

H2: Sustained attention skills significantly predict reading comprehension skills.

H3: The ability to quickly name things automatically significantly predicts reading comprehension skills.

H4: The ability to quickly name things directly influences reading comprehension through sustained attention skills.

Method

In the study, the predictive correlational survey model, one of the quantitative research methods, was used. Correlational models are used to determine the relationships, levels of change, and effects between two or more variables (Cohen et al., 2000; Karasar, 2007). Correlational studies are divided into two types: predictive and exploratory models. Predictive studies reveal the level of prediction of one variable by another, in addition to the relationships between variables (Büyüköztürk et al., 2017).

Participants

The participants in the study consisted of 56 third-grade elementary school students. Third grade is a period when the basic reading and writing skills are largely acquired and fluent reading and writing skills are reinforced (Akyol, 2019). For this reason, the study was conducted with third-grade students. Of the participants, 53.57% were female (n=30) and 46.43% were male (n=26). The age range of the students, who were from the same school and similar socioeconomic backgrounds, varied between 8.24 and 8.77 ($\bar{x}$=8.41, SD= 0.19). The native language of all students included in the study was Turkish.

During the data collection process conducted in the classes included in the research, integrated students and foreign students were also included in the process; however, the data of these students was not included in the analysis on the grounds that it did not fit the scope of the research. Under the exclusion criteria, students with visual impairment, color blindness, hearing loss, or any physical disability that could directly affect their reading and writing skills, as reported by teachers, were not included in the study. Furthermore, based on teacher opinions, students suspected of having dyslexia, who did not demonstrate age-appropriate reading performance, or who showed signs of attention deficit/hyperactivity disorder (ADHD) were also excluded from the study. The inclusion criteria were students who showed normal development, demonstrated age-appropriate reading and writing performance, and whose visual and auditory perception levels were deemed adequate by their classroom teachers. In short, the participants in the study consisted of Turkish students with no mental

or physical disabilities and who showed normal development. The necessary information about the students' physical and mental conditions was obtained from the opinions of their families and teachers. The sample size was determined using a power analysis performed with the G*Power 3.1 software. The analysis was based on a medium effect size (f = 0.25), a 95% confidence level, and 80% power (1-β), and it was found that at least 52 participants were needed. Therefore, the 56 participants in the study meet the minimum sample size requirement.

The data for this study were obtained from a school located in the Torbalı district of İzmir province. Torbalı district is a densely populated area, and the students belong to the middle/upper socioeconomic level. Socioeconomic level was determined based on the occupations and educational levels of the families and demographic information obtained from the school administration. The vast majority of the students' parents have professions that provide a regular income and have a high school education or higher. Therefore, the participants were considered to be of middle/upper socioeconomic status. The neighborhood where the school is located has a high population density. The school where the research was conducted has 19 classrooms, 27 teachers, and 678 students. Classes consist of an average of 35 students.

Data Collection Tools

Reading Comprehension (RC)

The study used curriculum-based assessment to measure RC skills. The text selected for curriculum-based assessment was chosen from the book written by Aydın and Demirel (2010) and approved by the Council of Education, which was used as the third-grade Turkish textbook in the 2010-2011 academic year. The text used to measure RC, titled "What Are Mountains Good For?", was selected from the third-grade Turkish textbook. The text consists of 842 syllables, 339 words, and 34 sentences. Using Ateşman's (1997) readability formula, the text's readability was determined to be at an easy level with a score of 73.02. The average sentence length of the text is 9.97 words, and the average word length is 2.48 syllables. This text was chosen because it is appropriate for the cognitive and language development level of third-grade students, can be related to daily life, and offers readable content. Additionally, the selection of the text from the textbook is related to its suitability for the student level, as Turkish textbooks have been approved by the Council of Education. In line with curriculum-based assessment, the taxonomy included in the question scale of the Error Analysis Inventory adapted into Turkish by Akyol (2019) was used. This inventory is one of the reliable tools used in the literature to determine students' reading comprehension levels. According to the inventory, three simple comprehension questions and three deep comprehension questions were prepared from the text to measure students' comprehension levels. For simple comprehension questions, 0 points were given for unanswered or incorrectly answered questions; 1 point for partially answered questions; and 2 points for fully answered questions. For in-depth comprehension questions, 0 points were given for questions that were not answered or answered incorrectly; 1 point for partially answered questions; 2 points for expected but incomplete answers; and 3 points for complete and effective answers (Akyol, 2019). The simple comprehension questions included in the study are as follows:

1. What percentage of the landmass consists of mountains?
2. How many types of mountains are there, and what are they called?
3. What are the benefits of mountains?

