



RAPID AUTOMATIZED NAMING IN PRIMARY SCHOOL CHILDREN

BRZO AUTOMATIZIRANO IMENOVANJE KOD DJECE OSNOVNOŠKOLSKOG UZRASTA

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ABSTRACT

The aim of the present study was to examine rapid automatized naming (RAN) abilities in primary school students and to construct percentile norms for the applied tasks. A total of 480 students participated in the study. The assessment included RAN tasks with objects, numbers, letters, and colors. Results showed that with increasing chronological age, naming speed improved. Percentile norms for the applied tasks are presented separately for each grade, from the second to fifth.

Keywords: dyslexia, rapid automatized naming, children.

SAŽETAK

Cilj ovog istraživanja bio je ispitati sposobnost brzog automatiziranog imenovanja kod učenika osnovne škole te konstruirati percentilne norme za primijenjene zadatke. U istraživanju je učestvovalo ukupno 480 učenika. Procjena je obuhvatila zadatke brzog imenovanja objekata, brojeva, slova i boja. Rezultati su pokazali da se s porastom hronološke dobi poboljšava brzina imenovanja prikazanih podražaja. Percentilne norme za primijenjene zadatke prikazane su odvojeno za svaki razred, od drugog do petog.

Ključne riječi: disleksija, brzo automatizirano imenovanje, djeca.

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INTRODUCTION

In today's world, the ability to read and write is essential for participating in everyday social life, work, and interpersonal communication. Modern societies depend heavily on written communication, making literacy a fundamental prerequisite for education, employment, and active social engagement. Considering the significance of these skills, it is remarkable that a considerable number of children struggle to acquire literacy successfully, even when they receive adequate instruction (Turker & Hartwigsen, 2022). The acquisition of reading skills is associated with series of reading-related linguistic processes, such as phonological awareness, orthographic awareness, morpheme awareness, and rapid automatized naming (RAN) (Zhao et al., 2023). Despite the special focus on reading acquisition during the early school years, there are large individual differences among children in the ease and speed with which they learn to read. Variability in reading skills is reliably associated with performance on tasks that are not directly related to reading, such as the RAN task (Cohen et al., 2018).

RAN has surged in popularity recently as an important indicator of reading difficulties, including dyslexia. Dyslexia is a specific learning disorder, classified as a neurodevelopmental disorder of biological origin, manifested by significant difficulties in reading, writing, and word decoding, as well as spelling problems. These difficulties typically emerge in early school years, persist for at least six months, and cannot be explained by intellectual disability, developmental disorders, or neurological/motor impairments. Clinically, dyslexia is characterized by reduced word reading accuracy, slower reading rate and fluency, and impaired reading comprehension. When dyslexia is used to describe this specific pattern of difficulties, it is also recommended to specify any additional problems, such as difficulties in mathematical reasoning or other academic domains (American Psychiatric Association, 2013).

Despite an extensive history of research on RAN, including recent meta-analyses indicating a unique contribution of RAN to reading above and beyond phonemic awareness, questions remain regarding RAN's relationship to reading (Gray & Powell-Smith, 2025).

Originally, RAN was employed to assess recovery in individuals who had sustained acquired brain injuries (Geschwind & Fusillo, 1966). The interest in the relation between RAN and reading started in the early 1970s (Denckla & Rudel, 1976) and has rapidly gained increasing attention during the last decades. In combination with familial risk status, phonological awareness, and letter knowledge RAN has been identified as one of the key cognitive predictors of reading disabilities, allowing for the identification of children at risk for dyslexia as early as 3.5 years of age (Puolakanaho et al., 2007).

RAN is a task that involves quickly and accurately naming repeated sets of familiar items. The assessment of RAN typically consists of measures that capture RAN of alphanumeric (e.g., letters) and non-alphanumeric (e.g., objects) items (Gray & Powell-Smith, 2025). Successful performance on the RAN task requires visual recognition of individual stimuli, access to phonological codes and rapid articulation. Sustained attention is required to manage perceptual encoding and vocal execution according to available working memory capacity in

order to optimize speed while minimizing interference between successive items. Individual variation in RAN performance could depend on any or all of these cognitive task components as well as the ability to coordinate these processes (Gordon & Hoedemaker, 2016).

Most RAN tasks appear very similar to the original tasks developed 50 years ago by Denckla and Rudel. These tasks have been described in the literature using slightly different terms, such as rapid serial naming, serial visual naming, continuous rapid naming, rapid naming, and naming speed (Norton & Wolf, 2012). Within this view, RAN tasks and reading are seen to require many of the same processes, from eye saccades to working memory to the connecting of orthographic and phonological representations. Equally importantly, RAN tasks depend on automaticity within and across each individual component in the naming circuit.

