PREDICTORS OF READING SKILLS

IN TURKISH-SPEAKING FOURTH GRADE CHILDREN

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# PREDICTORS OF READING SKILLS
# IN TURKISH-SPEAKING FOURTH GRADE CHILDREN

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DECLARATION OF ORIGINALITY

I, Ecehan Candan, certify that

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;
- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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ABSTRACT

Predictors of Reading Skills in Turkish-Speaking Fourth Grade Children

The present study aimed to investigate the concurrent contributions of phonological awareness (PA), rapid automatized naming (RAN), vocabulary, morphological awareness (MA), processing speed (PS), working memory (WM), and inhibitory control (IC) to reading skills in Turkish. It also examined the complex network of relationships among the variables by focusing on RAN, text reading fluency (TRF) and reading comprehension (RC). In the data collection process, a variety of cognitive and linguistic measures were administered to 112 Turkish-speaking Grade 4 children. Based on previous research, a preliminary model of reading was developed and tested through multiple regression analyses as part of a classical path analysis. The results showed that IC was the strongest predictor of RAN, followed by PS. In the next layer of the analysis, RAN explained the largest amount of variance in TRF, followed by MA and PS. In the ultimate model, MA was the most powerful predictor of RC, followed by PA, TRF and vocabulary. MA also explained a considerable amount of variance in vocabulary, which highlighted the interface between morphological and semantic processes involved in RC. Additional analyses revealed that the predictor variables also made a multitude of indirect contributions to RAN, TRF and RC in the highly agglutinative and morphologically rich structure of Turkish.

ÖZET

Ana Dili Türkçe Olan 4. Sınıf Çocuklarının Okuma Becerilerini Belirleyen Faktörler

Bu çalışma fonolojik farkındalık (FF), hızlı otomatik isimlendirme (HOTİ), sözcük bilgisi (SB), morfolojik farkındalık (MF), işleme hızı (İH), işler bellek (İB) ve engelleyici kontrol (EK) değişkenlerinin Türkçede okuma becerileri üzerindeki eşzamanlı katkılarını araştırmayı amaçlamıştır. Ayrıca, HOTİ, metin okuma akıcılığı (MOA) ve okuduğunu anlama (OA) becerileri üzerine odaklanılarak değişkenler arasındaki karmaşık ilişki ağları da incelenmiştir. Veri toplama sürecinde, ana dili Türkçe olan 112 ilkokul 4. sınıf öğrencisine bazı dilsel ve bilişsel testler uygulanmıştır. Önceki araştırmalar ışığında bir okuma modeli geliştirilmiş ve bu model klasik yol analizinin bileşenleri olan çoklu regresyon analizleri ile test edilmiştir. Sonuçlara göre, EK HOTİ'nin en güçlü yordayıcısı olmuş, bunu İH izlemiştir. Analizin bir sonraki katmanında HOTİ'nin MOA'daki varyansın önemli bir bölümünü açıkladığı görülmüş, bunu sırayla MF ve İH izlemiştir. Nihai modelde ise MF, OA'nın en güçlü yordayıcısı olmuş, ardından gelen FF, MOA ve SB değişkenleri de OA'ya önemli katkılarda bulunmuştur. Ayrıca, MF, SB'deki varyansın önemli bir kısmını açıklayarak, OA kapsamındaki morfolojik-semantik süreçlerin bağlantısını vurgulamıştır. Yapılan diğer analizler, Türkçenin morfolojik açıdan zengin ve eklemeli yapısında, yordayıcı değişkenlerin MOA ve OA becerilerine dolaylı yoldan da çok sayıda katkıda bulunduğunu göstermiştir.

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Öztekin, E. & Candan E. (2019). The role of corpora in language teaching. In G. Ekşi, L. Guerra, D. Werbinska, & Y. Bayyurt, (Eds.). *Research trends in English language teacher education and English language teaching* (pp. 327-342). Evora University Publications.

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Sönmez, E., Babür, N., & Haznedar, B. (2015). Learning how to spell in Turkish. *Boğaziçi Üniversitesi Eğitim Dergisi, 32*(1), 34-50.

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Öztekin, E., Candan, E., Kurt, Y., & Bayyurt, Y. (2020). Student Perspectives on English Medium Instruction: A Case from Turkey. Paper presented at *ILTERG 2 Virtual Conference.*

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Sönmez, E., & Haznedar, B. (2016). The Influence of bilingualism on linguistic and cognitive processes: Evidence from Kurdish-Turkish bilingual children. Paper presented at *26th Annual Conference of the European Second Language Association, University of Jyväskylä, Finland.*

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Sönmez, E., Babür, N., & Haznedar, B. (2016). Investigating spelling skills in Turkish: Linguistic and cognitive processes. Paper presented at the *7th World Conference on Psychology, Counseling and Guidance, Kuşadası, Turkey.*

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Sönmez, E., Haznedar, B. & Babür, N. (2018). Learning how to spell in Turkish: Evidence from third graders. In M. A. Akıncı, & K. Yağmur (Eds.), *The Rouen Meeting Studies on Turkic Structures and Language Contacts* (pp. 156-175), Wiesbaden: Harrassowitz Verlag.

Sönmez, E., Haznedar, B., & Babür, N. (2017). Fonolojik farkındalık ve sözcük bilgisinin yazma becerisi üzerindeki etkisi. B. Makaroğlu, İ. Pınar Bekar & E. Arıca Akkök (Haz.), *30. Ulusal Dilbilim Kurultayı Bildirileri* (ss. 85-91). Dilbilim Derneği Yayınları.

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Sönmez, E., Babür, N., & Haznedar, B. (2015). Türkçede yazma süreçlerinin incelenmesi. F. Karahan (Haz.), *28. Ulusal Dilbilim Kurultayı Bildiriler Kitabı* (ss. 172-186). Ayrıntı Yayınları.

Karakaş, A., & Sönmez, E. (2011). The teaching of θ and ð sounds in English. *Proceedings of the 1st International Conference on Foreign Language Teaching and Applied Linguistics,* 74-83.

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## ABBREVIATIONS

1.sg.: First Person Singular

Acc.: Accusative

C: Consonant

CTOPP: Comprehensive Test of Phonological Processing *(KFFT: Kapsamlı Fonolojik Farkındalık Testleri)*

D: Decoding

Dat.: Dative

EF: Executive Function

GJT: Grammaticality Judgement Test

IC: Inhibitory Control

LC: Linguistic Comprehension

Loc.: Locative

MA: Morphological Awareness

MoNE: Ministry of National Education *(MEB: Milli Eğitim Bakanlığı)*

PA: Phonological Awareness

Past: Past

PM: Phonological Memory

Pr. Prog.: Present Progressive

PS: Processing Speed

RAN: Rapid Automatized Naming *(HOTI: Hızlı Otomatik İsimlendirme)*

RC: Reading Comprehension

SBSM: Sound Based Sentence Method

SM: Sentence Method

SOV: Subject-Object-Verb

STM: Short-Term Memory

TRF: Text Reading Fluency

V: Vowel

VOC: Vocabulary Knowledge

WISC-R: Wechsler Intelligence Scale for Children-Revised

WM: Working Memory

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Reading is a highly complex ability which is built upon the interaction of several cognitive and linguistic processes. The acquisition of reading skills starts early in life, when children start to notice the relationship between sounds and printed signs; and continues to develop throughout the school years. From then on, reading ability begins to play a central role in lifelong learning. Because reading is a growth construct (Duke & Carlisle, 2011), the chance of learning new ways or strategies for a better reading experience never truly ends for the individual reader.

In very simple terms, reading means decoding words and sentences in a written text. However, the ultimate goal in every act of reading is to comprehend the message, and decoding alone is not functional if there is no comprehension. Reading comprehension is defined as "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language" (Snow, 2002, p. 11). This complicated process involves, but is not limited to, the coordination of word knowledge (e.g., sounds and meanings), syntactic information and the use of several reading strategies (Adams, 1990).

The road to successful reading comprehension starts with the ability to decode single words accurately (Adams, 1990; Snow, 2002; Torgesen, 2000). When decoding, the reader perceives letters visually and recode them into their corresponding sounds to reach the mental representation of a given word. Without decoding, it is not possible to recognize words and extract information from a text.

In the early years of education, literacy instruction is mostly focused on decoding words accurately. At later stages, especially when children start to read in order to learn new information, fluency becomes more important and strongly related to reading comprehension (Duke & Carlisle, 2011). Problems in reading fluency could increase the cognitive load on working memory, and reading comprehension could be negatively affected even in the presence of accurate word decoding (Perfetti, Marron, & Foltz, 1996). Therefore, in addition to accuracy, fluency in reading is an important factor contributing to reading comprehension (Berninger, Abbott, Vermeulen, & Fulton, 2006).

Although reading fluency seems to be a prerequisite for successful comprehension, the relationship between these two aspects of reading is a reciprocal one. Snow (2002) conceptualizes fluency as “both an antecedent to and a consequence of comprehension” (p .13). She explains that just as recognizing words fluently helps the reader with syntactic parsing and thus understanding the given message in the text, successful comprehension allows the reader to read the sentences in a more fluent and expressive manner.

Accuracy and fluency in word-level reading is central for reading comprehension. Evidence shows that children who have word reading deficits could also demonstrate reading comprehension deficits (Shankweiler, 1999). This finding, however, does not mean that lower-level (i.e., bottom-up) processes suffice for reading comprehension. In order to extract information provided in the text and construct meaning, the reader has to interact with the printed material by relying on some cognitive resources and background knowledge. In other words, the reader needs to utilize higher-level (i.e., top-down) processes to make sense of the written message.

Early theories of reading made a traditional distinction between bottom-up and top-down processes. Theories which emphasized bottom-up processing mainly addressed how readers deciphered the written message through systematic analyses of letters and words (e.g., Gough, 1972). On the other hand, theories focusing on top-down processes attributed a central role to readers, suggesting that readers created hypotheses about the possible words they would encounter depending on the contextual cues (e.g., Goodman, 1976). In this psycholinguistic guessing game, readers would test their hypotheses by partially processing graphic information provided by the text. It was assumed that poor readers failed to make use of contextual information, and developed weak strategies such as excessive reliance on phonics.

In the following years, interactive models of reading were introduced (e.g., Rumelhart, 1977) to bridge these two distinct accounts. According to the interactive models, skilled reading required the use of several sources of information (e.g., orthographic, semantic, etc.), and these sources interact with each other in a complex manner. Taking this account one step forward, Stanovich (1980) introduced the interactive-compensatory model, which suggested that during the synthesis of information, deficiencies in any level of processing could be compensated by greater reliance on information coming from different sources. Therefore, it was explained that poor readers actually utilized contextual cues when possible, and their relatively weak context use was an "epiphenomenon" of their slow and inaccurate decoding skills (Stanovich, 1984, p.16).

In addition to the processing models which attempted to understand how reading processes take place, componential models (e.g., Gough & Tunmer, 1986; Joshi & Aaron, 2000) and stage models (e.g., Chall, 1983; Frith, 1985) were developed in order to see which components play a role in reading ability, and what kind of developmental features are observed in the course of reading acquisition. In the simple view of reading, Gough and Tunmer (1986) proposed that reading comprehension depends on decoding skills and oral language comprehension. According to the model, efficient decoding is a prerequisite for further processes, which is formulated as follows:

Decoding (D) x Linguistic Comprehension (LC) = Reading Comprehension (RC)

Gough and Tunmer (1986) explained that when readers experienced decoding problems, their cognitive resources would not be available for successful comprehension. This explanation was in line with the earlier suggestions of LaBerge and Samuels (1974), who proposed that automaticity in lower-level reading skills allowed for greater cognitive capacity for higher-level reading skills required for comprehension. Years later, Joshi and Aaron (2000) modified simple view of reading by integrating processing speed as a separate entity into their component model with the following formula: $R = D \times C + S$. The researchers explained that speeded decoding was a requirement for efficient word recognition, which played a critical role in successful comprehension. In their study, they tested the modified model, and found that after the inclusion of processing speed, the model accounted for a greater amount of variance in reading comprehension.

Hoffman (2009) criticizes simple view of reading by stating that it treats reading as a linear process in which reading comprehension becomes similar to listening comprehension once decoding is mastered. Hoffman informs that factors such as the structure and quality of reading texts play an important role in shaping the reading experience and require the utilization of different strategies, which goes beyond linear reading of written sentences. Similarly, Paris and Hamilton (2009) argue that decoding and linguistic comprehension are two broad concepts which need further examination as they are composed of different subcomponents which demonstrate variation across different times, text types and contexts. They state that "decoding is necessary but not sufficient for reading comprehension" (p. 33). Supporting evidence for this argument comes from the studies reporting that children who are matched for their word reading skills could differ in terms of their success in reading comprehension (e.g., Oakhill & Cain, 2000).

Paris and Hamilton (2009) suggest that decoding skills which are quickly mastered during the early years of schooling play a role in reading comprehension at the beginning stages of literacy acquisition while factors related to language comprehension influence reading ability throughout one's life. Similarly, Cain, Oakhill, and Bryant (2004) suggest that although word decoding is the strongest predictor of reading comprehension during the early years, other factors start to influence reading comprehension to a greater extent as readers become more experienced. For this reason, the simple view of reading is often criticized for not explaining the developmental course of decoding, language comprehension and reading skills in general.

In an attempt to shed light on the developmental trajectory of reading skills, Frith (1985) proposed that children go through logographic, alphabetic and orthographic stages. At the logographic stage, children recognize words by relying on visual cues, with no sensitivity to sound-letter relationships. At the alphabetic (i.e., phonological) stage, they learn to decode words systematically with increasing awareness about phoneme-grapheme correspondences. Lastly, they start to process words as orthographic units rather than dealing with an analysis of individual letters and sounds. In a similar approach, Chall (1983) introduced a stage model of reading. According to this model, individuals acquire reading skills in six different stages. First (pre-school years), the reader acquires some foundational skills such as print awareness and letter knowledge, which will be useful for further stages of reading. In stage 2 (Grades 1 and 2), the reader starts to learn phoneme-grapheme correspondences and develop decoding skills (Grades 2 and 3). In the following stage, the reader becomes more fluent in reading and demonstrates higher performance in sight-word reading. In the fourth stage (Grades 4-8), the reader experiences a shift from “learning to read” towards “reading to learn”, and reading materials used in the classroom start to change as well. Instead of narrative texts which are commonly used during the early years, expository texts and passages for content area reading are introduced to the students. During the fifth stage, readers could read and understand texts with higher levels of complexity and reflect on different opinions about a specific topic. In the sixth stage, readers develop the ability to synthesize different views presented in a complex text. Although this model has contributed a great deal to literacy research, it has been frequently criticized as children do not necessarily follow the same linear pathway as they acquire literacy skills.

Another model of reading belongs to Kintsch (1998), who suggests that reading comprehension takes place in three levels. First, individuals read the text and they transform it into propositions (surface level). Later, they build a macrostructure by combining, deleting and integrating these propositions (text level). Lastly, the readers’ background knowledge is integrated into the information provided in the text by the situation model (deep level). Throughout this process, the reader has to retrieve word meanings, parse syntactic units, link sentences and paragraphs for coherence, and create a situation model of the given text. Kintsch (2005) argues that the act of reading starts with decoding and continues with a complex interaction between the model created out of the textual information and the situation model constructed by the reader's inferences and prior knowledge. For this reason, bottom-up and top-down processing are equally important for successful reading (Kintsch, 2005); and "the question for the theorist is not top-down or bottom-up, but how do these processes interact to produce fluent comprehension?" (p. 126).

It is difficult to create a complete account of reading because reading ability is not fixed, and demonstrates variation not only across individuals, but also within a single reader as new interpretations might emerge after reading, re-reading and reflecting on the same text (Paris & Hamilton, 2009). Still, attempts to understand the components of reading and how these components interact to contribute to the end product (i.e., reading comprehension) are continuously shaping the ways in which reading is conceptualized.

So far, a large body of research has been conducted in order to have a clearer understanding of how some critical components such as phonological awareness (PA), rapid automatized naming (RAN), processing speed (PS), vocabulary, morphological awareness (MA) and executive functioning (EF) contribute to reading ability at various levels across different languages (e.g., Babayiğit & Stainthorp, 2007; Carlisle, 2000; Caroll, 1993; Cutting & Denckla, 2001; Cutting, Materek, Cole, Levine, & Mahone, 2009; Deacon & Kirby, 2004; Goswami & Bryant, 1990; Norton & Wolf, 2012; Torgesen, 2002). In this part of the current study, each of these components and their relationships with reading ability will be introduced briefly. A more detailed review about how these variables contribute to reading achievement will be provided in the literature review chapter.