In-depth comprehension questions can also be defined as questions that require the reader to make various inferences based on the text. The in-depth comprehension questions included in the study are as follows:

1. Would you like to live at the foot of a high mountain? Why?
2. Who is the phrase "a mountain of a man" used for? Explain.
3. How would our world be affected if there were no mountains?

The reliability level of a study depends on the degree to which the study is free from errors in the data collection and analysis process (Ellez, 2014). A graded scoring key was prepared to score the responses to the questions in the study. Although there were a total of five researchers in the study, the evaluations were conducted by two independent researchers to ensure consistency in scoring. The use of two evaluators is a common practice in inter-rater reliability studies and is considered sufficient for reliability calculations (Miles & Huberman, 1994). For this reason, two researchers evaluated the participants' responses. Cohen's Kappa formula was used to determine the agreement between researchers (Miles & Huberman, 1994), and the result was determined to be .91. A score above .70 is acceptable for scoring reliability (Yıldırım & Şimşek, 2013). Furthermore, we used ICC (intraclass correlation coefficient) to calculate the inter-rater reliability coefficient. According to Koo and Li (2016), ICC is frequently used for inter-rater reliability. Therefore, in the present study, inter-rater reliability in the RC test was found to be excellent with ICC=.963 (95%).

Sustained Attention (SA)

The Bourdon Attention Test was used to measure students' SA skills. There are two types of the Bourdon Attention Test: letters and syllables. The letter form was used in the study. This test was adapted into Turkish by Karaduman (2004). This test, which is frequently used to measure SA, contains 660 letters in a mixed order. Students are expected to mark the letters "b, d, g, and p" from this mixed list. The test requires sustained attention (Bozan & Akay, 2012). There is no age limit for administering the test. However, participants must have acquired letter recognition skills. During the evaluation phase of the test, stimuli marked as correct or incorrect can be used (Karaduman, 2004). In the study, correct markings were taken into account, and one point was awarded for each correct marking.

Karaduman (2004) conducted the validity and reliability study of this test with elementary school students. The test-retest method was used for reliability, and the correlation coefficient was determined to be .78. In addition, the validity of the test was examined using the d2 attention test, and the inter-test correlation coefficient was determined to be .63.

Rapid Automatized Naming (RAN)

RAN tests involve tasks based on the rapid and accurate naming of images (Norton & Wolf, 2012; Öksüz & Akyol, 2024; Warmington & Hulme, 2012). Since speed is taken into account along with correct naming in RAN tests, time is measured and recorded as a score (Öksüz & Akyol, 2024).

The Rapid Naming Test (RNT) used in the study was developed by Ergül and Demir (2022) to assess the rapid naming performance of elementary school students. The test consists of four stages: color, letter, number, and letter sounding. In each stage, 10 items are presented to the student in five rows, and the student is expected to sound them out as quickly and accurately as possible. Factor analyses conducted to assess the validity of the test revealed that a single factor explained 67.53% of the variance. In addition, it was stated that the test was discriminative for each grade level and that the test-retest coefficients were .83 and .95. Finally, the Cronbach Alpha coefficient calculated for the reliability of the test was found to be .70.

Procedure

The ethical approval for the study, which aimed to examine the relationships between RAN, SA, and RC skills and to test the mediating effect of SA on RAN's impact on RC, was obtained from the Scientific Research and Publication Ethics Committee of Duzce University on 04.10.2024 with file number 2024/312 (Document Date and Number: 10/09/2024-485956). A "parental consent form" based on the principle of voluntariness was distributed to all students participating in the research, and completed and signed forms were requested from consenting parents. Since the ages of the students participating in the research were not appropriate for consent, consent was requested from their parents.

After obtaining all necessary permissions, the data collection process was carried out with two researchers and a guidance counselor from the school. The tests for RC and SA were completed in classrooms, while students participated in the RAN test individually. The data collection process for the study was completed in eight working days. The application of the measurement tools in the study was carried out in three stages. First, the reading comprehension test was administered over three class periods, and the next day, the sustained attention test was completed over another three class periods. In the final stage, the rapid automatized naming test was administered over a total of 18 class periods spread across six days.