RAN tasks point to processes that are, at least partially, independent of phonology and have led to the formulation of the double-deficit theory of developmental dyslexia. According to the double-deficit theory, reading difficulties may be caused by deficits in phonological processing, deficits in RAN, or in the most severe cases by a combination of both deficits. Although the mechanisms underlying RAN performance have not yet been fully clarified, it is assumed that the cognitive deficits leading to poor RAN results affect reading by interfering with the quality of orthographic representations themselves and with the formation of links between orthographic and phonological representations, which are crucial for reading (Bowers & Wolf, 1993; Bowers, 1993).

RAN requires a variety of cognitive and linguistic processes, which include: attention to stimulus; bihemispheric, visual processes that are responsible for initial feature detection, visual discrimination, and letter and letter-pattern identification; integration of visual feature and pattern information with stored orthographic representations; integration of visual information with stored phonological representations; access and retrieval of phonological labels; activation and integration of semantic and conceptual information and motoric activation leading to articulation (Wolf & Bowers, 1999). Brain-imaging studies of adult readers suggest that reading and object naming involve very closely related sets of neural circuits: the major difference between reading and object naming is that levels of activation in areas involved in speech production are higher during single-word reading than when naming the objects denoted by the same words (Price et al., 2006; Lervåg & Hulme, 2009).

Although performance on the colors and objects versions of the task is a useful predictor of reading achievement in preliterate children, the alphanumeric versions have been shown to be most strongly and enduringly related to reading (Powell et al., 2007).

If risk for reading difficulties can be determined very early, the chances to improve reading skills are greater. RAN tasks have proven of great potential because children can perform RAN tasks, naming familiar objects or colors, well before they are able to read and because RAN is correlated with reading ability in kindergarten and beyond (Norton & Wolf, 2012).

Learning to read is one of the key outcomes for early education and children who have reading difficulties often enter a downward spiral of low educational attainment and poor employment prospects with negative consequences for adult well-being (Hulme & Snowling, 2016). Considering the significance of RAN as a key indicator in the assessment of children's

language-cognitive development, it is essential to establish developmental norms adapted to the specific language and cultural context of Bosnia and Herzegovina. Therefore, the primary aim of this study was to develop validated developmental norms for RAN in children from Bosnia and Herzegovina, which will enable precise monitoring and evaluation of their functional language abilities in both clinical and educational settings.

MATERIAL AND METHODS

Sample of participant

This study included 480 participants (mean age: 9.18 years, age range: 7.0 – 11.5 years; 237 boys and 243 girls). The participants were attending the second, third, fourth, and fifth grades of primary school. All participants were native speakers of Bosnian and were enrolled in public schools in Bosnia and Herzegovina.

Method of conducting research

Each student, accompanied by their teacher, was individually brought to a separate, quiet room where the assessment was administered on an individual basis. Including the instructions for completing the task, each individual assessment lasted between five and ten minutes on average. The research was conducted by a qualified speech and language therapist.

Measuring instruments

The assessment of RAN was conducted using tasks from the Test for the Assessment of Dyslexia (Duranovic, 2013), which included subtests for naming objects, colors, letters, and numbers. Participants were asked to name all presented stimuli as quickly and accurately as possible. The time taken to complete each subtest was recorded in seconds. Speed was recorded; that is, higher values mean slower naming for all RAN tasks. The naming process followed a column, by column format, with stimuli presented in a predetermined sequence.

First Task – Rapid Object Naming: The task consists of 50 images of familiar objects arranged in ten rows and five columns. The images belong to various semantic categories, including animals, objects, food, clothing, footwear and miscellaneous items.

Second Task – Rapid Colour Naming: This task presents 45 colored squares arranged in nine rows and five columns. Six colors are used: red, yellow, green, blue, black and white. The colors are randomly distributed, with no repeated sequence.

Third Task – Rapid Number Naming: The task consists of 50 single-digit numbers (0–9) presented in a random order within a grid of ten rows and five columns.

Fourth Task – Rapid Letter Naming: This task displays 50 uppercase printed letters arranged in a grid of ten rows and five columns.

Cronbach's alpha for the RAN tasks was measured at 0.751.

Data processing methods

The collected data were processed using IBM SPSS Statistics 21 software for statistical analysis. Basic statistical parameters were calculated, including the mean, standard deviation (SD), and percentile values for each RAN task across grades.