One of the most fundamental predictors of reading is phonological awareness (PA). It is defined as the knowledge that spoken words could be divided into smaller units such as syllables, onsets/rimes and phonemes, and the ability to manipulate these units (Gillon, 2007). PA in children follows a developmental route progressing from larger units (e.g., words and syllables) towards smaller units of sound (e.g., phonemes) (Anthony & Francis, 2005). The most advanced level of PA is phoneme awareness (Snider, 1995). At this level, children are able to manipulate phonemes in different ways. Still, certain tasks (e.g., phoneme deletion, phoneme reversal) are more challenging, and take longer time to master when compared to others (e.g., phoneme segmentation, phoneme blending) (Adams, 1990).

A considerable volume of research has been carried out in order to understand the relationship between PA and reading skills in a variety of languages (e.g., Adams, 1990; Aidinis & Nunes, 2001; Bradley & Bryant, 1983; Bryant, MacLean, Bradley & Crossland, 1990; Caravolas, Volin & Hulme, 2005; Geva & Siegel, 2000; Landerl & Wimmer, 2008; MacDonald & Cornwall, 1995; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006), and findings have revealed that PA is a strong predictor of reading, especially at the beginning stages of literacy development (Adams, 1990; Stanovich, 1993). The foundational role of PA across different languages could be explained by the fact that children rely on PA skills in order to learn phoneme-grapheme correspondence rules in their native languages.

Another important component of reading is rapid automatized naming (RAN). Designed by Denckla and Rudel (1974), RAN tasks require the participants to name a set of familiar objects, colors, letters or digits as accurately and rapidly as possible. There are two versions of RAN: a) discrete rapid naming, and b) serial rapid naming. In the former, the participant names one item at a time while in the latter, he or she names recurring items which are organized in the form of a grid. In literacy research, serial RAN is used more commonly due to its similarity with the nature of reading, and evidence shows that it is a more efficient measure to discriminate between good and poor readers (Wolf, 1991).

Numerous studies show that serial RAN is a powerful predictor of reading fluency across different languages (Albuquerque, 2012; Furnes & Samuelsson, 2011; Norton & Wolf, 2012; Papadopoulos, Spanoudis & Georgiou, 2016) including Turkish (Babayiğit & Stainthorp, 2007, 2010, 2011). However, there are different views as to the complex nature of RAN, and its relationship with reading. Some suggest that RAN requires speeded access to and retrieval of phonological knowledge from the long term memory, and it is a subcomponent of phonological processing (Torgesen, Wagner, & Rashotte, 1994). Others argue that RAN and PA make independent contributions to reading competence, and they should be considered as separate constructs (Wolf & Bowers, 1999). This account focuses on the orthographic processing skills as a mediator variable between RAN and reading. Lastly, Kail and Hall (1994) argue that processing speed explains the relationship between RAN and reading as they both involve speeded processing of the visual stimuli.

Unlike PA and RAN, processing speed (PS) is a domain-general cognitive factor, which contributes to the rate of reading fluency. Although RAN is inherently linked to PS, findings suggest that they make unique contributions to reading competence (Cutting & Denckla, 2001). In an early study, Kail and Hall (1994) investigated the age-related improvement in naming time, and suggested that this change resulted from a global change in the general processing mechanism rather than the automaticity in retrieving item names due to the increased levels of familiarity. The findings of the study also revealed that improved performance in PS leads to improved rapid naming, reading recognition and reading comprehension. Kail and Hall's (1994) study was a prominent one which promoted the investigation of domain-general processes underlying reading ability. More recent studies have focused on the role of PS in the case of reading difficulty, and found that children with reading difficulty demonstrated core deficits in speeded processing of stimuli (Jacobson et al., 2011; McGrath et al., 2011).

Another factor which plays an important role in reading ability is vocabulary knowledge. Several studies have documented that vocabulary knowledge is strongly associated with reading comprehension (Carroll, 1993; de Jong & van der Leij, 2002; Muter, Hulme, Snowling, & Stevenson, 2004) especially in the later stages of reading development when the predictive power of sub-word level skills such as PA or alphabet knowledge starts to decrease (Duke & Carlisle, 2011). In Turkish, Babayiğit and Stainthorp (2014) found that although listening comprehension, verbal short-term memory, and grammatical skills measured at kindergarten were significant predictors of reading comprehension in Grade 1, vocabulary knowledge was the only significant precursor of reading comprehension in Grade 2.

Morphological awareness (MA) is another component which is influential on how readers recognize and process words and sentences. MA is defined as learners' "conscious awareness of the morphemic structure of words and their ability to reflect on and manipulate that structure" (Carlisle, 1995, p. 194). Words consisting of more than one morpheme (i.e., multimorphemic words) could be divided into smaller units; and each of these units could help learners understand the meaning of a word and pronounce or spell it correctly (Kirby, Deacon, Bowers, Izenberg, Wade-Woolley, & Parrila, 2012). For example, - *le* is a derivational suffix which transforms nouns into verbs in Turkish, and it could be spelled and pronounced as *-la* in accordance with the vowel harmony (e.g., *el* ‘hand’, *elle-* ‘to touch’; *su* ‘water’, *sula-* ‘to water’). When this morphological rule is acquired, it becomes easier to read and understand words with a similar structure. Findings from several studies suggest that MA plays an important role in reading achievement (Carlisle, 1995, 2000; Deacon & Kirby, 2004; Kirby et al., 2012; Nunes & Bryant, 2006), and its contribution to reading tends to increase at later stages of literacy development (Anglin, 1993; Carlisle, 2000).

While PA, RAN, PS, MA, and vocabulary are well-researched predictors of reading ability across languages, less is known about the link between executive functions (EF) and reading in different languages. EF is defined as a set of skills which include demonstrating independent, goal-directed behavior, allocating and shifting attention depending on task requirements, solving problems, planning, and storing and processing information in the working memory (Jacobson & Mahone, 2012). As the development of EF-related brain regions parallels the development of reading skills, research in EF has important implications for improving pre-reading skills, word reading, and reading comprehension (Cartwright, 2012). Jacobson et al. (2017) suggest that reading comprehension might involve different EF operations such as storing and using previous information while reading new sentences, switching between different ideas or topics, and using background knowledge in order to understand the main message in a text. A meta-analysis by Booth, Boyle and Kelly (2010) revealed that children who experienced reading difficulties also demonstrated poor performance on EF tasks. This finding shows that investigating

EF in relation to reading ability could be critical in order to shed light on the problems children face throughout their literacy development. For this reason, it is important to understand which component of EF is associated with which level of reading (i.e., fluency and reading comprehension).

So far, some studies have investigated the role of EF in single word reading (e.g., Messer, Henry, & Nash, 2016), reading comprehension (e.g., Cutting et al., 2009) or in both dimensions (e.g., Arrington, Kulesz, Francis, Fletcher, & Barnes, 2014; Jacobson et al., 2017). Most of these studies were conducted with English-speaking participants. The present study will focus on two components of EF (i.e., working memory and inhibitory control) in relation to reading fluency and reading comprehension in Turkish.

An important component of EF is working memory (WM). It is defined as a cognitive mechanism which includes multiple components used for storing and processing information in mind for brief time periods (Baddeley, 2000). A growing body of research suggests that WM is a central construct for reading (e.g., Just & Carpenter, 1992; Locascio, Mahone, Eason, & Cutting, 2010; Perfetti, Landi, & Oakhill, 2005; Sesma, Mahone, Levine, Eason, & Cutting, 2009; Swanson, Zheng, & Jerman, 2009). Because readers need to process, understand, retain and manipulate words and meanings given in a coherent text, WM is often considered to be more important for reading comprehension than word reading (Christopher et al., 2012). However, WM could also be associated with reading individual words, because the ability to read and access the mental representations of words quickly is a foundational step for understanding the message given in the text. In line with this argument, some suggest that WM is equally important for word reading, text reading (Jacobson et al., 2017), and reading comprehension (e.g., Christopher et al., 2012).

Another component of EF is inhibitory control (IC), which is also known as attentional control. It refers to the ability to suppress irrelevant responses and initiate relevant processes when directing attention to the requirements of a particular task (Gathercole & Baddeley, 1993). IC might play an important role in reading comprehension as the reader has to suppress redundant information or misleading cues in order to understand the gist of a given text (Cain, 2006). Some studies which investigated the interaction of IC and reading ability have documented that poor comprehenders have deficits in IC measures (e.g., Locascio et al., 2010), and good comprehenders perform significantly better than poor comprehenders in inhibiting unnecessary information (De Beni & Palladino, 2000; Cain, 2006).

The role of IC in reading ability is not as clear as the role of WM because IC involves a set of different but related operations (Friedman & Miyake, 2004) which are response inhibition, sustained attention and cognitive inhibition (Arrington, et al. 2014). Response inhibition refers to the controlled, purposeful suppression of ongoing actions as a response to the changes in the environmental stimuli (Nigg, 2000). Sustained attention is defined as the ability to concentrate on the requirements of a given task with a consistent pattern in attention (Aaron, Joshi, Palmer, Smith, & Kirby, 2002). Cognitive inhibition refers to the deliberate suppression of irrelevant information from WM (Nigg, 2000). In the current study, cognitive inhibition will be measured as an index of the IC mechanism.

All of the linguistic and cognitive variables discussed so far play a part in the highly complex process of reading. They also interact with language specific characteristics, which have important implications for the development of reading skills in children. One such characteristic is the orthographic depth of a language. Turkish has a transparent orthography with highly regular phoneme-grapheme correspondence rules. This means that there is one-to-one mapping between each sound and the corresponding letter. Furthermore, this regularity is manifested not only in the phoneme to grapheme direction, but also in the grapheme to phoneme direction. As a result of this regularity, accuracy in word and pseudoword recognition is found to be highly correlated in Turkish (Durgunoğlu, 2017). This suggests that Turkish speaking children tend to apply similar decoding strategies in both conditions. In addition, with the help of this consistency, Turkish speaking students learn to decode words very easily and twice as early as their English-speaking peers (Durgunoğlu & Öney, 1999). The transparency of the Turkish orthography might also influence how cognitive resources such as memory interact with word recognition. Findings of a recent study by Özata (2013) have shown that the regularity of phoneme-grapheme correspondences in Turkish allows readers rely less on phonological memory (PM) when they decode words in comparison to their English-speaking peers.

In addition to its orthographic consistency, Turkish has some other features that may possibly ease the reading process for children. One such feature is the simple syllable structure, which is mostly (98 %) in the form of V, VC, CV, and CVC (Durgunoğlu & Öney, 1999). Among these syllables, the most common syllable type is CV (51 %) (Aşlıyan, Günel, & Filiz, 2006). The absence of consonant clusters in these syllables enables Turkish-speaking children to recognize syllable and word boundaries quite easily. These language specific characteristics of Turkish allow normally-developing children to learn phoneme-grapheme correspondence rules very early, and master decoding Turkish words within the first year of schooling (Babayiğit, 2009; Durgunoğlu & Öney, 1999).

Some studies have documented that PA, as an index of accuracy, is strongly related to decoding in Turkish (Babayiğit & Stainthorp, 2007, 2010, 2011; Durgunoğlu & Öney, 1999). However, as decoding accuracy reaches ceiling levels very early, it does not have strong correlations with reading comprehension in Turkish. For this reason, while measures of early reading skills are mostly based on accuracy in opaque languages such as English and French, they commonly address reading fluency in Turkish, as in other transparent languages (Durgunoğlu, 2017). Therefore, in comparison to PA measures, RAN, which is an index of fluency in word recognition, plays a more central role in predicting reading achievement in languages with transparent orthographies (de Jong & van der Leij, 2002).

Another important feature of Turkish which should be taken into consideration in reading research is its morphological structure. Unlike most of the European languages, Turkish is a highly agglutinative language, which means that it has a wide variety of suffixes, and each suffix added to the root or stem of a given word contributes to the meaning of the new formation. For this reason, very complex meanings could be expressed by very long words. In such a system, morphological awareness (MA) is likely to play an important role in different levels of reading; and this relationship could provide a clearer understanding about the nature of reading development in agglutinative languages.

Since all these language specific features are potential predictors of reading development in Turkish, it is important to investigate how cognitive and linguistic factors contribute to reading skills in relation to these features. In this way, it will be possible to design and implement more effective teaching materials, instructional methods and intervention programs.

## 1.2 Purpose of the study

The aim of this doctoral study is to provide an insight into the concurrent contributions of PA, RAN, PS, MA, vocabulary, WM and IC to the reading skills of normally developing, Turkish-speaking Grade 4 children. It also seeks to examine the relationships among the variables with a focus on RAN, text reading fluency (TRF) and reading comprehension (RC) in Turkish. To illustrate the relationships more clearly, a reading model will be developed and tested, which will reflect the predictor variables' direct and indirect effects on the reading outcomes in Turkish.

## 1.3 Significance of the study

So far, a considerable amount of research has been conducted to investigate literacy development in English and other European languages. Most of these studies focused on predictors such as PA, RAN, PS, MA and vocabulary in relation to reading. Less is known about the role of EF in reading ability, especially in the case of normally developing children (Altemeier, Abbott, & Berninger, 2008; Arrington et al., 2014). In addition, the number of studies which take different predictors of reading and EF into consideration at the same time is rather limited (e.g., Jacobson et al., 2017). To fill this gap, some recent studies have investigated the relationship between different EF skills and reading ability in English (Jacobson et al., 2017; Messer et al., 2016), Brazilian Portuguese (Engel de Abreu et al., 2014) and across English and Chinese (Lan, Legare, Ponitz, Li, & Morrison, 2011). As for Turkish, although there is growing interest in literacy research, the number of studies focusing on the links between cognition, language and literacy is still limited (e.g., Akdemir, 2018; Babayiğit & Stainthorp, 2007, 2010, 2011; Bektaş, 2017; Durgunoğlu & Öney, 1999; Kuzucu-Örge, 2018; Öney & Durgunoğlu, 1997; Özata, 2013, 2018; Sönmez, 2015).

Most of the studies investigating literacy acquisition in Turkish have focused on the contributions of fundamental variables such as PA, vocabulary and RAN to reading achievement. To the knowledge of the author, few studies have examined the roles of several cognitive and linguistic variables at the same time in an attempt to create a reading model in Turkish (e.g., Akdemir, 2018; Babayiğit & Stainthorp, 2011; Özata, 2018). Akdemir (2018) investigated the roles of RAN, PS, MA, WM, vocabulary and text reading fluency in Grade 5 reading comprehension. Similarly, Özata (2018) investigated the roles of parental education, PS, MA, PA, RAN, vocabulary, PM and orthographic knowledge in reading across Grades 2 and 4. Although memory was included as a predictor variable in these studies, inhibitory control (IC) was not measured, and there was no reference to the potential connections between EF and reading ability in Turkish.

In a longitudinal study across Grades 2 and 5, Babayiğit and Stainthorp (2011) investigated the development of reading and writing skills in Turkish. Reading ability was measured at the levels of word reading fluency, text reading fluency and reading comprehension; and the predictor variables were IQ, vocabulary, listening comprehension, PA, RAN, short term memory (STM) and WM. Although the study was a comprehensive one, it did not include variables such as MA, PS and IC. Given the highly rich morphology of Turkish, the inclusion of MA in a reading model could provide valuable insights into the nature of literacy acquisition in Turkish-speaking children.

In the current study, which had a cross-sectional research design, the roles of PA, RAN, MA, vocabulary, PS, WM and IC were examined in terms of their potential contributions to text reading fluency (TRF) and reading comprehension (RC) in Turkish. Based on previous research, a reading model was developed and tested to reveal the potential interactions of these cognitive and linguistic variables with the reading skills of Grade 4 children in a morphologically rich and orthographically transparent language. The rationale behind the selection of Grade 4 children as the participants was that during this critical grade, a transition occurs from the stage of “learning to read” towards the stage of “reading to learn”, where reading becomes a more functional and complex activity for children (Chall, 1983).

By showing how a variety of factors contribute to reading ability in Turkish, the findings of the current study will provide important pedagogical implications for the teaching of literacy skills at Turkish school settings. It is also expected that the findings will provide parents, teachers, curriculum designers and policy makers with a deeper understanding about the nature of reading acquisition in Turkish; and contribute to the future developments in literacy instruction, material design and intervention programs for children with reading difficulties.

This chapter has presented a brief introduction about reading as a multicomponent ability and its connections with different cognitive and linguistic variables. It has also provided the purpose and significance of the current doctoral dissertation. The following chapter will present a detailed review of the literature about each of these predictors and how they influence reading ability across different languages.