Data Analysis

A structural equation model was used to analyze the data obtained in the study. In addition, SPSS 24 (IBM Corp., 2016) was used for the correlation and Sobel z test, which were necessary analyses in the study, while SmartPLS 4 (Ringle et al., 2024) was used for the mediation test and structural equation model.

The data analysis of the study began with normality and multicollinearity analyses, which are prerequisites for mediation. Multicollinearity refers to a high level of relationship between predictor/independent variables (Büyüköztürk, 2010). Multicollinearity can be detected by the correlation between independent variables. According to Büyüköztürk (2010), multicollinearity can be considered for independent variables with a correlation of .80 or higher. The analyses revealed that the data followed a normal distribution and that there was no multicollinearity problem among the variables.

Findings

This section of the study includes normality data for the variables, correlation data, and direct and indirect effects.

Table 1. Descriptive Data on Variables

Variables	n	$\bar{x}$	SD	Skewness	Kurtosis
Object	56	46.85	8.85	.869	.861
Colour	56	47.34	9.44	.410	-.293
Number	56	28.48	5.80	.371	-.634
Letter	56	27.53	6.44	1.05	1.45
SA	56	86.18	19.26	-1.10	1.14
RC	56	5.46	2.85	.367	-.330

The normality of the research data was determined based on skewness and kurtosis values. Skewness and kurtosis coefficients within the range of ±2 indicate that the data are normally distributed (George & Mallery, 2001). Based on this, Table 1 shows that all variables in the study are normally distributed.

Since the data showed a normal distribution, the Pearson Correlation test was applied to determine the relationship between the variables, and the findings are presented in Table 2 below.

Table 2. Findings from the Pearson Correlation Test for Variables

	Object	Colour	Number	Letter	SA	RC
Object	1	-	-	-	-	-
Colour	.89**	1	-	-	-	-
Number	.63**	.58**	1	-	-	-
Letter	.51**	.48**	.79**	1	-	-
Sa	-.45**	-.42**	-.29*	-.31*	1	-
RC	-.39*	-.32*	-.22	-.27*	.47**	1

**p< .01, *p< .05

Table 2 shows that there is a positive, high-level, and significant relationship between object and color (r=.89, p< .001), object and number (r=.63, p< .001), and letter and number (r=.79, p< .001). Again, according to Table 1, there is a positive, moderate, and significant correlation between letters and objects (r=.51, p< .001), numbers and colors (r=.58, p< .001), letters and colors (r=.48, p< .001), and RC and SA (r=.47, p< . 001) are positively correlated at a moderate level and are statistically significant. In addition, there is a negative, moderate, and significant relationship between SA and object (r=-.45, p< .001), between SA and color (r=-.42, p< .001), and between RC and object (r=-.39, p< .001). There is a negative, low-level, and significant relationship between RC and color (r=-.32, p< .05), between SA and number (r=-.29, p< .05), between SA and letter (r=-.31, p< .05), and between RC and letter (r=-.27, p< .05). On the other hand, there is no significant relationship between RC and numbers (r=-.22, p> .05). Furthermore, the relationships between RAN, SA, and RC were examined, and findings regarding the mediating effect of SA on RC were presented.