RESULTS

Table 1 presents the descriptive statistics for RAN tasks (objects, numbers, letters, and colors) across grades 2 to 5. Overall, the results show a consistent developmental trend, with mean completion times decreasing across grade levels, indicating faster and more efficient retrieval processes with age.

In Grade 2, children demonstrated the slowest performance across all tasks, particularly in objects naming ($M = 80.05$, $SD = 22.34$) and color naming ($M = 52.63$, $SD = 16.42$). By Grade 3, a substantial improvement was observed, with mean scores declining to 68.78 ($SD = 13.23$) for objects naming and 43.51 ($SD = 10.81$) for color naming. This developmental progression continued in Grades 4 and 5, where children reached their fastest mean scores across all domains. For instance, in Grade 5, objects naming decreased to $M = 60.84$ ($SD = 14.74$), number naming to $M = 24.79$ ($SD = 6.22$), letter naming to $M = 22.27$ ($SD = 3.71$), and color naming to $M = 35.51$ ($SD = 9.21$).

Table 1. Descriptive statistics for RAN tasks across grades

Grade		N	Mean	SD
2	Objects	120	80.05	22.34
	Numbers	120	39.95	14.43
	Letters	120	36.62	16.15
	Colors	120	52.63	16.41
	Valid N (listwise)	120		
3	Objects	120	68.78	13.23
	Numbers	120	33.01	9.79
	Letters	120	28.64	5.88
	Colors	120	43.51	10.80
	Valid N (listwise)	120		
4	Objects	120	66.35	16.67
	Numbers	120	29.17	8.97
	Letters	120	26.07	5.29
	Colors	120	39.96	8.57
	Valid N (listwise)	120		
5	Objects	120	60.84	14.73
	Numbers	120	24.79	6.22
	Letters	120	22.27	3.71
	Colors	120	35.51	9.21
	Valid N (listwise)	120		

In Grade 2, percentile values indicated wide variability in performance across all RAN tasks. Median times were 74 seconds for objects, 36.00 seconds for numbers, 34.00 seconds for letters, and 48.00 seconds for colors. The spread between the 5th and 95th percentiles was largest for objects and colors, suggesting greater individual differences in these tasks compared to numbers and letters.

Table 2. Percentiles for RAN Tasks in Second Grade

Tasks	5	10	25	50	75	90	95
	---	--	-	+	++	++	+++
Objects	129.95	120.00	90.00	74.00	64.25	58.00	56.05
Numbers	82.65	55.00	43.00	36.00	31.25	28.00	26.00
Letters	55.00	48.00	40.75	34.00	29.00	25.00	21.00
Colors	91.95	73.00	60.00	48.00	41.00	36.00	35.00

For Grade 3, median completion times decreased relative to Grade 2, with children naming objects in 66.00 seconds, numbers in 30.00 seconds, letters in 28.00 seconds, and colors in 43.00 seconds. The distribution also became narrower, as reflected in smaller gaps between the lowest and highest percentiles, indicating reduced variability in performance.

Table 3. Percentiles for RAN Tasks in Third Grade

Tasks	5	10	25	50	75	90	95
	---	--	-	+	++	++	+++
Objects	89.95	85.00	78.75	66.00	58.25	54.00	49.05
Numbers	58.00	46.00	35.75	30.00	26.00	24.00	23.00
Letters	40.95	35.9	32.00	28.00	24.00	22.00	20.00
Colors	58.00	54.8	48.00	43.00	36.00	33.00	29.05

In Grade 4, further improvements were observed across all tasks. Median values declined to 63 seconds for objects, 27.00 seconds for numbers, 25.5 seconds for letters, and 39.00 seconds for colors. Compared to earlier grades, the percentile ranges were more compressed, reflecting increased consistency and stability in performance.

Table 4. Percentiles for RAN Tasks in Fourth Grade

Tasks	5	10	25	50	75	90	95
	---	--	-	+	++	++	+++
Objects	94.00	90.00	72.00	63.00	56.00	50.10	46.05
Numbers	44.00	41.00	30.00	27.00	24.00	21.00	20.00
Letters	36.95	33.90	29.00	25.50	22.25	19.10	18.00
Colors	55.95	52.00	45.00	39.00	35.00	30.00	26.00

By Grade 5, the fastest median times were recorded, with 57.50 seconds for objects, 24.00 seconds for numbers, 22.00 seconds for letters, and 35.00 seconds for colors. The narrowing gap between percentiles suggests that performance across the sample had become more homogeneous, with fewer extreme values at both ends of the distribution.