# CHAPTER 2

# LITERATURE REVIEW

This chapter starts with a review on how fluency is linked to reading comprehension, and continues with a review on the roles of PA, RAN, MA, vocabulary, PS, WM and IC in different aspects of reading ability.

## 2.1 Fluency and reading comprehension

Fluency is defined as a combination of rate and accuracy, which is based on the number of words that are read accurately within a fixed time period (Torgesen, Rashotte, & Alexander, 2001). In a more comprehensive definition, Rasinski, Reutzel, Chard, and Linan-Thompson (2002) suggest that fluency is “a characteristic of reading that occurs when readers’ cognitive and linguistic systems are developed to the extent that they can read with sufficient accuracy and rate to allow for understanding the texts and reflecting its prosodic features” (p. 287).

The National Reading Panel (2000) views fluency as a critical aspect of successful reading, and emphasizes the importance of fluency instruction in classrooms. Rasinski et al. (2002) report that reading fluency develops through repeated reading practices. In this way, readers could start to process information with higher levels of automaticity, and develop an awareness of prosodic features. This knowledge, in turn, could allow them to identify any boundaries between words, phrases and sentences during the process of meaning making (Schreiber, 1991). Once readers become able to read the same texts fluently, they will possibly benefit from this automaticity when they attempt to read new texts in the future (Samuels, 1979).

An important account regarding the role of fluency in reading comprehension belongs to LaBerge and Samuels (1974), who introduced the automaticity theory in the early years of literacy research. According to the theory, the mastery of lower-level reading skills (i.e., word recognition) contributes to reading fluency, which, in turn, frees cognitive resources to be used for comprehension. LaBerge and Samuels (1974) argue that the information given in a written text is processed by different memory systems (i.e., visual, phonological, semantic and situated memory), and coordinated by attention, which is responsible for the allocation of cognitive resources. When there are difficult words in the text, most of the attention is placed on decoding, which leaves fewer resources for comprehension. For this reason, the ability to decode words in an automatized manner is a requirement for successful comprehension.

In line with this account, Perfetti and Hogaboam (1975) suggested that lower-order skills such as word decoding could be automatized while higher-order skills, such as inference making, rely more on cognitive resources and require attentional control at a conscious level. In this view, automaticity in word identification is a prerequisite for the accomplishment of higher-order reading skills. In another view, Rumelhart (1994) argues that word reading speed and reading comprehension function in an interactive manner, in which top-down processes such as knowledge of syntax might enhance word recognition speed. In a different approach, fluency is defined within a broad framework including neurobiological systems related to executive functioning (Berninger, 2001). Accordingly, the distinction between fast and slow readers is an outcome of performance differences in the brain’s functions to coordinate cognitive and linguistic skills across individuals.

Kuhn and Stahl (2003) suggest that fluency could be defined as a composite variable including not only accurate decoding and automatized word recognition but also efficient use of prosody. For the researchers, prosody, an inherent aspect of speaking, is what makes oral language easier to understand when compared to comprehension of connected text. If a reader is able to apply expression and rhythm to the sentences appropriately through accurate parsing of the sentences, he or she will become more fluent, and comprehend the text to a greater extent.

Adams (1990) informs that readers recognize words faster when they appear in meaningful sentences rather than in isolation. This finding indicates that contextual information and syntactic knowledge facilitate reading fluency, and contributes to reading comprehension. Besides syntactic knowledge, fluency and comprehension also rely on the reader's understanding of a text's macrostructure (Kintsch & Kintsch, 2005), which refers to coherence or overall organization in a reading text. For narrative texts, macrostructure might correspond to features such as the setting or the main events while for expository texts, it could be the general purpose or text structure (Klauda & Guthrie, 2008). For this reason, investigating fluency and its contribution to reading comprehension is likely to offer deeper insights into the underlying mechanisms of reading.

In a study with 278 English speaking children at Grade 5, Klauda and Guthrie (2008) found that different levels of fluency (i.e., reading individual words, sentences and a passage) uniquely contributed to reading comprehension even after controlling for background knowledge and inferencing skills. The researchers also found that reading comprehension and fluency had a bidirectional relationship in the long term. In another study, de Jong and van der Leij (2002) reported that word reading fluency played a major role in the prediction of reading comprehension in Dutch across

Grades 1 and 3. Their findings also showed that listening comprehension and vocabulary knowledge were other important components of reading comprehension.

In a different study, Jenkins, Fuchs, van den Broek, Espin, and Deno (2003) investigated the roles of word reading fluency and text reading fluency in predicting reading comprehension. The participants were English-speaking Grade 4 students (*N* = 113) living in the United States. For text level reading, they were asked to read a folktale, and for word level reading, they read aloud isolated words from the folktale. The results showed that reading connected text, which has a contextual integrity, made a greater contribution to reading comprehension than reading isolated words. In addition, word level reading and comprehension were found to make unique contributions to text reading fluency. In line with this finding, Rasinski et al. (2002) suggest that fluency could both precede and result from comprehension in simultaneous or interactive ways, and due to this highly complex relationship, more research is needed with a focus on fluency both as a dependent and independent variable.

## 2.2 Phonological awareness and reading

Phonological awareness (PA), defined as the ability to divide spoken words into smaller parts and the ability to manipulate these parts (Gillon, 2007), is one of the most important components of literacy (Adams, 1990; Anthony & Francis, 2005; Babayiğit & Stainthorp, 2007; Caravolas et al., 2005). PA follows a developmental sequence, moving from larger units (i.e., words and syllables) towards finer distinctions of speech sounds (i.e., onset-rimes, and lastly phonemes) in the course of literacy acquisition (Ziegler & Goswami, 2005). Therefore, for beginning readers, certain measures of PA could be more challenging than others. To exemplify, phonemic awareness is a far more complex aspect of PA (Snider, 1995) when compared to syllable and onset-rime awareness. Even among PA tasks which measure phonemic awareness, some tasks pose higher levels of difficulty for children. For instance, measures such as phoneme deletion or phoneme reversal are more challenging when compared to measures such as phoneme segmentation (Adams, 1990).

PA is consistently reported to play a major role in the development of literacy skills across languages. In an early study, Bradley and Bryant (1983) investigated the relationship between PA and reading skills in a group of English speaking children. The researchers followed a large number of preschoolers ($N$ = 403) into Grades 1 and 2, and found that early onset and rime awareness made a significant contribution to reading and spelling performance in the following years. In another study, Ball and Blachman (1991) investigated the effectiveness of different PA training programs in English. They assigned 90 kindergarten students to three different groups according to the type of treatment. In the first group, the instruction focused on a combination of phoneme awareness (i.e., phoneme segmentation) and letter knowledge while in the second group, the teacher gave instructions solely on letter knowledge. The third group was the control group and they did not receive any special training during the seven-week period. The findings of the study indicated the students who received phoneme segmentation training made a significant progress in their reading and spelling skills which were measured at the end of the training period. Furthermore, their gains were significantly higher than those of the children in the control group and letter-knowledge training group. As reflected by these two studies, most of the early research attempted to examine the relationship between PA and reading ability in English, which has an opaque orthography. However, Anthony and Francis (2005) suggest that in addition to individual differences, language-specific characteristics could a play critical role in the development and the ultimate attainment of PA skills.

Regarding the interaction between PA and language-specific features, an important theory (i.e., the psycholinguistic grain size theory) was proposed by Ziegler and Goswami (2005). According to this theory, in languages with opaque orthographies, readers tend to rely on a larger inventory of grain size units including both smaller and larger sound units. On the other hand, individuals reading in transparent orthographies rely more on smaller units (i.e., phonemes) as they almost always succeed in their attempts to decode words by depending on the highly consistent phoneme-grapheme correspondences in their languages. Goswami (2010) explains:

> As an example, children who are learning to read in English need to develop multiple strategies in parallel if they are to become successful readers. They need to develop whole-word recognition strategies so that they can read words like *choir* and *yacht*, they need to develop rhyme analogy strategies so that they can read irregular words like *light*, *night* and *fight*, and they need to develop grapheme-phoneme recoding strategies so that they can read regular words like *tip, fat* and *dog*. (p. 36)

The psycholinguistic grain size theory is supported by the evidence coming from letter position studies across different orthographies. For example, Ktori and Pitchford (2008) compared readers of Greek and English in a visual search task in which the participants were asked to detect a previously presented target letter in a random string consisting of five letters. The findings showed that while both groups responded faster when the target letter was in the initial position than in the second; only English readers demonstrated a final (fifth) letter advantage over the fourth letter. For the authors, this finding indicated that English readers relied on lexical processing to a greater extent, with a tendency to recognize words as holistic units.

Considering the effects of language-specific features on the development of PA and reading skills, several studies were conducted in order to investigate literacy development across different languages (e.g., Caravolas et al., 2005; Seymour, Aro, & Erskine, 2003). In their study, Seymour et al. (2003) found that the rate of reading acquisition might differ across languages based on their orthographic depth. More specifically, children learning to read in opaque systems such as English are likely to be slower at acquiring basic reading skills when compared to their peers who are learning to read in transparent languages. This finding suggests that in opaque languages, the irregular mapping between graphemes and phonemes makes it more difficult to break the code during the early years of literacy development. For this reason, reading accuracy continues to be a significant predictor of reading achievement in opaque languages for a longer period of time. Consequently, PA, as a means to analyze sounds for accurate reading, has a more prevailing influence on reading in opaque languages, while its effect is time-limited in transparent languages (Georgiou, Parrila, & Papadaopoulos, 2016) due to the early mastery of decoding in a consistent orthographic system (Landerl & Wimmer, 2008). Hence, reading fluency, rather than reading accuracy is more often taken into account when measuring literacy skills in transparent languages. As a result, RAN, instead of PA is believed to be a more reliable index of reading ability in such languages (de Jong & van der Leij, 1999).

In another study, Caravolas et al. (2005) compared the role of PA in literacy skills across English and Czech in two groups of children followed between Grade 2 and 5. Their findings suggested that phonemic awareness (i.e., phoneme deletion) predicted reading and spelling skills in both languages despite the fact that Czech has a more transparent orthography in comparison to English. These results seem to contradict with the finding that PA is more important in opaque languages. However, orthographic transparency could be defined as a continuum with varying degrees across different languages, and other language-specific features (e.g., high number of consonant clusters as in Czech) might play a role in determining the ease of reading acquisition and the involvement of PA in this process (Seymour et al., 2003).

In order to better understand the role of PA in reading across different orthographies, Georgiou, Parilla, and Papadopoulos (2008) compared Greek-speaking children's reading skills with those of English-speaking children in Grade 1 and Grade 2. The findings of the study showed that PA was associated with reading accuracy in both languages and this relationship was stronger in English. It was also found that Greek-speaking children had higher scores in reading accuracy when compared to their English speaking peers, which could be explained by the higher consistency in the Greek orthography. For this reason, RAN was found to be a more important measure of reading speed in Greek than in English. Another finding of the study was that RAN and PA had higher correlations in English (around .60) than in Greek (around .30).

In another study, Babayiğit and Stainthorp (2007) investigated the role of early PA in predicting reading fluency in Turkish. They measured different aspects of PA skills in a group of kindergarten children ($N$ = 56) who were followed into Grade 1 and Grade 2. Their results showed that PA, especially the sound oddity measure, was the most powerful long-term predictor of spelling ability; however, it did not make any significant contribution to fluency in word, pseudoword and text reading in Turkish. The authors explain this finding by the possible role of highly regular phoneme-grapheme correspondences in Turkish, which might make phonological analysis redundant for successful reading outcomes even at the earliest stages of literacy development. The researchers reported similar findings in one of their following studies (Babayiğit & Stainthorp, 2011), which revealed that while RAN was the strongest predictor of reading fluency, PA was the most powerful precursor of spelling skills in Turkish. This pattern was also reported for other transparent languages such as German (e.g., Wimmer & Mayringer, 2002).

Most of the evidence on the link between PA and reading ability shows that PA is related to lower-level reading skills such as decoding. However, findings also suggest that PA might be directly related to reading comprehension in different languages (Cárnio, Vosgrau, & Soares, 2017; Edwards & Taub, 2016; Engen & Høien, 2002; Holsgrove, 2003; Kroese, Hynd, Knight, Hiemenz & Hall, 2000). In their recent study, Cárnio et al. (2017) investigated the associations between PA and reading comprehension in Portuguese-speaking Grade 4 children with and without learning difficulties ($N = 60$). Their findings showed that PA was correlated with sentence and text reading comprehension in both groups.

In another study, Edwards and Taub (2016) examined which subskills of PA (i.e., sound segmentation and sound blending) were related to reading comprehension from Grade 1 to Grade 4. They used nonword segmenting and nonword blending tasks in a group of English-speaking minority children ($N = 86$), and found that both phoneme blending and segmenting skills were significantly correlated with reading comprehension. Further analyses revealed that phoneme blending had a larger effect size in its relationship with reading comprehension when compared to phoneme segmenting. As for grade-level differences, the researchers found that the influence of sound blending on reading comprehension was greater for lower grades (i.e., Grades 1 and 2) than for higher grades (i.e., Grades 3 and 4). This finding was in line with the evidence suggesting that the influence of PA on reading skills tends to decrease at later stages of literacy development.

In a similar study, Holsgrove (2003) investigated the role of phonological processing along with the roles of syntactic processing and working memory in reading comprehension. The participants were English speaking adolescents attending Grade 8 (*N* = 60) in Australia. The results of the regression analyses revealed that both phonological and syntactic processing skills predicted reading comprehension in English. In another study, Engen and Høien (2002) examined the associations between PA and reading comprehension in Norwegian-speaking Grade 1 children (*N* = 1300). The students participated in tests of phoneme awareness, syllable awareness, word reading and reading comprehension. The results of the structural modelling showed that PA had a direct influence on reading comprehension both for poor and average word decoders. The researchers explained that besides playing an important role in measures such as vocabulary and short term memory, PA might also reflect some metacognitive processes underlying reading comprehension. Another finding was that phonemic awareness was more strongly related to reading ability in comparison to syllable awareness in Norwegian.

In a different study, Kroese et al. (2000) investigated the relationships between PA, phonological memory (PM), reading and spelling skills in a mixed group of readers (between ages 8-12), which included normally developing children, children with reading disabilities and children with attention-deficit/hyperactivity disorder. Their findings showed that PM and phoneme awareness (especially elision and reversal) accounted for a large amount of variance in reading (word attack and reading comprehension) and spelling skills in the sample. The researchers also informed that more challenging tasks of PA influenced literacy skills to a greater extent at the later stages of elementary school.

Overall, findings from the literature suggest that PA is a central component of reading skills across languages, and it might influence different aspects of reading depending on some factors such as task type, language-specific features, and the level of literacy development.

### 2.3 Rapid automatized naming and reading

Rapid automatized naming (RAN) refers to naming a set of familiar objects, colors, digits, or letters in an accurate and rapid way. RAN tasks were designed and developed by Denckla and Rudel (1974, 1976), and have been extensively used as a measure of reading fluency in literacy research. The tasks have two different versions which entail discrete or serial naming of the visual stimuli. In the discrete version, the test taker names the items one at a time. In the serial version, which has been used in the current study, the items are presented in a grid with five rows, each including ten items that are randomly repeated. Serial RAN is a more common measure of reading fluency as it resembles the continuous nature of an authentic reading task (Wolf, 1991).

Readers who demonstrate fluent naming performance on RAN tasks are found to read words accurately and rapidly (Bowers, 1993). Numerous studies (see Norton & Wolf, 2012, for a review) have shown that RAN is a strong predictor of reading speed across different orthographies (e.g., Babayiğit & Stainthorp, 2010; Georgiou et al., 2016; Landerl & Wimmer, 2008; Papadopoulos et al., 2016; Verhagen, Aarnoutse, & van Leeuwe, 2008). Although there is robust evidence that RAN is a strong predictor of reading ability, there are different views on the nature of RAN, and its complex relationship with reading. This is an outcome of the difficulty in defining RAN, which is a multicomponent measure involving the coordination of several subskills (Wolf, Bowers, & Biddle, 2000). Some argue that RAN reflects the retrieval of phonological representations of printed material from the long term memory (Wagner & Torgesen, 1987), and it is a component of the broader phonological processing skills.

In a different approach, RAN and phonological skills are viewed as independent predictors of reading ability (Wolf & Bowers, 1999) based on the evidence that performance on these two constructs might show dissociation in children with dyslexia (Bowers, 1995). In line with this account, Savage and Frederickson (2005) found that while PA was an index of reading accuracy and comprehension, rapid digit naming was a measure of reading accuracy and speed (which was not the case for rapid picture naming). Further analyses revealed that after controlling for reading accuracy, alphanumeric RAN continued to predict reading speed. In light of these findings, the researchers argued that PA and RAN measured separate aspects of reading ability. The argument that phonological processing cannot fully account for RAN-reading connection is further supported by the finding that serial RAN is more closely associated with word reading fluency when compared to discrete RAN although both types of RAN require the retrieval of phonological information from the long term memory (Georgiou, Parrila, Cui, & Papadopoulos, 2013).