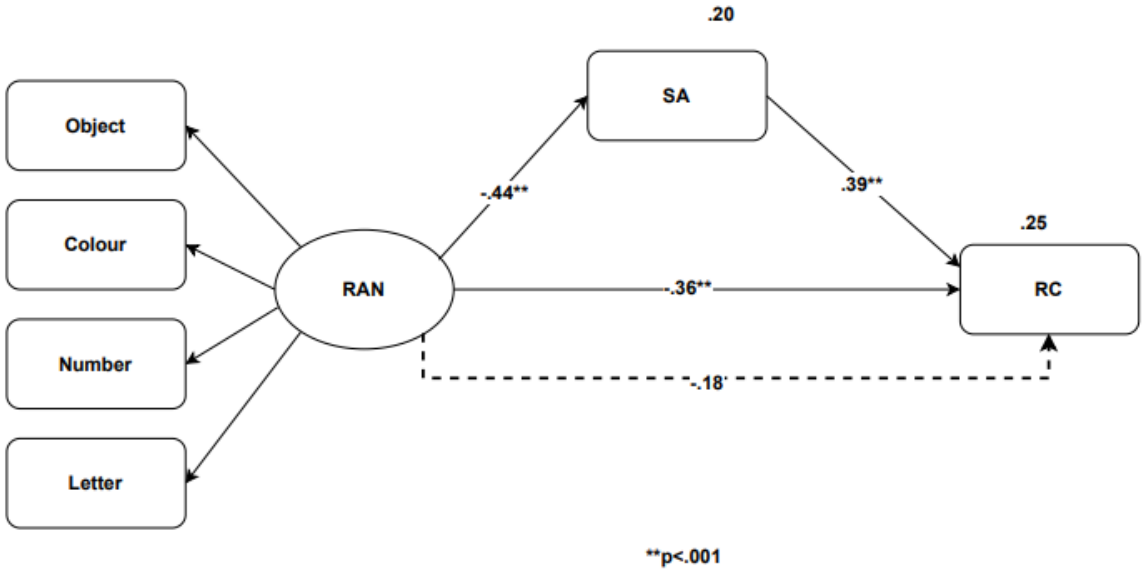

Figure 2. Standardized Regression Coefficients for the Relationships Between RAN Mediated by SA and RC

Table 3. Effects Between Variables Related to the Model

Variable 1	Variable 2	Total Impact	Direct Impact	Indirect Effect	SD	t
RAN	**RC**	-.364	-.188	-.176	.102	3.22*
RAN	**SA**	-.443	-.443	-	.137	3.23**
SA	**RC**	.389	.389	-	.091	4.28**

**p<.001, *p<.05

Table 3 and Figure 2 reveal that RAN has a direct (β=-.19, t=3.22, p<.05) and indirect (β=-.18) effect on RC, with SA mediating this effect. Furthermore, it was observed that RAN has a direct effect on SA (β=-.44, t=3.23, p<.000) and SA has a direct effect on RC (β=.39, t=4.28, p<.000). Therefore, these findings confirm hypotheses H1, H2, and H3. On the other hand, according to Figure 2, RAN explains 20% of the variance in SA, while RAN and SA explain 25% of the variance in RC.

Table 4. The Interaction Created Between Attention as a Variable in Reading Comprehension and Rapid Automatized Naming

Mediation	With no mediating variable	With mediating variable	Mediation type
RAN>SA>RC	-.36 (p=.000)**	-.18 (p=.070)	Complate Mediation

**p<.001

When examining Table 4, the direct effect of RAN-RC found to be significant in the RAN-SA-RC mediating relationship becomes insignificant when the mediating variable (SA) is added to the model, and therefore the SA variable complately mediates this relationship. Furthermore, it can be stated that SA (Sobel's $z = 2.10$, $p < .036$) has a significant mediating effect on RAN's effect on RC. This finding also confirms H4 hypothesis.

Tartışma

The present study examined the relationships between rapid automatized naming, sustained attention, and reading comprehension, and tested the mediating effect of sustained attention on the impact of rapid automatized naming on reading comprehension. As in various studies in the literature (Abolafya, 2008; Albayrak, 2023; Altani et al., 2017; Bakır, 2007; Demirtaş, 2017; Savage & Frederickson, 2005), this study also found a positive and significant relationship between the subscales of rapid automatized naming. Albayrak (2023) states that in a study conducted with children aged 5-7, there was a moderate and positive significant relationship between the object test and the color naming test. In the current study, it was found that there was a positive and highly significant relationship between the object and color subdimensions of rapid automatized naming. It is also stated that the relationship between numbers and letters, which are subdimensions of rapid automatized naming due to their symbol-based nature, is higher (Bakır, 2007). Similarly, in the current study, a positive and highly significant relationship between letters and numbers was found. Furthermore, while a positive and highly significant relationship was observed between the object and the number, a positive, moderately significant relationship was observed between the object and the letter, the number and the color, and the letter and the color. In this respect, the research has produced results similar to those in the literature.

The present study found a negative relationship between rapid automatized naming and reading comprehension; in other words, students who completed the rapid automatized naming test in a shorter time also scored higher on reading comprehension. This finding suggests that reading comprehension may be related to symbolic and non-symbolic stimuli at different levels. Indeed, the present study found a negative, low-level, and significant relationship between reading comprehension and color and letters, while a moderate and significant relationship was found with objects. When considered alongside Bakır's (2007) findings indicating that number and letter naming skills are more highly related to reading than color and object naming, this suggests that symbolic stimuli may be more decisive in the reading process. However, the current study found no significant relationship between reading comprehension and numbers. This finding suggests that symbolic units may be based on different cognitive processing mechanisms despite belonging to the same category. Saydam (2020), who reported no linear relationship between students' rapid automatized naming times in preschool and their reading comprehension levels in first grade, also supports this result. Therefore, the fact that their relationship with reading comprehension is not in the same direction, despite being symbolic units, may stem from this cognitive difference (Van den Bos et al., 2002).