Table 5. Percentiles for RAN Tasks in Fifth Grade

Tasks	5	10	25	50	75	90	95
	---	--	-	+	++	++	+++
Objects	92.00	79.60	68.75	57.50	51.00	48.00	43.05
Numbers	40.00	35.00	27.00	24.00	20.00	19.00	18.00
Letters	28.95	26.90	25.00	22.00	19.25	18.00	17.00
Colors	52.95	45.90	40.00	35.00	30.00	24.10	21.00

DISCUSSION

The aim of this study was to examine RAN abilities in students from the second to fifth grade of primary school, with the purpose of establishing percentile norms for the applied tasks. The findings revealed that naming speed improved with increasing chronological age. Across all examined grade levels, students were slowest in naming objects and colors, faster in naming numbers, while the highest speed was consistently observed in letter naming.

The results of this study are consistent with the research conducted by Denckla and Rudel (1974), who also observed that RAN digits and letters are named faster than RAN objects. This raises the question of what distinguishes the naming of letters and numbers from the naming of other objects or colors. Morin and Forrin (1965) identified three possible distinguishing factors: 1) the degree of automatization (overlearning), 2) the discriminability of the stimuli, and 3) the level of response competition, i.e., the number and strength of other responses competing with the dominant or correct response.

One possible explanation for the differences in naming speed can be linked to the earlier findings of Cattell (1885), who pointed out that verbal reaction time to a color is longer than to the written word denoting that color. A similar pattern was observed in naming concrete stimuli, such as drawn objects or geometric shapes, compared to “reading” their names (Fraisse, 1964). These results suggest that the process of visual recognition and linking of a stimulus with the corresponding phonological representation is more cognitively demanding than recognizing an already familiar graphic symbol, such as a word. Numerous subsequent studies have confirmed this pattern (Spring & Capps, 1974; Meyer et al., 1998; Van den Bos, Zijlstra & Spelberg, 2002; Bowey, McGuigan & Ruschena, 2005; Åvall, Wolff & Gustafsson, 2019).

The reason why digits and letters are named faster than colors and objects can be explained by the different nature of the stimuli. The term uncertainty refers to the multiplicity and strength of referential relations between stimuli and name representations. Increased uncertainty is likely to increase naming reaction times due to diffuse activation of multiple and/or

inconsistent stimuli-name correspondences. The digits and letters are associated with a single response name, and thus are less uncertain than pictures of objects and colors which, may be linked to several possible names (Johnson, Paivio & Clark, 1996; Närhi et al., 2005). RAN has also been linked to the executive functions. These differences between symbolic and nonsymbolic RANs suggest that the processing stream from encoding to articulation functions more smoothly and is less susceptible to interitem interference for the letter and digit RANs than for the object and color RANs. A stronger association between items and their names for the symbolic compared with the nonsymbolic RANs is one possible contributor to this difference though it is likely that other factors (e.g., visual complexity and inherent phonetic length of RAN items) also contribute (Gordon & Hoedemaker, 2016).

Although this study did not directly investigate executive functions, it is assumed that RAN tasks engage these functions to varying degrees. The aim of the research was to establish percentile norms for RAN tasks in students from grades 2 to 5. This is important because previous studies suggest that naming objects and colors requires greater engagement of executive functions than naming letters and numbers (Carte, Nigg, & Hinshaw, 1996; Denckla & Cutting, 1999; Tannock, Martinussen, & Frijters, 2000). The results showed that students named letters and numbers faster than objects and colors, with median naming times for letters and numbers being shorter and variability among participants lower. These findings indicate a gradual development of automatization in performing these tasks.

Interestingly, children show faster naming of letters and numbers, which they acquire only at the beginning of schooling, compared to naming pictures of familiar objects, whose names they have known for years before starting school. This pattern clearly highlights differences in the naming speed of different types of stimuli in children during the early school years.

Establishing percentile norms for RAN tasks is of great importance, as it allows for the early identification of children at risk for reading difficulties. Such norms provide professionals with a clear comparison of a child's performance relative to their peers and facilitate timely inclusion in appropriate interventions. Early support can help reduce the negative consequences of reading and writing difficulties, including lower academic achievement and social isolation. Further research on RAN contributes to a better understanding of developmental patterns, the identification of factors affecting learning success, and supports the development of more precise screening tools and targeted interventions for children of different ages and abilities.

CONCLUSION

Creating percentile norms for RAN tasks is very important. These tasks help in screening and spotting children who may have reading problems. If children are identified early, they can join the right interventions on time. This can greatly reduce later problems, such as poor school results, feeling isolated from peers, and other long-term difficulties.

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