In another approach, Sunseth and Bowers (2002) suggest that the relationship between RAN and reading could be mediated by the processing of orthographic information. Accordingly, RAN indexes fluent, effortless recognition of words as holistic units, without the application of grapheme-phoneme level analyses. This process is called sight-word reading (Ehri, 1992), which is important for overall reading fluency and reading comprehension. For readers, sight word reading is possible after they analyze and master words' orthographic structure. This information allows them to build mental representations of words and access them rapidly and automatically. Upon each encounter with a sight word, readers utilize further information about that particular word's meaning, spelling or pronunciation (Ehri, 1992). Therefore, orthographic knowledge could play a critical role in the RAN-reading relationship through the automatized retrieval of word specific information. However, there are studies reporting that RAN is a unique predictor of reading fluency beyond the contributions of orthographic processing (e.g., Cutting & Denckla, 2001); and that orthographic processing accounts for only a small amount of variance in the RAN-reading relationship (e.g., Georgiou et al., 2016).

Another theoretical approach suggests that the relationship between RAN and reading is affected by domain-general factors such as processing speed (Badian, 1996; Kail & Hall, 1994), which plays an important role in the execution of underlying mechanisms in reading. In an early study, Badian (1996) investigated RAN performance in a group of poor readers who were divided into two groups based on their IQ levels. The results of the study showed children with higher IQ levels, despite their reading difficulties, scored higher in RAN tasks in comparison to the group with lower IQ scores. The researcher explained that the underlying mechanism of the RAN-reading relationship was based on general processing speed rather than linguistic abilities such as phonological knowledge. However, in a recent study, Georgiou et al. (2016) found that processing speed played a more important role in explaining the connections of RAN with phonological and orthographic processing rather than mediating the RAN-reading relationship. The researchers argued that RAN's unique contribution to reading fluency was more important than its connection with speed of processing, as with phonological and orthographic abilities.

To complicate matters further, recent studies now focus on the possible contributions of executive functions in mediating the RAN-reading relationship. Amtmann, Abbott and Berninger (2007) suggest that working memory (WM) plays a critical role in this connection. Accordingly, in both RAN and reading, the information given in the printed material is to be retained in WM, where orthographic information is integrated into phonological representations in a time-sensitive manner. Bexkens, Van Den Wildenberg, and Tijms (2015) argue that besides phonological processing and processing speed, inhibitory control is likely to influence RAN performance, especially when dealing with interference. The rationale behind this approach is that during a RAN task, the reader keeps a set of stimuli in WM while trying to name the upcoming stimuli, and there exists a competition between the upcoming stimulus and the previously named items that are still accessible to the reader. At this point, the reader has to focus on the target item and inhibit all the other alternatives that are already activated for the selection of the correct response. To test their hypothesis, Bexkens et al. (2015) investigated this relationship in a group of Dutch-speaking dyslexic children. Their findings showed that although inhibition did not significantly contribute to reading and spelling skills in their sample, it was an important predictor of RAN along with phonological processing and processing speed. When these three subcomponents were partialled out in the analyses, RAN no longer had consistent relationships with reading and spelling skills of the dyslexic children. Despite these findings, there exist contradictory evidence about the role of EF in mediating the connection between

RAN and reading ability. For instance, Altani, Protopapas, and Georgiou (2017) found that EF measures such as inhibition, updating and shifting did not account for the variance shared by serial rapid naming and reading fluency in Greek. The researchers also reported that there were no strong correlations between the different measures of EF and RAN.

Despite the ongoing debate about the nature of the RAN- reading relationship, research consistently shows that RAN is an important predictor of reading across different languages. In a cross-linguistic study, Furnes and Samuelsson (2011) investigated the effects of RAN and PA on the reading and spelling skills of English (highly opaque orthography) and Norwegian/Swedish (relatively transparent orthographies) speaking children, who were followed from preschool years to Grade 2. Their findings suggested that regardless of the orthographic differences between the languages, RAN was a significant predictor of reading fluency measured at the level of word recognition and decoding of non-words.

In another study, Albuquerque (2012) examined the associations between RAN, PA, reading and writing skills in European Portuguese, and compared their developmental patterns across Grades 1 and 2. The results of the study showed that RAN had stronger correlations with reading fluency while PA was more closely associated with decoding accuracy. PA was highly correlated with spelling accuracy both in Grade 1 and 2. On the other hand, RAN was moderately correlated with writing accuracy and fluency especially in Grade 2. It was reported that RAN started to have stronger correlations with literacy skills in Grade 2 while PA tended to lose effect. The author explains this finding with the early mastery of decoding in the transparent orthography of Portuguese, and implies that RAN might tap lexical (i.e., orthographic, rather than phonological) processing at later stages of literacy acquisition. Similar findings were reported for Turkish by Sönmez (2015), who found that RAN established a more central role in the prediction of reading and spelling skills as children progressed from Grade 3 to Grade 4.

Although these studies do not suggest that RAN is a direct measure of orthographic processing, they inform that RAN might be important in the recognition of high-frequency words by sight upon the mastery of word specific orthographic knowledge. Despite robust evidence suggesting that readers mostly rely on sublexical (i.e., one-to-one mapping of sounds and letters) processing in the regular systems of transparent orthographies (see Ziegler & Goswami, 2005), it is possible that they also utilize larger grain size units depending on task requirements (Georgiou et al., 2008). Georgiou et al. (2008) suggest that readers of transparent languages such as Greek might switch from smaller grain size units to larger units particularly in speeded measures of reading. Here, it should be noted that what is conceptualized as orthographic processing (i.e., utilizing lager units) could be a highly automatized way of processing sublexical units in transparent languages.

In a recent study, Papadopoulos et al. (2016) examined the relationship between RAN and reading fluency in Greek, which is considered a highly transparent language. The authors followed 286 students from Grade 1 to Grade 2 and investigated the role of RAN in reading fluency by comparing different types of reading (i.e., oral versus silent reading) and different versions of RAN tasks (i.e., alphanumeric versus non-alphanumeric RAN). Their results suggested that RAN significantly contributed to oral reading fluency (but not to silent reading fluency) in Greek in both concurrent and longitudinal analyses. They also found that using different versions of RAN tasks did not alter the relationship between RAN and reading. Additionally, their results revealed that phonological and orthographic skills contributed to reading ability, and mediated RAN-reading relationship at significant levels. That is, RAN had both direct and indirect effects on oral reading fluency in Greek.

In a similar study, Georgiou et al. (2016) examined the relationship between RAN and reading in a group of Greek-speaking Grade 4 children. Their results showed that while PA did not contribute to reading fluency in the transparent orthography of Greek, RAN contributed to reading fluency both directly and indirectly through orthographic knowledge. The authors emphasized the role of RAN in predicting reading fluency beyond the potential effects of processing speed, PA and orthographic knowledge.

In another study, Verhagen et al. (2008) followed the development of literacy skills in Dutch-speaking children from Grade 1 to Grade 2. Their findings showed that after controlling for factors such as letter knowledge and vocabulary, RAN predicted the accuracy and speed of word recognition at the end of Grade 1 and Grade 2. PA, on the other hand, predicted word recognition accuracy only at the end of Grade 1. The authors interpret these findings as follows:

> Early in the development of reading in languages with consistent orthographies, phonological awareness predicts word recognition ability but only for a limited developmental period, whereas naming speed appears to be a reliable predictor of variations in measures of speeded word recognition over a longer developmental period. (p. 320)

In a longitudinal study, Landerl and Wimmer (2008) investigated the relationships between different measures of literacy in the highly consistent orthography of German. They followed 115 students from Grade 1 to Grade 8, measuring their reading and spelling skills along with RAN, PA, letter knowledge, short term memory (STM) and nonverbal intelligence. The participants were tested three times (i.e., at the end of Grade 1, Grade 4 and Grade 8). The findings of the study indicated that early RAN performance was a stronger predictor of fluent word recognition than PA, whereas PA was a strong predictor of spelling skills. The authors state that especially in transparent orthographies, speeded word recognition is an important factor which determines reading achievement (i.e., reading texts fluently and attentively) throughout the school years. Another important observation was that most of the children who had difficulty in the early measurements of the study ended up with problems in reading and spelling skills in Grade 8.

In another study, Babayiğit and Stainthorp (2010) investigated the role of RAN along with PA and grammatical knowledge in reading and spelling skills in Turkish. They followed 57 students from Grade 1 to Grade 2. Their findings showed that while grammatical and phonological knowledge contributed to spelling performance, RAN was the strongest longitudinal predictor of reading speed, which was measured at the levels of word reading, nonword reading and text reading fluency. RAN accounted for reading ability at significant levels regardless of the factors such as word complexity (i.e., single versus multimorphemic word) and modality of the reading task (i.e., presented in a context versus in isolation). The findings also revealed that RAN's contribution to reading was still significant even after controlling for earlier reading skills of the participants.

In addition to its important role in predicting reading fluency, RAN is also reported to have some direct influence on reading comprehension. For example, Manis, Seidenberg and Doi (1999) examined the effects of RAN and PA on a variety of reading measures in a group of children followed from Grade 1 to Grade 2 ($N$ = 67). Their results showed that both RAN and phoneme awareness accounted for unique variance in reading ability even after controlling for verbal ability. Although there was some overlap between RAN and sound deletion in predicting reading, these two measures were found to explain independent variance in word reading and reading comprehension measures.

In another study, Kirby, Parrila and Pfeiffer (2003) found that RAN and PA which were measured at kindergarten made unique contributions to different levels of reading (i.e., word reading, nonword reading, and reading comprehension) between Grades 1 and 5. Their findings also showed that RAN had an increasing predictive value on reading ability at later grade levels while PA tended to lose its effect. In a different study, Joshi and Aaron (2000) used RAN as a measure of PS, and reported that rapid letter naming made a unique contribution to reading comprehension beyond decoding and linguistic comprehension in English.

In a study with French-speaking children (*N* = 267), Plaza and Cohen (2003) investigated the contributions of PA, syntactic knowledge and RAN to reading and spelling abilities in Grade 1. The results of the study showed that each of the three predictor variables explained unique variance in written language performance (i.e., a composite score including reading words and nonwords, reading comprehension, and spelling). Accordingly, PA explained most of the variance (14%), followed by RAN (8%) and syntactic awareness (2%) in reading and spelling in French.

Overall, these studies show that RAN is a key component of reading across different languages. Its predictive power in reading is reported to be stronger in transparent orthographies, especially at the later stages of literacy development. Therefore, RAN is a highly important predictor of reading in the context of the current study, which investigates the literacy skills of Grade 4 children in their attempts to read words, pseudowords and paragraphs in the transparent orthography of Turkish.

## 2.4 Processing speed and reading

Processing speed (PS) is defined as a domain-general factor which affects one's performance on the completion of a cognitive task within a time frame (Kail & Hall, 1994). Peter, Matsushita and Raskind (2011) explain that there exist two contrasting views about the nature of PS: one view supports domain specificity suggesting that PS during a linguistic task is totally independent from PS during a cognitive or motor task while the other view hypothesizes that PSs are "mutually associated" across different task types, and share "a common biologic substrate" (p. 885). The researchers also inform that recent findings support the latter view.

PS is reported to play an important role in reading comprehension as it predicts how quickly a reader decodes words and connects them in order to construct meaning (Christopher et al., 2012). In their early account, Kail and Hall (1994) state that children process information more rapidly as they get older, and some global mechanism, which changes with age, is responsible for their ability to complete perceptual and cognitive tasks faster. Kail and Hall (1994) investigated the connection between PS and naming speed in relation to word reading and reading comprehension in a group of participants ($N = 144$) aged between 8 and 13. Their results showed that age was associated with PS, accounting for nearly half of its variance (49 %). When age and PS were entered into the model, they explained 62 % of the variance in naming speed. In the following step, together with age and PS, RAN accounted for 62 % of the variance in word recognition. Lastly, when word recognition was included in the equation, the overall model explained 72 % of the variance in reading comprehension. The analyses further indicated that PS, but not age, was an important predictor of naming speed. Based on these findings, the researchers explain that the ability to access the names of familiar items becomes faster due to the influence of age-related factors on the global mechanism rather than the automaticity acquired based on previous experiences with familiar stimuli.

In a study with forty English-speaking children in Grade 3, Joshi and Aaron (2000) examined whether the simple view of reading could be modified with the integration of PS into the model. They utilized a rapid letter naming task to measure PS in the sample. The results of the study showed that PS made an additional contribution to reading comprehension beyond decoding and listening comprehension, and its inclusion increased the predictive power of the component model. The authors hypothesized that the predictive value of the model is likely to increase in Grade 4 and beyond (p. 95) where speed becomes more relevant, and students rely more on sight-word reading (Joshi & Aaron, 2000).

In another study, Urso (2008) investigated the relationship between different measures of PS and poor word recognition skills in 53 English-speaking children between Grades 1-3. The participants were all poor readers who had low scores in a comprehensive set of diagnostic tests. The findings of the study indicated that there was a strong correlation between PS and poor word reading ($r = .749$), and nearly 38 % of the poor readers also had slower PS performance. In the subset of children with poor performance both in PS and word recognition, visual matching and decision speed tests were found to have the strongest correlations with poor word reading among other measures of PS (i.e. pair cancellation, cross out, and rapid picture naming, which was operationalized as a narrow cognitive ability subsumed in the broader cognitive ability of PSs). In a different study, Babür (2003) investigated the role of PS in relation to PA, STM, letter knowledge and different types of RAN (digits/letters and objects) in the reading skills of English-speaking children across Grades 1 and 2. Her findings revealed that PS was associated with basic reading skills (i.e., word and nonword reading, word attack and letter-word identification) both directly and indirectly through STM, PA and RAN (digits/letters) in Grade 1 while it only had indirect effects on reading (through STM and PA) in Grade 2.

In another study, Peter et al. (2011) investigated the relationship between PS and reading ability in a large sample divided into different cohorts including children with dyslexia, children with typical reading skills and adults with typical reading skills. The researchers used a wide range of linguistic, motor and cognitive measures, and found that all timed measures loaded on the same (i.e., speed) factor, supporting the view that PS is a domain-general construct exerting its influence across a wide range of task types in all cohorts. PS was reported to increase with age during childhood while it tended to decrease with older age after adulthood. Another important finding was that poor readers had lower PS scores than typical readers.

In a recent study, Christopher et al. (2012) investigated the role of several speed measures and executive functions (i.e., PS, naming speed, WM and inhibition) in predicting word reading and reading comprehension in a large sample ($N$ = 483) of English-speaking participants aged between 8 and 16. The researchers divided the participants into two groups in order to see possible differences across the stages of "learning to read" and "reading to learn". Their findings showed that word reading had a mostly invariant connection with reading comprehension across the two groups, and PS was a unique predictor of word reading and reading comprehension after controlling for other measures.

Papadopoulos et al. (2016) suggest that in transparent orthographies in which reading fluency is taken as an index of reading achievement, RAN and reading ability rely on PS to a greater extent. They found that PS was a significant precursor of oral reading fluency (i.e., word and nonword reading fluency) in the longitudinal analyses while orthographic and phonological skills predicted silent reading fluency in the concurrent analyses. The authors explain that the students might have relied on serial processing of the stimuli at the beginning stages, as they tried to reach phonological and orthographic codes in the written text. However, when they reached higher levels of automaticity in lexical access, PS might have played a more important role in the prediction of their reading performance.

As shown by the findings in the literature, PS is a key factor in reading development, especially in terms of automaticity in lexical access and reading fluency. As reading fluency (rather than accuracy) is a more relevant measure of reading achievement in the transparent orthography of Turkish, the examination of PS in the current study is to offer deeper insights into the connections between reading fluency and reading comprehension in Turkish.

### 2.5 Vocabulary knowledge and reading

There are different views as to the nature of relationship between oral language skills and reading ability. While some suggest that oral language directly contributes to reading (e.g., Scarborough, 2005), others argue that factors such as phonological processing could mediate this relationship (e.g., Whitehurst & Lonigan, 1998). This discrepancy, as Storch and Whitehurst (2002) suggest, might result from the fact that contributions of oral language skills (i.e., vocabulary, syntax and conceptual knowledge) to reading show variation throughout reading development. Accordingly, at the initial stages of development, (i.e., Grades 1 and 2) oral language contributes to reading ability indirectly through lower-level skills such as phonological processing. At this stage, reading accuracy and comprehension are strongly intertwined. At later stages (i.e., Grades 3 and 4), however, accuracy and reading comprehension become two separate constructs, and oral language starts to exert a direct influence on reading comprehension.