Another finding of the present study indicates that there is a positive, moderate, and significant relationship between reading comprehension and sustained attention. Similarly, studies in the literature also show a positive and significant relationship between reading comprehension and attention (Öksüz & Akyol, 2023; Yıldız & Çetinkaya, 2017). Saydam (2020) states that there is a low-level, positive, and significant relationship between students' attention levels before school and their reading comprehension levels in first grade. When examining the relationship between sustained attention and the subdimensions of rapid automatized naming, it is concluded that there is a negative, moderate, and significant relationship between sustained attention and objects, and between sustained attention and colors. Similarly, the results indicate that there is a negative, low-level, and significant relationship between sustained attention and numbers and between sustained attention and letters. Similarly, the results of the study conducted by Saydam (2020) indicate that there is a negative, medium-level, and

significant relationship between students' attention levels in preschool and their rapid automatized naming times. According to this result, students with high levels of sustained attention also have shorter naming times for the subdimensions of rapid automatized naming. In other words, as the time for rapid automatized naming decreases, success increases; individuals with high rapid automatized naming success also have high levels of attention.

Another finding from the study indicates that rapid automatized naming has both a direct and indirect effect on reading comprehension. In a study conducted by Karadağ et al. (2019) with second-grade students, it was noted that the relationship between rapid automatized naming and reading comprehension was insignificant, and that rapid automatized naming had an indirect effect on reading comprehension. In this effect, reading skills were found to have a complate mediating role according to the results of the study. Similarly, the study conducted by Özata and Haznedar (2018) with second-grade students reported that rapid automatized naming (RAN) had no direct effect on reading comprehension but had an indirect effect through fluent word reading. Unlike the aforementioned studies, the present study was conducted with third-grade students and found that rapid automatized naming had both direct and indirect effects on reading comprehension. In this effect, sustained attention was found to have a complate mediating role. Weng et al. (2016), in a study with 58 university students aged between 19 and 21, examined the mediating role of working memory in the effect of rapid automatized naming on reading comprehension. The results of the study indicated that there was both a direct and an indirect effect between rapid automatized naming (RAN) and reading comprehension, and that working memory played a mediating role in this effect. Based on all these findings, it is suggested that the relationship between rapid automatized naming and reading comprehension varies depending on the participants' age, and that as participants grow older, the nature and strength of this relationship evolve accordingly. Li et al. (2009) stated that students are in the phase of "decoding" or "learning to read" up to the third grade; however, at higher grade levels, the focus shifts toward "reading comprehension" or "reading to learn." Therefore, they emphasized that participants from higher grade levels should be included when examining the relationship between rapid automatized naming and reading comprehension. Similarly, other studies have also reported that the predictive power of rapid automatized naming increases with age (Georgiou et al., 2009; Kirby et al., 2003).

Finally, the present study found that rapid automatized naming (RAN) had a direct effect on sustained attention, and sustained attention, in turn, had a direct effect on reading comprehension. In the mediation model of the relationship among rapid automatized naming, sustained attention, and reading comprehension, the previously significant direct effect of rapid automatized naming on reading comprehension became nonsignificant when the mediator variable—sustained attention—was included in the model. Thus, sustained attention was found to complate mediate this relationship. This finding is thought to result from the similarity between the cognitive skills involved in rapid automatized naming and those required in the reading process.

Based on all these findings, the complate mediating role of sustained attention in the effect of rapid automatized naming (RAN) on reading comprehension is considered noteworthy. This may be due to the fact that the rapid verbal access, processing speed, and visual-auditory integration skills required by rapid automatized naming are closely related to the continuous engagement of attention during reading. In other words, rather than directly predicting reading comprehension, rapid automatized naming indirectly influences it by activating students' attentional processes. Indeed, attention plays a crucial role in maintaining textual coherence, retaining information in working memory, and efficiently allocating cognitive resources throughout reading (Arrington et al., 2014). Moreover, since rapid automatized naming provides predictive insights into students' future reading performance (Ozernov-Palchik et al., 2017; Yeung, 2016), it serves an important role in the early identification of potential reading difficulties. In summary, in the relationship among rapid automatized naming, reading comprehension, and sustained attention, both the predictive power of rapid automatized naming for reading comprehension and the mediating role of attention should not be overlooked.