As an important predictor of reading ability, vocabulary knowledge develops based on PA and MA (Bowey, 2001; Carlisle, 1995; Gillon, 2007). At the beginning stages of literacy development, children learn phonemic distinctions between different sounds in words, and start to have finer lexical representations (Gillon, 2007), which, in turn, improve their vocabulary depth and breadth. PA acts as a foundational skill for children to analyze phonemes and graphemes in an unfamiliar word, and to access its full orthographic representation. This information, then, allows the child to recognize words more efficiently in a self-teaching manner (Share, 1995). As children progress towards the later stages of literacy acquisition, MA becomes more relevant for oral language and reading ability (Carlisle, 2000).

In a study with English-speaking preschool children, Metsala (1999) found that children's performance in a number of PA tasks explained unique variance in their vocabulary development. In another study, McBride-Chang et al. (2005) investigated the role of PA along with MA in vocabulary and word recognition skills of Grade 2 children across English, Korean and Chinese. For word recognition, their findings showed that PA was more important in English and Korean than in Chinese, while MA had a more central role in recognizing words in Chinese and Korean when compared to English. As for vocabulary, PA and MA had similar relationships with each other and vocabulary knowledge (ranging from .39 to .47) across languages. The researchers concluded that "across cultures, vocabulary knowledge appears to build on both the phonology and morphology of a language" (p. 155).

In a longitudinal study, Bowey (2001) found that nonword repetition and phonological sensitivity contributed to grammar and receptive vocabulary in four-year-old children. In a comprehensive cross-linguistic study, McBride-Chang et al. (2008) investigated the literacy skills of 663 preschool children with different linguistic backgrounds (i.e., Korean, Cantonese and Mandarin speaking children). The participants were tested on a series of measures including MA, vocabulary knowledge, reasoning and PA twice over a period of nine months to one year. Their findings showed that after controlling for the other measures, Time 1 MA made a unique contribution to Time 2 vocabulary knowledge across the three languages. Likewise, after controlling for Time 1 MA, vocabulary knowledge explained unique variance in the subsequent MA skills measured in all of the languages. The researchers pointed to the reciprocal relationship between MA and vocabulary development, especially in languages in which lexical compounding is highly common. In Turkish, lexical compounding is a very productive process, particularly in the case of nominal compounds (Aslan & Altan, 2006). To this end, investigating the possible contributions of MA to vocabulary knowledge might provide a better insight into the acquisition of reading skills.

As a major component of oral language skills, vocabulary knowledge plays a central role in decoding skills (Scarborough, 2001), visual word recognition (i.e., sight-word reading), and reading comprehension (Ouellette, 2006). With the learning of each new word, phonemic awareness is likely to improve, which, as a consequence, allows readers to decode words more efficiently (Goswami, 2001). As for visual word recognition, some argue that the process is phonologically oriented as in decoding, because the mastery of phoneme-grapheme correspondence rules enables the reader to reach full orthographic representations of words (e.g., Share, 1995). Other researchers, however, suggest that visual recognition differs from decoding in that it requires the interaction of semantic knowledge with orthographic representations (e.g., Coltheart, 2005). In the latter scenario, vocabulary might exert a more direct influence on word reading ability.

In opaque orthographies, word recognition processes might show more variation depending on the nature of the target word. In order to read words with irregular phoneme-grapheme mappings, readers rely on the processing of larger units (Ziegler & Goswami, 2005). Therefore, the contribution of vocabulary skills to word reading could be more evident in opaque languages such as English (e.g., Ouellette, 2006). In transparent languages, however, decoding (pseudoword reading) and visual word recognition (word reading) are strongly related, and they go through similar processes due to the highly regular phoneme-grapheme correspondences. Durgunoğlu (2017) reports that early decoding is the strongest predictor of future decoding skills in Turkish, and points to a stable pattern of development in word-level reading. Given the quick mastery in decoding and the difficulty in making a clear-cut distinction between decoding and word recognition, vocabulary is not found to have a direct role in predicting reading fluency in Turkish (e.g., Babayiğit & Stainthorp, 2010; 2011) despite the possible role of word frequency effect (Durgunoğlu, 2017).

Both the number and the quality of items in the mental lexicon facilitate efficient word recognition, which, in turn, contributes to reading comprehension (Perfetti, 1998; Perfetti & Hart, 2001). The sheer number of words known by the reader is defined as breadth of vocabulary knowledge while the quality of these lexical items is addressed as depth of vocabulary knowledge. Ouellette (2006) suggests that vocabulary storage includes both phonological representations and semantic units which are different but connected systems, and it is necessary to handle the number of vocabulary items existing in the mental lexicon (breadth) separately from the semantic knowledge about words (depth). Based on this distinction, Ouellette explains that even though a child might add a new word to his or her mental dictionary, he or she may not understand its exact meaning.

One of the most influential accounts on the connection between vocabulary and reading is the lexical quality hypothesis (Perfetti, 2007). According to this account, the lexicon acts as a pressure point between the word identification system, which needs high-quality linguistic and orthographic information to identify words rapidly; and the comprehension system, which receives input from the word identification system for the process of meaning making. Similarly, Perfetti and Stafura (2014) propose that word knowledge lies in the center of the reading systems, and 'text comprehension depends on understanding words and integrating their meaning into a mental model of the text' (p. 26).

Perfetti and Stafura (2014) argue that vocabulary is likely to play a direct role in reading apart from its indirect effect through general language comprehension. According to the authors, 'word meanings stored in memory (the lexicon) are only part of word comprehension, as they (and other memory-driven associations) are activated during reading and then tuned to what the context (the representation of the situation) demands' (p.32). For fluent integration of words into text, they list the following requirements: a) rapid and automatized access to lexical items, b) rapid and automatized activation of associated knowledge in memory, c) access to memory for the recent knowledge of the text at text and/or situation models, and d) knowledge and retrieval of meaning in relation to the context (p.34).

In a different account, Stanovich (1990) argues that automaticity in reading mostly depends on the quality of lexical representations in memory, which are formed through efficient processing of the written stimuli. Accordingly, readers with high quality lexical representations could read more fluently with no reliance on context while those with poor lexical representations would try to infer the meanings of unknown words by relying on the contextual cues. Therefore, readers with poor lexical representations will eventually slow down to comprehend the message in a given text.

In a longitudinal study, Verhoeven and van Leeuwe (2008) attempted to test the lexical quality hypothesis and simple view of reading in a large sample of Dutch speaking children ($N$ = 2143) during their elementary school years. They investigated the roles of listening comprehension, word decoding and vocabulary on the acquisition of reading comprehension skills. They found that word decoding had a significant influence on reading comprehension at the beginning stages and its effect tended to decrease towards the end of the elementary school. Vocabulary knowledge and listening comprehension were also significant predictors of reading comprehension; however, while listening comprehension demonstrated reciprocal associations with vocabulary at later stages, vocabulary continued to directly predict reading comprehension. This finding shows the importance of vocabulary knowledge in determining reading achievement throughout elementary school years.

Nation and Snowling (1999) compared good and poor comprehenders who were matched for their decoding ability in terms of their sensitivity to semantically related word pairs in a semantic priming task. The test items were divided into two distinct conditions, namely category pairs (e.g., cat-dog) and function pairs (e.g., broom-floor); and the pairs differed in terms of association strength. The findings of the study showed that both groups of readers demonstrated priming effects for function pairs. On the other hand, poor comprehenders showed priming effect for category pairs only when the strength of association was high. Good comprehenders, however, demonstrated priming effect for category pairs regardless of the strength of association. The researchers explain that good comprehenders have higher levels of automatization in accessing semantic information, even for words with more abstract relationships. Therefore, they suggest, reading comprehension might rely on the efficiency of semantic access, and knowledge of categories which is built upon children's "event-based" experiences (p. b10).

In Turkish, Babayiğit and Stainthorp (2011) investigated the predictors of reading and writing skills in a longitudinal study. They followed two groups of students (Grades 2 and 4) for one year (into Grades 3 and 5), and measured their literacy skills at two different times. One of the main findings of the study was that listening comprehension and vocabulary predicted Time 1 reading comprehension, which was the most powerful predictor of Time 2 reading comprehension. On the other hand, vocabulary was not a significant predictor of reading fluency (including word-level and text-level reading), which was also reported in one of their earlier studies (Babayiğit & Stainthorp, 2010).

Although vocabulary did not make a unique contribution to word reading skills in their earlier studies, Babayiğit and Stainthorp (2014) acknowledged that "vocabulary may impact upon reading comprehension directly through its effect on the semantic processing of text as well as indirectly through its facilitating effect on word recognition skills" (p. 187). This effect might not have reached statistical significance due to the relatively effortless use of sublexical strategies for the recognition of highly regular words in Turkish. Babayiğit and Stainthorp (2014) reported similar findings as to the important role of vocabulary in reading comprehension in their longitudinal study. They found that kindergarten vocabulary was the only predictor to make a unique contribution to Turkish-speaking children's reading comprehension in Grade 2.

In Dutch, which is another transparent language, Verhoeven, van Leeuwe and Vermeer (2011) investigated the effects of vocabulary on word-level reading fluency and reading comprehension throughout the elementary years of schooling. The findings of the study revealed that vocabulary size was an early predictor of word reading fluency and reading comprehension in Dutch. However, the role of vocabulary in comprehension was more pronounced than in word-level reading. As in the case of Turkish, the authors explained that vocabulary was not pivotal in explaining word-level reading, probably as a result of the highly transparent orthography. The researchers also reported that word reading could facilitate vocabulary growth through the connections between orthographic and semantic units. In addition, they documented a bidirectional relationship between vocabulary and reading comprehension in Dutch.

In another study, Tannenbaum, Torgesen and Wagner (2006) investigated different aspects of word knowledge in relation to reading comprehension in a group of English-speaking Grade 3 children. In addition to depth and breadth of vocabulary knowledge, fluency in word retrieval and use was considered a different dimension of word knowledge. The measures included a semantic fluency task in which the students named a series of objects in different categories (e.g., animals, clothes) under time pressure, and a timed task in which students were asked to use a target word in a sentence. In the best fitting model, breadth of vocabulary and the combination of fluency and depth of vocabulary appeared as the two main factors. The results of the analyses revealed that both factors made significant contributions to reading comprehension. However, breadth of vocabulary knowledge had stronger correlations with reading comprehension when compared to the combination of depth and fluency. Another finding was that the shared variance between these two factors was also a significant predictor of reading comprehension. Regarding the close relationship between fluency and vocabulary depth, the authors inform that as knowledge about word meanings becomes broader and more flexible, the rate of lexical access is likely to improve.

Roth, Speece, and Cooper (2002) investigated how oral language is connected to reading development by following a group of kindergarten children (*N* = 39) into Grades 1 and 2. Their findings revealed that while PA predicted word and pseudoword reading skills in Grades 1 and 2; semantic skills, which included oral definitions of words and lexical retrieval, predicted reading comprehension in Grade 2. Although Roth et al. (2002) did not specifically use the term “vocabulary depth”, their results showed that depth of vocabulary knowledge played a more influential role in reading comprehension as the grade level increased.

Ouellette (2006) investigated the effects of vocabulary breadth and depth on decoding, visual word recognition and reading comprehension in a group of English-speaking Grade 4 children. The rationale behind the inclusion of Grade 4 students was that the role of vocabulary in reading became more evident at this stage of literacy development, when children had highly efficient word recognition skills. The study also examined the effects of vocabulary knowledge on reading in relation to receptive and expressive skills. It was found that receptive vocabulary breadth predicted decoding ability, which, as the researcher explained, highlighted the relationship between vocabulary growth and increased sensitivity to phonological representations of words. Another finding was that expressive vocabulary breadth explained unique variance in visual word recognition beyond the contribution of receptive vocabulary breadth. This was interpreted by a possible role of both phonological and semantic processes involved in visual word recognition. Lastly, it was found that depth of vocabulary accounted for unique variance in reading comprehension beyond expressive and receptive measures. For Ouellette (2006), this result underscored the major role of oral language beyond word recognition skills, and supported the simple view of reading. In addition, it showed that semantic processes were more important than phonological knowledge at this stage of reading development.

Evidence from the literature consistently shows that vocabulary knowledge plays a significant role in predicting reading ability. Measuring not only breadth but also depth of vocabulary knowledge seems to be an important step in the examination of the vocabulary-reading relationship, which could provide a deeper insight into the complexities of literacy acquisition.

## 2.6 Morphological awareness and reading

Carlisle (1995) defines morphological awareness (MA) as the awareness of words' morphological features and the ability to manipulate morphological units. Several studies show that MA is an important predictor or reading achievement (Carlisle, 1995; Deacon & Kirby, 2004; Nunes & Bryant, 2006).

First signs of MA are observed during early childhood, when children learn and use basic affixes such as the plural marker for novel objects. As in other literacy skills, MA is acquired in a developmental order. Kirby et al. (2012) suggest that awareness of inflections develop earlier and faster than awareness of derivational morphemes; and for this reason, knowledge of derivations might be a long term predictor of reading ability. Kirby et al. (2012) also argue that it is easier for children to understand morphemes with phonologically transparent relationships such as *help-helpful* while it is difficult to notice the morphological relationship between words such as *sign-signal* due to the change in the phonological structure (p. 392).

According to Adams (1990), MA enables children to understand the connections between word spellings and meanings provided that they have acquired the foundational skills and reached a stage where they encounter morphologically complex structures in reading materials. In line with this view, research shows that the contribution of MA to reading tends to increase over the development of reading skills (Carlisle, 2000; Deacon & Kirby, 2004; Kuo & Anderson, 2006; Singson, Mahony, & Mann, 2000). For instance, Carlisle (2000) found that MA explained unique variance in reading comprehension both in Grade 3 and Grade 5, but the contribution of MA was stronger in Grade 5. This means that investigating MA in relation to reading becomes more relevant during the later stages of schooling.

Since morphemes are the building blocks of meaning which are used to make syntactically well-formed sentences, MA is reported to play a significant role in reading comprehension across different languages (e.g., Carlisle, 2003; D'Alessio, Jaichenco, & Wilson, 2019; Nagy, Berninger, & Abbott, 2006; Kuo & Anderson, 2006). Being knowledgeable about the parts of multimorphemic words may also help readers guess the possible meanings of unfamiliar words in a text (Carlisle, 2000). For this reason, MA also plays a role in enhancing reading speed both at word and text levels (Kirby et al., 2012).

Carlisle and Stone (2005) state that MA is associated with fast word recognition because it involves recognition of morphemes, which are larger units than phonemes and graphemes. This will be applicable to pseudoword reading because pseudowords could include morphological units or parts which are similar to real words (Deacon & Kirby, 2004). In the same vein, Nunes and Bryant (2006) argue that MA facilitates the parsing of multimorphemic words more efficiently, which, in turn, allows for faster word recognition.

Carlisle (2010) reports that MA is an important factor in understanding reading development as it involves the processing of several other aspects of language such as orthography, semantics, syntax and phonology. She also suggests that MA contributes to linguistic knowledge especially when instruction focuses on morphemic structure of words, meaning of printed words and their spellings. When children learn about morphemes which are used in different contexts, they develop representations of free and bound morphemes in memory. For example, it is possible that words such as *teacher* are stored as single entries; however, as the same morpheme with similar semantic and grammatical properties regularly appears in different words such as *player* or *singer*, learners start to store the representation of this bound morpheme (i.e., *-er*) separately. This will contribute to the word analysis skills required to infer the meaning of an unknown word, which will have positive consequences on general reading proficiency (Carlisle, 2010).

Kirby et al. (2012) investigated the role of MA in predicting different aspects of reading ability. They found that after controlling for verbal intelligence, nonverbal intelligence and PA, MA predicted word reading (both speed and accuracy), text reading speed and reading comprehension in children followed from Grades 1 to 3. Another finding of the study was that MA tended to play a more important role in reading in Grade 3. At this grade level, MA was moderately and significantly correlated with each aspect of reading ability (i.e., ranging between .55 and .67), and it was in a closer relationship with text level reading and reading comprehension. Additional analyses revealed that MA made a unique contribution to text reading fluency and reading comprehension above and beyond word reading speed. The researchers argued that in addition to its role in word recognition, MA might play an independent role in the meaning making process. They stated that MA should be taken into consideration as an important component of reading ability and utilized in instructional design and material development.

In another study, Wu et al. (2009) investigated the effects of MA training on literacy skills in Chinese. The researchers integrated the training program into Grade 1 language curriculum for one year. The treatment group and the control group were tested at Grades 1, 2 and 3. The findings indicated that in Grades 2 and 3, the treatment group outperformed the control group on MA and literacy measures, especially in terms of analyzing characters and morphemes. In Grade 3, it was found that MA training had positive and long-lasting effects on reading comprehension. The findings of the study seem to contradict with Adam's (1990) suggestion that children can benefit from MA only after acquiring some foundational reading skills, because the children were found to benefit from MA training during the early years of education. However, Wu et al. (2009) also found that while MA had a unidirectional relationship with literacy skills in Grade 2, this relationship became bidirectional in Grade 3, where MA was "an antecedent and cause of reading development" (p .45). This suggests that the connections between MA and reading ability become more complex at later stages of literacy acquisition.

Lyster (2002) argues that since morphemes have phonological features, morphological instruction could facilitate phonological skills and enhance word reading performance. In an experimental study with 237 Norwegian children attending pre-school education programs, Lyster aimed to test the effectiveness of phonological and morphological awareness training. Given the regularity of the letter-sound correspondences in Norwegian, she predicted that PA training would have moderate effects on reading while MA training would have stronger contributions. Upon the completion of training programs, the children were tested on reading five months before school entrance, at the time of school entrance, and at the end of Grade 1. The results showed that the PA and MA training groups outperformed the control group on the reading tests administered before school entrance and at the time of school entrance. At the end of Grade 1, the students in the MA training group outperformed the control group in terms of word identification, orthographic coding, and word/sentence/text reading. In addition, they outperformed the PA training group in the word reading measures. However, Lyster acknowledged that mothers' educational level was another influential factor contributing to the participants' reading performance, and it was a particular advantage for the children in the MA training group.

D'Alessio et al. (2019) investigated the role of MA in word decoding and reading comprehension in Spanish-speaking Grade 4 children. The results of the path analyses showed that MA made a direct contribution to reading comprehension but failed to predict word decoding skills in Spanish, in contrast to the findings in English. The researchers explain that the high regularity of the phoneme-grapheme correspondence rules in Spanish allows children decode words efficiently and with correct pronunciation. Therefore, MA is not involved in this process as a monitoring system to correct the pronunciation of the target word in case of a discrepancy between phonemic and graphemic representations. On the other hand, MA plays an important role in reading comprehension since it provides readers with sematic and syntactic knowledge of words in a reading text.

In a longitudinal study, Deacon and Kirby (2004) followed a group of English-speaking children between Grades 2 and 5, and examined the role of MA in different dimensions of reading (i.e., word reading, pseudoword reading, and reading comprehension). The findings revealed that MA made significant contributions to reading comprehension and pseudoword reading throughout the three-year period even after controlling for factors such as PA, intelligence and earlier reading skills. Although MA also predicted single word reading, its contribution was smaller.

In another study, Singson et al. (2000) investigated MA (i.e., knowledge of derivational morphemes) and decoding skills in English-speaking children between Grades 3 and 6. The findings showed that decoding skills, knowledge of derivational morphemes and phonemic awareness improved as the grade level increased. Another important finding of the study was that MA contributed to decoding ability beyond PA, and its predictive power tended to increase at higher grade levels. Singson et al. (2000) argue that the association between PA and MA in opaque languages is important as the combination of phonological and morphological representations takes place in a more “abstract” level in these orthographies (p. 219).

As for the role of MA in Turkish, Durgunoğlu (2017) explains that the role of morphological knowledge is particularly important in morphologically rich languages. Similarly, Babayiğit and Stainthorp (2010) suggest that the role of morphology is central in agglutinative languages, and grammatical knowledge could play an important role in the development of literacy skills in Turkish. Regarding the interaction between phonemic and morphemic knowledge, Durgunoğlu and Öney (1999) inform that the agglutinative nature of Turkish might facilitate PA skills of Turkish-speaking children since they focus on suffixation. In this way, they acquire higher levels of sensitivity for the phonemes at the word-final position and phonemic structure of words in general.

Although MA is reported to be an important factor in explaining reading development in Turkish, the number of studies which include MA as an independent variable is very limited (e.g., Akdemir, 2018; Babayiğit & Stainthorp, 2010; Bektaş, 2017; Kuzucu-Örge, 2018; Özata, 2018). In her study, Akdemir (2018) examined the relationship between RAN, PS, MA, vocabulary, WM, text reading fluency and comprehension of expository texts used in science education. The participants were eighty Grade 5 students, who were divided into the groups of adequate and poor readers based on their teachers' reports. The results of the study indicated that text reading fluency and vocabulary were the most powerful predictors of reading comprehension, and MA contributed to reading comprehension indirectly through vocabulary in the group of adequate readers. As for the poor readers, MA was the most important predictor of reading comprehension, making both direct and indirect (i.e., through vocabulary) contributions to this outcome variable.

Babayiğit and Stainthorp (2010) examined the role of grammatical awareness along with RAN and PA in the reading and writing skills of Turkish-speaking children across Grades 1 and 2. Their measure of grammatical awareness was a composite of MA and syntactic awareness. The findings of the study showed that grammatical awareness predicted spelling skills but not reading skills regardless of word type (i.e., word, nonword, agglutinated word reading) and task modality (i.e., isolated vs. in context). The researchers argue that during the early stages of development, grammatical skills might not play a reliable role in Turkish-speaking children's reading ability.

In another study, Özata (2018) investigated the relationships between a variety of linguistic and cognitive components and reading (i.e., word reading fluency and reading comprehension) in Turkish across Grades 2 and 4 ($N$ = 92). The findings revealed that RAN and orthographic knowledge (OK) were the most powerful predictors of word reading fluency in both grade levels. PA and PS made indirect contributions to word reading fluency through OK in Grade 2. In Grade 4, PA lost its effect, and PS remained as the only indirect predictor of word reading fluency. SES, vocabulary and word reading fluency made direct contributions to reading comprehension in both grade levels. As for the role of MA, it was found that MA was a significant predictor of vocabulary, and it had indirect contributions to reading comprehension through vocabulary knowledge both in Grade 2 and Grade 4.

In another study, Bektaş (2017) investigated the roles of RAN, PA, PM and MA in word and pseudoword reading skills of Turkish-speaking children in Grades 2 and 4. The results confirmed the previous findings in that RAN was the strongest predictor of word reading across grade levels, and PA lost its effect as the grade level increased. As for the role of MA, it was found that MA made a unique contribution to word and pseudoword reading skills in the sample ($N$ = 87). However, this effect was not consistently observed in the analyses conducted separately for Grades 2 and 4. Across grade levels, MA was found to make a contribution to word and pseudoword reading in Grade 2 but not in Grade 4. This contribution was significant only when MA entered into the equation after PM, and lost its significance upon the entry of RAN and PA.

In a similar study, Kuzucu-Örge (2018) examined the role of PA, RAN, PM and MA in word reading fluency across good and poor readers. The findings of the study showed that while reading fluency was significantly correlated with RAN and

PA in poor readers, it had significant correlations with PA and MA in good readers. PA was the most powerful predictor of reading fluency in poor readers, and RAN made an additional contribution to reading fluency in this group. On the other hand, MA was the only significant predictor of reading fluency in good readers. The researcher explained these findings by the developmental differences across the two groups. Accordingly, poor readers had lower-level word identification skills while good readers had moved into a more complex stage where semantic processes were involved in word recognition.

The research findings reviewed here so far show that MA is closely associated with phonological skills, vocabulary, decoding, word recognition and reading comprehension across different languages (see Kuo & Anderson, 2006, for a review). Still, investigating the role of MA in Turkish is particularly important to understand the complexities of reading ability in morphologically rich languages.

## 2.7 Executive functions and reading

Executive function (EF) is the higher-level cognitive control mechanism which is utilized for the achievement of a particular goal. Evidence from neuroimaging studies has shown that normally developing children have high levels of activation in their prefrontal cortex (signaling the involvement of EF) when they are dealing with a specific task (Moriguchi & Hiraki, 2013). Miyake et al. (2000) suggested that EF is composed of three main components which are working memory (updating), shifting and inhibition. Although these three dimensions are related to each other, they are viewed as separate constructs.

Given the fact that readers are engaged in an online process of building and integrating knowledge as they read, EF becomes relevant in the storage, use and coordination of information coming from different sources. In the envisionment building theory, Langer (2011) suggests that as readers start reading, they build envisionments, which are continuously shaped by the upcoming events, characters or situations described in the text, and integrate this information into their background knowledge. Langer (2011) explains this process as follows:

> Envisionments represent our understanding and questions at a particular point in time. They are always open to new input and fresh perspectives. Envisionment building is enriched by the variety of stances that we take toward the evolving envisionment: getting started with the material, developing understanding, learning from the material, thinking critically and going beyond. (p. 27)

Given the continuous evolution of information during a reading activity, EF is likely to play an important role in storing and using information, relying on previous knowledge to construct meaning and switching between different topics and ideas presented in a text (Jacobson et al., 2017). Cartwright (2012) states that since EF and reading skills develop concurrently, it is important to investigate EF to understand and facilitate reading development in children. In the current study, working memory (WM) and inhibitory control (IC) were taken into account as the main indices of EF. Thus, the following parts provide a review of the literature with a focus on the links between WM, IC and different aspects of reading.

### 2.7.1 Working memory and reading

Working memory (WM) is an important index of executive functioning. It is a multicomponent cognitive mechanism (including the central executive, phonological loop and visuospatial sketchpad) which stores and processes information for a brief period of time (Baddeley, 2000). WM is often reported to play a central role in reading (e.g., Just & Carpenter, 1992; Perfetti et al., 2005) as the reader has to synthesize information coming from different sources and retain necessary points from the previous parts of the text when, at the same time, dealing with the upcoming information (Oakhill, Hartt, & Samols, 2005). Cain et al. (2004) suggest that reading comprehension requires the reader to construct a coherent model of the text, and in this process, integration and inference skills facilitate local and overall coherence respectively (p. 31). At this point, the information provided by the text along with prior knowledge should be accessible to the reader, and WM is likely to come into play while the reader is trying to integrate recently processed propositions with the current information.

In their early study, Daneman and Carpenter (1980) found that WM was correlated with reading comprehension in college students, and suggested that WM played an important role in a number of critical skills such as analyzing pronouns, making inferences about the meanings of unfamiliar words, and remembering facts. Similarly, Daneman and Merikle (1996), who conducted a meta-analysis on the connections between WM and language comprehension, reported that WM had a correlation of .41 with a variety of language comprehension measures including vocabulary knowledge and reading comprehension.

Evidence shows that good and poor comprehenders differ in terms of their verbal WM (e.g., Cain et al., 2004). In their longitudinal study, Cain et al. (2004) found that WM was a significant predictor of reading comprehension in a group of children aged between 8 and 11. In a similar study, Oakhill et al. (2005) examined the associations between comprehension monitoring strategies and WM across good and poor comprehenders (aged 9-10), who were matched in terms of vocabulary and word recognition. The findings showed that the participants did not differ in terms of detecting word-level anomalies. As for the detection of sentence level anomalies, it was found that poor comprehenders had difficulty especially when the contradictory information was presented in separate sentences instead of adjacent sentences. Good comprehenders were better at making inferences and synthesizing information presented in different parts of the given text. WM was not related to word level error detection while it was moderately related to sentence level error detection and comprehension test scores. Poor comprehenders were found to have lower WM capacity when compared to good comprehenders. The authors explained that poor comprehenders managed to integrate local information but failed to integrate information from different sections as they could not build comprehensive text models for the whole text due to their superficial representations.

In another study, Seigneuric and Ehrlich (2005) investigated the role of WM, nonword decoding and vocabulary in the development of reading comprehension in French-speaking children across Grades 1 and 3. Based on the simple view of reading, the researchers assumed that decoding would be more effective in the early years of reading development while the effects of vocabulary and WM would increase at later stages. In line with their assumptions, the results showed that decoding was the strongest predictor of reading comprehension in Grade 1 and its predictive power tended to decrease as the grade level increased. On the other hand, vocabulary, another significant predictor, tended to explain more variance in reading comprehension in higher grade levels. WM made a unique contribution to reading comprehension in Grade 3 only. Another finding was that vocabulary measured in Grade 1 and WM measured in Grade 2 had additional effects on reading comprehension in Grade 3. The researchers explain that after a certain level of automatization is gained in decoding, factors related to linguistic comprehension (i.e., vocabulary and WM) start to exert more influence on reading comprehension.

Georgiou, Das and Hayward (2008) investigated the effects of WM along with PA and RAN on word reading and reading comprehension in English-speaking children in Grades 3 and 4. Their results showed that WM explained unique variance in word reading only when the effect of age was partialled out. When RAN and PA were entered into the equation as independent and significant predictors, WM did not contribute to word reading in English. On the other hand, WM continued to be a significant predictor of reading comprehension upon the inclusion of RAN and PA in the model. The authors suggested that WM played a more important role in reading comprehension when compared to word-level reading skills.

In Turkish, Babayiğit and Stainthorp (2011) predicted that WM would emerge as a longitudinal predictor of late reading comprehension through its contribution to earlier reading comprehension across Grades 2-3 and 4-5. The researchers found that WM had similar correlations with different reading outcomes (around .30), and its contribution to RC was small and marginally nonsignificant when included in the regression model along with listening comprehension. Babayiğit and Stainthorp suggested that further research with a focus on the subcomponents of WM is needed for a clearer understanding of its role in reading comprehension.

### 2.7.2 Inhibitory control and reading

Inhibitory control (IC), also known as attentional control, is the ability to ignore redundant information and focus on relevant cues for the completion of a task (Gathercole & Baddeley, 1993). It is likely that IC is involved in reading comprehension especially when readers suppress irrelevant information and focus on a specific part in a reading text (Cain, 2006). In comparison to the considerable amount of research on WM, less is known about the connections between IC and reading. Most of the recent studies examine the role of IC along with WM and other predictors of reading. In the following part, some of these studies are reviewed.

In a recent study, Jacobson et al. (2017) investigated the effects of WM, strategic problem solving and attentional switching in a set of different reading outcomes beyond the role of RAN, PA, vocabulary and processing speed in a large sample of children and adolescents (aged between 8 and 16) from diverse racial and ethnic backgrounds. The findings showed that WM was a significant predictor of single word reading, contextual word reading, reading fluency and reading comprehension in English. Attentional switching made a unique contribution to word recognition and reading fluency, but not to reading comprehension. This was an unexpected result as the authors hypothesized that attentional switching would be involved in discriminating between necessary and redundant information while reading a text. The authors explained this finding with the difference between the nature of the attentional switching task (timed) and reading comprehension test (untimed). Another finding was that problem solving significantly contributed to reading comprehension. In general, the variance explained by EF skills was greater in higher-level reading outcomes (contextual word reading, fluency and comprehension) than in single word reading.

In another study, Engel de Abreu et al. (2014) investigated the influence of WM, cognitive flexibility, selective attention and inhibition on the reading achievement of normally developing Brazilian children (aged 6 to 8), who were rated by their teachers as good and poor readers. Factor loadings for 12 EF tasks used by the researchers showed that WM and cognitive flexibility measures loaded on the same factor, and three different components of attentional control, namely interference suppression, selective attention and response inhibition loaded on distinct factors. Reading achievement ratings (decoding and reading comprehension) had the strongest correlations with the WM/cognitive flexibility factor. It was also found that poor readers had significantly lower scores on the WM/cognitive flexibility factor. On the other hand, the two groups did not significantly differ from each other in terms of the other EF skills. The authors explained that these findings reflected the case of normally developing readers.

In a different study, Altemeier et al. (2008) investigated the effects of inhibition, rapid automatized switching, and a combination of inhibition/switching on a set of reading measures in English. The researchers conducted two experiments including normally developing children and children diagnosed with dyslexia. In the normally developing group, it was found that increased inhibition from Grade 1 to Grade 4 was a significant predictor of word reading and spelling in Grade 4. Another finding was that EF predicted untimed word/pseudoword reading measures (accuracy) to a greater extent in earlier grades, and its influence tended to decline towards the later stages. The authors explain that decoding is an effortful task for beginning readers, and they might rely on inhibitory control in order to suppress irrelevant information during word recognition. As for the timed measures, the role of EF in fluency increased along with the grade level and was steady during the later stages. Unexpectedly, the contribution of inhibition to reading comprehension was relatively weak. Altemeier et al. explain that inhibition might be more related to lower-level reading skills (decoding) as “inhibition and set shifting occur moment to moment in linking letters and sounds” (p. 602), and other EFs such as planning and problem solving are more associated with higher-level reading skills. In the dyslexic group, Altemeier et al. found that EF accounted for less amount of variance in reading and writing skills, and boys had lower scores in inhibition and inhibition/switching measures when compared to girls.