Results

Considering that attention—identified as a crucial factor for success in rapid automatized naming (RAN) tasks—is also closely related to reading comprehension, it appears that the mediating role of sustained attention in the effect of RAN on reading comprehension has been largely overlooked. Accordingly, the present study examined the mediating role of sustained attention in the relationship between rapid automatized naming and reading comprehension. The results revealed significant correlations among the subcomponents of rapid automatized naming (object, color, number, and letter naming), reading comprehension, and sustained attention, except for the relationship between reading comprehension and number naming, which was not significant. It has been suggested that number naming tasks involve more automatized processes, and therefore have a more limited predictive power for reading comprehension compared to other subtests (Norton & Wolf, 2012). Another key finding of the study was that rapid automatized naming had both direct and indirect effects on reading comprehension. In the mediation model involving RAN, sustained attention, and reading comprehension, the previously significant direct effect of RAN on reading comprehension became nonsignificant once the mediator variable—sustained attention—was introduced into the model. This result indicates that sustained attention is a critical cognitive resource in the reading process and that the relationship between rapid automatized naming and reading comprehension occurs largely through attentional mechanisms. In other words, success in RAN tasks reflects not only processing speed but also the ability to sustain attention. It can thus be argued that attention serves as a regulatory mechanism in reading comprehension (Alloway et al., 2014; Yıldız & Çetinkaya, 2017). Consequently, sustained attention was found to have a complate mediating role in this effect. In this context, the present study contributes theoretically by clarifying the interaction between rapid automatized naming and attentional processes in relation to reading comprehension, and practically by reminding educators that they should focus on the attention-based cognitive mechanisms underlying students' reading difficulties. Therefore, to enhance students' academic success, it is essential to identify and support those with weak reading skills or reading difficulties at an early stage. The findings also highlight the need to develop early intervention programs that include activities targeting both rapid automatized naming and sustained attention

Limitations and Recommendations

While this study revealed that sustained attention mediates the effect of rapid automatized naming (RAN) on reading comprehension, it has several limitations. The first and most significant limitation is that the study group consisted of students from only one grade level in primary school. This situation negatively affects the generalizability of the findings. Therefore, it is recommended that future research include larger-scale studies encompassing all grade levels of primary education. In addition, teacher reports were used to determine the inclusion and exclusion criteria in the present study. Students who had visual impairments, color blindness, hearing loss, or any physical disability that could directly affect reading and writing skills, as well as those showing signs of dyslexia or attention deficit/hyperactivity disorder (ADHD), were excluded from the study. However, no formal measurement procedures were conducted for these exclusion criteria within the scope of the study; instead, the researchers relied solely on teachers' opinions. Since this identification process was based on self-report, it is open to bias and manipulation. Therefore, this represents an important limitation of the current study.

Another major limitation of the study is the singularity of the measurements used for the variables. Presenting data related to the same skill through different measurement tools with proven validity and reliability would increase the overall validity and reliability of the study. From this point of view, it is recommended that future researchers collect data related to the variables by employing multiple data collection methods.

The final limitation of the study concerns the use of the Error Analysis Inventory for obtaining reading comprehension data, as the question scale of this inventory is not a standardized comprehension test. The lack of standardization may lead to potential bias in researchers' scoring. Although two researchers independently scored the reading comprehension data to minimize this bias, it still represents a significant limitation. Therefore, the use of standardized comprehension tests or alternative measurement tools in future studies is the final recommendation based on the limitations of this research

Independent of the study's limitations, it is primarily recommended that future researchers employ neurocognitive methods such as eye-tracking and EEG (Electroencephalography) to examine the existing relationships in greater depth.

The present research is a predictive correlational study, which falls under the category of cross-sectional research. However, especially during the primary school years, longitudinal studies could provide more detailed insights into the development of the relationships identified in this study and the causality underlying them. Therefore, it is recommended that future researchers design longitudinal studies that can more clearly reveal the effects of cognitive processes on reading comprehension.

Finally, the study revealed that sustained attention has a significant effect on reading comprehension. Based on this finding, it is recommended that teachers allocate time for short activities aimed at improving students' attention skills before classroom reading sessions, as this may enhance reading comprehension efficiency.

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