Altemeier et al.'s explanation about the involvement of inhibition in lower-level reading processes could be supported by McClelland and Rumelhart's (1981) early model of letter perception. In their model, McClelland and Rumelhart proposed that upcoming visual information is processed in a parallel way, in which elements go through a competition via excitatory and inhibitory connections. The elements which have higher amounts of excitation lead to the inhibition of other elements in competition, and the information processing system chooses one specific interpretation of the presented material. The authors exemplify letter perception with the processing of *work*, which will trigger other competitors such as *weak*, *wear* and *word* (p. 383). Accordingly, *word* will rise as a possible candidate as most of its letters are consistent with *work,* and will be eliminated due to the ongoing competition. On the other hand, *wear* and *weak* will be inhibited by the system more quickly as they share only the first letter of the target word. This process could be the interface where the IC mechanism becomes involved in word-level reading.

In another study, Christopher et al. (2012) examined the role of EF (WM and inhibition) and speed measures (processing speed and naming speed) in word reading and reading comprehension. The participants were English-speaking students aged between 8 and 16 ($N$ = 483). The findings of the study showed that speeded naming of non-alphanumeric stimuli (i.e., naming objects or colors) failed to make any significant contributions to the reading outcomes. When alphanumeric (i.e., letters and digits) naming tasks were included in the analyses, it was found that naming speed made a unique contribution to word reading. According to Christopher et al. (2012), this finding shows that the close association between naming speed and word reading is based on the ability to recognize and use alphanumeric stimuli rather than the ability to "overtly name stimuli" (p. 483). As for the roles of PS, WM, and inhibition, it was found that PS and WM were significant predictors of both word reading and reading comprehension. On the other hand, inhibition failed to make a unique contribution to the reading outcomes. While PS had a closer relationship with word reading, WM was equally important for word reading and reading comprehension. Regarding these differences, the authors explain that although word reading and reading comprehension are closely associated with each other, they are separable aspects of reading ability.

In a longitudinal study, Welsh, Nix, Blair, Bierman, and Nelson (2010) investigated the developmental trajectories of WM, IC, early literacy (i.e., elision, blending and print awareness) and numeracy skills of children coming from low-income families in the USA. They assessed the children at the beginning of their pre-kindergarten year, at the end of the year, and lastly at the end of kindergarten. The results showed that WM and IC predicted the improvement in literacy and numeracy skills during the pre-kindergarten period. Additionally, growth in WM and IC contributed to math and reading skills (i.e., a composite of letter-word identification, word/pseudoword reading, and story recall) which were measured at the end of kindergarten.

In a recent study, Nouwens, Groen, Kleemans and Verhoeven (2020) investigated the role of Grade 4 EF skills (WM, inhibition and planning) on Grade 5 reading comprehension in Dutch-speaking children. The results of the study showed that planning and WM had direct effects on reading comprehension. It was also found that inhibition and WM contributed to reading comprehension via decoding skills. In line with this finding, Papadopoulos et al. (2016), who investigated the nature of the RAN-reading relationship in Greek, found that both WM and IC played important roles in explaining how RAN was related to reading fluency. The authors suggested that the inconsistent findings in the literature as to the roles of WM and IC in reading might have resulted from the fact that they were often investigated along with RAN, which possibly masked their indirect effects in mediating the RAN-reading relationship.

In another recent study, Chang (2020) investigated the relationship between EF and reading comprehension in a large sample of English-speaking kindergarten children (around 18.000) who were followed into Grades 1 and 2. It was found that inhibition, WM and cognitive flexibility measured at kindergarten made unique contributions to reading comprehension in Grade 2, with WM having the largest total effect. Another finding was that linguistic skills (i.e., story interpretation) and reading fluency which were measured in Grade 1 played a mediating role in the relationship between EF and reading comprehension.

With a focus on the EF differences across different reader profiles, De Beni and Palladino (2000) found that good comprehenders performed significantly better than poor comprehenders in inhibiting unnecessary information on a WM measure. In a similar study, Cain (2006) found that although good and poor comprehenders show similar performances on simple short-term memory tasks, poor comprehenders were significantly worse than their counterparts in inhibiting irrelevant information on more complex recall tasks in a set of WM measures. On the other hand, van der Sluis, de Jong, and van der Leij (2004) found that children with reading difficulty did not differ from normally developing children in terms of their IC skills. However, children with arithmetic problems and children with both reading and arithmetic problems were found to have impaired performance in a number of shifting tasks.

In a cross-linguistic study, Lan et al. (2011) examined the role of EF in predicting academic achievement (i.e., word recognition, simple math and complex math) in American and Chinese preschool children. The findings of the study showed that inhibition failed to predict word recognition in either language. On the other hand, WM was a significant predictor of word recognition in Chinese but not in English. The authors explain that reading in a logographic orthography might have placed greater demands on WM when compared to reading in the alphabetical system of English.

In a comprehensive meta-analysis, Follmer (2018) reported that EF was moderately correlated with reading comprehension across different age groups and measures. Accordingly, evidence consistently showed that the contribution of EF to reading comprehension was beyond factors such as vocabulary, decoding, word recognition and reading fluency. Follmer informed that although most of the recent studies focused on the unidirectional influence of EF on reading achievement, EF and reading had a bidirectional relationship, and the improvements in academic abilities might contribute to the development of EF skills.

Overall, evidence from numerous studies shows that reading ability is built upon several factors such as PA, RAN, MA, vocabulary, PS, WM, and IC. Still, further research is needed to see how these components play a role in predicting reading fluency and reading comprehension across different languages, especially in transparent orthographies such as Turkish. The following chapter will examine the orthographic, phonological and morphological features of the Turkish language, and review the policies and practices in literacy education at the Turkish school settings.

# CHAPTER 3

# CHARACTERISTICS OF THE TURKISH LANGUAGE AND LITERACY INSTRUCTION IN TURKISH

This chapter presents orthographic, phonological, and morphological characteristics of the Turkish language. It also provides information about the current methods of teaching literacy skills at the Turkish schools settings, along with a brief review on the efficiency of these methods.

Turkish is a member of the Turkic language family, and the number of its speakers accounts for 40 per cent of the total number of people speaking Turkic languages (Kornfilt, 1997). It is estimated that over 80 million people speak Turkish across the world, with most of the population living in the Republic of Turkey (Durgunoğlu, 2017). As an Altaic language which originated in Central Asia and later expanded across Anatolia, Turkish is closely related to the varieties spoken in Azerbaijan and several other countries in Central Asia (e.g., Turkmenistan, Uzbekistan) (Durgunoğlu, 2017).

## 3.1 Turkish orthography

During the early years of Anatolian period, Turkish was written in the Arabic script (Kornfilt, 1997) under the influence of Islam. After the foundation of the Turkish Republic, several reforms which were designed to westernize the country were introduced to the Turkish society. One of the most influential reforms aimed to change the writing system by adopting the Latin alphabet in 1928. The new Turkish alphabet was highly transparent in which each letter corresponded to one particular sound in a systematic manner. The regularity between letters and sounds of Turkish was observed in two ways: from graphemes to phonemes and from phonemes to graphemes. Besides the aim of modernizing the country, this system was adopted to increase literacy rates rapidly in the society (Durgunoğlu, 2017).

The modern Turkish alphabet includes 29 letters. Of these, 21 letters correspond to consonant sounds while 8 letters represent vowel sounds. Unlike other consonants in the alphabet, consonant *ğ* has a special feature, which causes a shift or lengthening in the preceding vowel (Ergenç, 1991). In addition, this letter cannot be found at word-initial positions since it does not have a clear pronunciation in the standard variety of Turkish. While consonant clusters can be found at word-final positions (e.g., *üst* ‘top’), they are not allowed at word-initial positions with the exception of borrowed words such as *spor* ‘sports’.

It is known that the regularity of the Turkish orthography allows Turkish-speaking children to master decoding at the very early stages of literacy acquisition (Durgunoğlu & Öney, 1999). The consistency in phoneme-grapheme mappings enable children to read words twice as faster than their English-speaking peers, who try to acquire literacy skills in an opaque orthography. In their study, Öney and Durgunoğlu (1997) found that Turkish-speaking children reached ceiling levels for decoding and spelling accuracy by the end of Grade 1. For this reason, the role of word decoding (i.e., accuracy) was limited in predicting reading comprehension in Turkish. On the other hand, listening comprehension continued to predict reading comprehension for a longer period of time. The authors argued that once children mastered decoding in Turkish, reading speed, rather than accuracy might be more related to reading comprehension in this highly transparent orthography.

Despite the high regularity in phoneme-grapheme correspondence rules, the silent letter *ğ*, voicing assimilations (e.g., *dolap* ‘cupboard’ vs. *dolabı* ‘cupboard -

Acc.'), destressing of consonant doublets, dialectal differences and variations in daily speech (e.g., pronouncing *geliyorum* 'come -Pr. Prog. -1.sg.' as *geliyom*) could pose some challenges for Turkish-speaking learners and cause them to produce spelling errors (Durgunoğlu, 2017).

## 3.2 Turkish phonology

Syllables are highly salient units of Turkish phonology with a limited range (i.e., mostly appearing in the forms of V, CV, VC, and CVC) and CV being the most common syllable type (Durgunoğlu, 2017; Durgunoğlu & Öney, 1999). Vowels are the syllabic units, and there are no syllabic consonants in Turkish. The syllabic saliency is so strong that it overrides the morphological structure of words (Durgunoğlu, 2017) when dividing them into syllables (i.e., *kuşa* 'bird -Dat.' is divided into syllables as *ku-şa* instead of *kuş-a*). In addition to the fact that consonant clusters do not appear at the beginning of words, the limited number of syllable types and high levels of syllabic saliency allow Turkish-speaking children to decode words faster and divide them into smaller units more easily when compared to their English-speaking peers (Durgunoğlu & Öney, 1999).

Based on their place of articulation, Turkish consonants could be categorized as bilabial, labio-dental, dental, alveolar, alveo-palatal, palatal, velar and glottal sounds. They are also classified, based on the manner of articulation, as plosives, affricates, fricatives, nasals, taps, laterals and glides. Voicing is another feature which differentiates these sounds as voiced or voiceless consonants. Table 1 presents the inventory of consonant sounds in Turkish.

Table 1. Turkish Consonants

| | | Bilabial | Labio-dental | Dental | Alveolar | Alveo-palatal | Palatal | Velar | Glottal |
|---|---|---|---|---|---|---|---|---|---|
| Plosives | *voiceless* | *p* | | *t* | | | *c* | *k* | |
| | *voiced* | *b* | | *d* | | | *ɟ* | *g* | |
| Affricates | *voiceless* | | | | | *tʃ* | | | |
| | *voiced* | | | | | *dʒ* | | | |
| Fricatives | *voiceless* | | *f* | *s* | | *ʃ* | | *ɣ* | *h* |
| | *voiced* | | *v* | *z* | | *ʒ* | | | |
| Nasals | *voiced* | *m* | | *n* | | | | | |
| Tap (Flap) | *voiced* | | | | *ɾ* | | | | |
| Lateral | *voiced* | | | *ɫ* | | *l* | | | |
| Glide | *voiced* | | | | | | *j* | | |

Source: Erguvanlı-Taylan (2007, p. 17).

The velars */k/* and /*g*/ are palatalized and turn into /*c*/ and /*ɟ*/ in some words such as *kağıt* ‘paper’ and *gavur* ‘infidel’ as opposed to words such as *kafa* ‘head’ and *gaz* ‘gas’. The lateral consonant could be pronounced as an alveo-palatal /l/ as in *hâlâ* ‘still’ or as a dental */ɫ/* as in *hala* ‘aunt’. Soft g, which corresponds to the letter *ğ* in Turkish, is represented by /*ɣ/*, and it lengthens the preceding vowel as in the pronunciation of *dağ* ‘mountain’ as /da:/.

Turkish vowels are categorized as high, mid and low vowels based on the height of the tongue during articulation. They are also classified as front and back vowels based on the position of the tongue in the oral cavity. Lastly, they are divided into round and non-round vowels according to the position of the lips. Table 2 presents the inventory of vowel sounds in Turkish.

Table 2. Turkish Vowels

| | Front | | Back | |
|---|---|---|---|---|
| | Non-round | Round | Non-round | Round |
| High | *i* | *y (ü)* | *ɯ (ı)* | *u* |
| Mid | *e* | *œ (ö)* | | *o* |
| Low | *ɛ* | | *a* | |

Source: Erguvanlı-Taylan (2007, p. 10).

Vowel clusters are not allowed in Turkish. However, one can find examples of this phenomenon in many of the borrowed words such as *aile* 'family' and *ziraat* 'agriculture'. Another feature about the Turkish vowels is vowel harmony, which has two sub-types called the fronting harmony and rounding harmony (Göksel & Kerslake, 2006). In fronting harmony, any of the eight vowels can be found in the first syllable, but it conditions the following vowels appearing in the other syllables of the word based on frontness and backness. For instance, the plural suffix could be used in the forms of *-ler* or *-lar* to inflect the words *top* 'ball' as *toplar* and *tip* 'type' as *tipler* in accordance with the vowel harmony (Durgunoğlu, 2017, p. 440). Borrowed words could violate vowel harmony as in the example of *silah* 'weapon', or *hakim* 'judge', which have Arabic origins. Still, the suffixation process of these words takes place according to the rules of vowel harmony, based on the last syllable: *silahlar* 'weapons' and *hakimler* 'judges'.

Rounding harmony places some constraints on the occurrence of vowels within words based on the position of lips. Accordingly, non-round vowels could be followed by non-round vowels only, (i.e., *kedi* 'cat' is in line with rounding vowel harmony whereas *filo* 'fleet' violates it) while round vowels could be followed by non-round mid-low vowels (*a, e)* or round high vowels *(u, ü)* as in the words *mola* 'break' or *dolu* 'full'. This means that /*o*/ and /*œ*/ (ö) could be found only in the initial syllable of a word, and therefore, words such as *doktor* ‘doctor’ violate rounding harmony. One exception to this rule is posed by the imperfective suffix -*(I)yor* (Göksel & Kerslake, 2006), which could be attached to all kinds of verbs regardless of their vowel structure. Additionally, fronting and rounding harmony do not apply to compound nouns which are written as one word in Turkish (e.g., *bilgisayar* ‘computer’, *başçavuş* ‘master sergeant’).

Durgunoğlu and Öney (1999) inform that even during pre-school years, Turkish-speaking children develop phonological awareness rapidly, especially when they are dealing with syllables and word-final phonemes. This process is probably facilitated by the syllable saliency in Turkish, and the necessity to pay attention to the word endings as each morphological unit attached to the end of words could take on different phonological forms in line with vowel harmony and voicing assimilation (Durgunoğlu, 2017). In their study, Durgunoğlu and Öney (1999) found evidence for the contribution of these language specific characteristics to the literacy skills of Turkish-speaking children. Their results showed that when compared to their English-speaking peers, Turkish students had higher scores in manipulating syllables and final phonemes of identical pseudowords. In line with this finding, Babayiğit and Stainthorp (2010) found that Turkish-speaking children’s phonological awareness was correlated with their morphological and syntactic knowledge in Grade 1.

### 3.3 Turkish morphology

Turkish is an agglutinative language with a rich morphological system, in which inflected and derived words are formed through suffixation. This means that instead of prepositions, postpositions are used (i.e., *masa -da* ‘table -Loc.’) in order to change the morphological structure of a given word (Durgunoğlu, 2017). Although there exist words with prefixes, they are rather limited in number, and come from languages such as Persian (e.g., *bi- çare* 'helpless', *na- mert* 'vile', *hem- zemin* 'level'). Prefixation can also be used in order to modify adjectives and adverbs and to express degrees of quality (Kornfilt, 1997) by reduplication (e.g., *uzun* 'long', *up-uzun* 'very long'). Turkish suffixes mark several elements in nouns such as number, person, aspect, modality, mood and voice while they can mark tense, negation and person in verbs (Durgunoğlu, 2017).

Turkish morphology is a rich and productive system, allowing for iterative loops of inflectional and derivational suffixes. This means that technically, words with infinite length could be produced in Turkish (Durgunoğlu, 2017), and this trait allows for the formation of very long words, which, sometimes, could correspond to full sentences in English (e.g., *Gör-üş-tür-ül-e-me-ye de bil-iyor mu-ydu-nuz?* 'Did it also sometimes happen that you were not allowed to see each other?') (Göksel & Kerslake, 2006, p. 48).

Despite this complexity, suffixation in Turkish follows a certain order, which allows for a smooth transition between its morphological units. For example, derivational morphemes are used in the first place, and inflectional morphemes follow them (e.g., in the word *kitap -çı -lar* 'book sellers', the suffix *-cı* derives *kitapçı* 'someone who sells books' from *kitap* 'book', and the plural suffix *-lar* comes after). It is not possible to use this suffixation in an alternative way such as **kitaplarcı*. Another suffixation rule is that tense markers precede person markers (e.g., *yürüdüm* 'walk -Past -1.sg.' rather than **yürümdü*). Higher number of inflections attached to a word reduces the number of possible candidates for further suffixation, and these processes enable Turkish speakers to utilize probabilistic information on morphotactics and to know which suffixes are likely to follow in a given word (Durgunoğlu, 2017, p. 441). Turkish suffixes could have different phonological forms based on the rules of vowel harmony or voicing assimilation on the final sound, and all these changes are demonstrated in the printed versions of words (Öney & Durgunoğlu, 1997). For instance, the perfective suffix *-ti* could take on many different forms (i.e., *-dı, -di, -du, -dü, -tı, -ti, -tu, -tü*) in order to mark past tense (Göksel & Kerslake, 2006) in Turkish verbs (e.g., *Ders başla -dı* ve *bit -ti* 'The class start -Past and finish -Past').

The fact that Turkish has a rich and complex morphology, and each morphological unit has a unique function in a certain environment makes morphological knowledge central in the meaning making processes in this language. For this reason, sensitivity to morphological structure of words is reported to develop at the very early stages of language acquisition in Turkish (Aksu-Koç & Slobin, 1985). In their study, Aksu-Koç and Slobin (1985) found that by 24 months of age, normally developing Turkish children used noun inflections and most of the verb inflections skillfully in their speech, and they did not demonstrate errors in vowel harmony and voicing assimilation.

As previously stated, person can be marked at the end of Turkish verbs. For this reason, Turkish is a pro-drop language in which the overt subject could be dropped in a sentence even when the antecedent is not previously mentioned (Kornfilt, 1997). The same rule applies to the marking of the possessor in noun clauses. Overt subjects and possessors are used in sentences based on the contextual requirements such as topic change or emphasis.

Word order is highly flexible in Turkish although the most common type is reported to be the canonical subject-object-verb (SOV) (Kornfilt, 1997). The pro-drop nature of the language contributes to the flexibility of word order, and despite the common SOV structure, the first noun phrase could often be the object of a sentence. Therefore, the distinction between objects and subjects is made according to the suffixation in Turkish (Durgunoğlu, 2017) as in the following example:

(a) *Ali ev-i sat-tı*. ‘Ali house -Acc. sell -Past.’

(b) *Evi Ali sattı*. ‘House -Acc. Ali sell -Past.’

In both of the sentences above (Göksel & Kerslake, 2006, p. 343), the subject is *Ali* while the object is *evi*. Both sentences are grammatical; however, they are used in different contexts. In (a), the stress is generally placed on *evi* ‘the house’, and the hearer will know that it is the house but not any other type of building which was sold by Ali. In (b), on the other hand, the stress is mostly placed on Ali, directing the hearer to focus on the fact that it was Ali, and not someone else, who sold the house.

### 3.4 Literacy instruction in Turkish

The national education system in Turkey has witnessed many alternations and regulations with changing governments and ministers. In 1997, eight years (Grades 1-8) of elementary education became compulsory for all children in the country, and primary schools (Grades 1-5) and secondary schools (Grades 6-8) were integrated into a single unit. Starting from the 2012-2013 academic year, the regulations of compulsory education were updated to include a twelve-year period, which is divided into three stages, each including four years of formal education (known as 4 + 4 + 4 system). Accordingly, Turkish children receive primary education during Grades 1-4, secondary education during Grades 5-8, and high school education during Grades 9-12 (MEB, 2012). As the physical and psychological development differs across primary and secondary school children, school buildings from the previous eight-year system went through reconstruction so that students from different stages attend classes in different schools or buildings. Pre-school education is not included in the compulsory system, and with the latest regulations, children at the ages of 36-68 months could be registered at pre-school education programs.

For many years, as a top-down way of teaching reading skills, the Sentence Method (SM) was used by primary school teachers. In this method, full sentences were introduced to students in the first place and they were asked to divide these sentences into words, syllables and phonemes in the following stages. For this reason, activities related to letter-sound relationships took place towards the end of the school year (Baydık & Bahap-Kudret, 2012). In 2004, the Ministry of National Education (MoNE) replaced the SM with the Sound Based Sentence Method (SBSM), which was a bottom-up approach focusing on teaching letter-sound relationships first, and asking students to combine these sounds to make syllables, words and sentences. Along with the introduction of the SBSM, cursive handwriting became compulsory for the teaching of spelling skills in Turkish. However, this was later changed into printing in 2017, following the negative comments in the nation-wide surveys conducted by MoNE.

Unlike the SM, the SBSM places more emphasis on the use of activities related to phonological awareness, and is believed to be a suitable method for Turkish, which has highly regular phoneme-grapheme correspondence rules (Baydık & Bahap-Kudret, 2012). The SBSM is integrated into the teaching of reading, writing, listening and speaking skills in Turkish, and requires students to combine sounds to form meaningful syllables, words, sentences and texts. As it facilitates the construction of information in a sequential manner, the SBSM is reported to be in line with the constructivist learning approach (MEB, 2009, p. 233). In addition, unlike the SM, the SBSM focuses on diversity (i.e., a wide variety of syllables, words and sentences) rather than using a limited number of formulaic sentences. This prevents students from memorizing sentences and contributes to the development of core thinking skills, creativity, attention, and comprehension. Furthermore, as the SBSM enables students to gain awareness of the sounds they hear and produce, it facilitates fluency, distinguishing sounds, correct pronunciation and spelling (MEB, 2009, p. 233). In this way, students see the similarities between reading and writing, and experience a smooth transition from spoken language to written language.

In the SBSM, the sounds are categorized based on their frequency of occurrence and ease of production, and introduced to students in small sets. In the current practice (MEB, 2019), the presentation of the sound sets is as follows:

| | | |
|---|---|---|
| Group 1: e-l-a-k-i-n | Group 2: o-m-u-t-ü-y | Group 3: ö-r-ı-d-s-b |
| Group 4: z-ç-g-ş-c-p | Group 5: h-v-ğ-j-f | |

Studies investigating teacher views on the efficiency of the SBSM have revealed mixed results. While some teachers believe that this method contributes to the acquisition of reading skills (e.g., Arslantaş & Cinoğlu, 2010; Tok, Tok, & Mazı, 2008), others think that the SBSM could negatively affect some aspects of reading in Turkish (e.g., Durukan & Alver, 2008; Erkul & Erdoğan, 2009).

In their study, Arslantaş and Cinoğlu (2010) interviewed with thirty primary school teachers. Although the teachers reported that the SM had a positive influence on reading speed, they found the SBSM highly useful especially in terms of starting to read, spelling and reading comprehension. Similarly, Tok et al. (2008) examined the views of 157 primary school teachers on the comparison of the SM and the SBSM in teaching literacy skills. According to their findings, the teachers believed that the SBSM was more in line with the phonological characteristics of Turkish, and it helped students start reading more quickly. On the other hand, they suggested that the SM enabled students to read faster, pay more attention to punctuation marks, and make sense of the reading text to a higher extent.

In another study, Durukan and Alver (2008) interviewed with eight primary school teachers who suggested that the SBSM accelerated the acquisition of reading and spelling skills in Turkish. However, the teachers also indicated that in this method, students might have some problems in reading comprehension especially at the early stages of training. They argued that the SM could be more efficient in the teaching of comprehension skills. Similarly, Akman and Aşkın (2012) interviewed with 18 teachers, and in general, the teachers criticized the SBSM believing that it had negative effects on the meaning making processes. They reported that they had difficulty in using the method, and a top-down method should be implemented to help students comprehend what they read.

In another study, Erkul and Erdoğan (2009) investigated the problems faced by teachers during the implementation of the SBSM method. They collected data from 26 primary school teachers and their reports revealed that students had difficulty in sensing and producing consonants, reading words correctly, and understanding the texts they read. Students were also reported to read slowly, and to be misguided by their parents about the pronunciation of sounds. In addition, the participating teachers reported some issues about the lack of materials and insufficiency of related activities in the coursebooks. They also argued that they had not received adequate training about the SBSM method.

Akyol and Temur (2008) compared the efficiency of the SBSM and the SM in the reading performances of Grade 1 students (*N* = 18) attending two different schools. In each group, there were students with high, mid and low reading performance, as reported by their teachers. The findings of the study revealed that the performance in reading speed and comprehension was similar across the groups with the SBSM being slightly more advantageous for high achievers; and the SM yielding slightly better results for mid achievers. The authors argued that many other factors such as the quality of literacy resources available to the child, home literacy environment, pre-school education, parental support, and individual differences (e.g., motivation) could contribute to the reading outcomes. As high and mid achievers were more likely to take advantage of these additional factors, they were reported to become proficient readers regardless of the method. As for low achievers, the results showed that the ones in the SM group had greater difficulty in completing the reading task. Therefore, the authors suggested that the SBSM could be a better option for teaching literacy to children with low levels of reading skills.

In another study, Bay (2010) followed 144 Grade 1 students for eight months and investigated the influence of the SBSM on the students' literacy development. The findings showed that most of the students made a really good progress in terms of their reading and writing skills (85 %), and out of 144, 141 students started to decode words successfully in a short period of time. In addition, the SBSM was found to contribute to skills such as pronouncing sounds, reading visual materials and oral expression in children with learning difficulties. According to the author, these findings indicated that the SBSM was an efficient way of teaching literacy skills at primary schools.

In a different study, Baydık and Bahap-Kudret, (2012) interviewed with 13 primary school teachers who were teaching Grades 1-3 about the SBSM. In general, the teachers believed that the method accelerated learning to read for both normally developing students and struggling readers. Eight teachers noted that they integrated the SBSM into the previous curriculum in which they had to use the SM. The teachers also reported that when compared to the SM, it took students a bit longer to achieve reading fluency and comprehension in the SBSM. However, they informed that once students started reading fluently, they had no difficulty in understanding what they read; and the SBSM freed students from rote learning as they could apply phonological rules to novel words and sentences. Three teachers argued that an eclectic approach could be adopted and the SM could also be utilized to optimize reading outcomes in the classroom.

The findings from the literature have shown that primary school teachers have mixed opinions about the efficiency of the SBSM. Overall, the method is commonly reported to work better for bottom-up skills and facilitate speeded reading in the consistent orthography of Turkish. On the other hand, the SBSM is reported to pose some problems for top-down processing skills, which could have negative consequences on reading comprehension.

This chapter has provided information on the characteristics of Turkish and portrayed the details of literacy instruction at the Turkish school settings along with a brief review on the recent literature. The next chapter will present the methodology of the current study.

# CHAPTER 4

# METHODOLOGY

This chapter provides information about the methodology of the current study with a focus on the research design, participants, data collection instruments, procedure, research questions, research hypotheses and the statistical analyses.

## 4.1 Research design

The current study had a cross-sectional research design in which the concurrent relationships of PA, RAN, MA, vocabulary, PS, WM, IC, text reading fluency (TRF) and reading comprehension (RC) were examined in Turkish.

## 4.2 Participants

The participants were 112 Turkish-speaking students attending Grade 4 at a state school in the city of Burdur, Turkey. At the beginning of the data collection, 148 students participated in the test of reading comprehension, which was administered collectively in the classrooms. As two of the participants were immigrant students (one Somalian and one Afghan), their tests were excluded from the study. Of the remaining 146, 120 students volunteered to take part in the individual test sessions. Eight students were found to be univariate outliers and removed from the sample. Table 3 presents the demographic information about the participants including gender and age (in months).

Table 3. Participant Demographics

| Gender | | | Age (months) $\bar{x}$ | SD |
|---|---|---|---|---|
| Male | 66 | (59 %) | | |
| Female | 46 | (41 %) | | |
| Total | 112 | | 119.5 | 4.1 |

The participating children were all monolingual speakers of Turkish with no documented learning difficulties or sensory deficits. Although the children had English classes (two hours per week) at school, they could not be defined as bilinguals due to the introductory nature of the course content. The rationale behind the selection of Grade 4 students was that they were well beyond the stage of "learning to read" and had already moved to the stage of "reading to learn" (Chall, 1983). From this stage on, children deepen their knowledge of different text genres (i.e., narrative and expository) and start to perform better in understanding story structures and main ideas of reading texts (Duke & Carlisle, 2011). In the Turkish context, this transition is reflected in the course objectives related to reading skills in the curriculum for the teaching of Turkish in Grade 4 (MEB, 2019). In addition, it is documented that several components of reading such as RAN, vocabulary, MA and PS start to play more prominent roles in the prediction of reading ability at later stages of reading development (e.g., Carlisle, 2000; Joshi & Aaron, 2000; Storch & Whitehurst, 2002).

The information about the educational background of the parents was taken from the school's registration system with the permission of the parents and the administrative staff. It was observed that most of the mothers had high school education (32 %) while most of the fathers had a bachelor's degree (32 %). Table 4 shows the range of parental education in the sample.

Table 4. Parental Educational Profile

| Educational Level<br>*N* = 112 | Mother | Father |
|---|---|---|
| Illiterate | 1 | 0 |
| Primary School | 22 | 17 |
| Secondary School | 14 | 12 |
| High School | 35 | 29 |
| College | 11 | 12 |
| Bachelor's Degree | 26 | 35 |
| Master's Degree | 2 | 4 |
| PhD Degree | 0 | 1 |
| Not Specified | 1 | 2 |

## 4.3 Data collection instruments

### 4.3.1 Test of reading comprehension

This test was developed by the researcher of the current study, in accordance with the reading levels of normally developing Grade 4 children. It is a comprehensive test which includes different types of texts and questions. Following each text, the participants are required to give some short answers to open-ended questions.

#### 4.3.1.1 Test development

It is important to investigate reading comprehension by utilizing both narrative and expository texts as "comprehension of different genres of text involves different processes" (Duke & Carlisle, 2011, p. 219). At the beginning of the test development process, several coursebooks for Grade 4 (i.e., Turkish, Science and Social Sciences) were analyzed and the texts were counted and categorized. The analysis revealed that the majority of the written materials in the coursebooks were expository texts (61 %), and the rest consisted of narrative texts (39 %). Expository texts were mostly descriptive (54 %), which was followed by problem-solution (18 %), compare-contrast (11 %), sequence (10 %), and cause-effect texts (7 %). In order to enhance content validity, this distribution was reflected in the first draft of the reading comprehension test. More specifically, the test included 3 narrative and 6 expository texts; and of the expository texts, two were descriptive and each of the remaining texts represented four distinct subcategories (i.e., problem-solution, compare-contrast, sequence and cause-effect). A variety of children's publications (e.g., books, magazines, and online sources) were collected and reviewed for the selection of the texts with the help of a primary school teacher who was teaching Grade 4 students. Special attention was paid so that the concepts and vocabulary items were in accordance with the ones presented in the students' coursebooks.

For item development, an extended version of the taxonomy introduced by Pearson and Johnson (1978) was used. A total of 42 questions were developed and divided into two main categories as literal and inferential questions. While literal questions allowed the reader to find the answer directly from the information given in the text, inferential questions required the reader to make inferences based on the textual cues. Literal questions were divided into three subtypes: a) reference questions, whose answers were explicit and relatively easy to find in the text, b) paraphrase questions, which used slightly different expressions from the explicit information given in the text, and c) ordering questions, which required the reader to find and organize the explicit information presented in the text. Inferential questions were also divided into three subtypes: a) textually implicit questions, which required making inferences based on the cues given in the text, b) scriptally implicit questions which directed the reader to make logical assumptions based on the textual cues and background knowledge, and c) synthesis questions which involved connecting different pieces of information and using this knowledge to address new situations.

#### 4.3.1.2 Piloting and item analysis

For an initial understanding of how the test items worked and how long it took to complete the test, the first draft was piloted on a small group of Grade 4 children (*N* = 15) at a state school in İstanbul during the spring semester of 2018. This session allowed the researcher to see how much time was needed in order to complete the test (55-60 minutes on average), and to take notes about the students' answers to the questions. Later, an expert with a PhD degree in Turkish Education read and evaluated the texts in terms of spelling, punctuation and readability. Then, the test was administered to another group of students (*N* = 13), and the researcher had the chance to try some alternative questions. In total, 36 common questions were answered by the whole group (*N* = 28).

Based on the student's answers to the pilot questions, the researcher developed a rubric in order to have consistency when evaluating the answers of the future participants. Each answer was scored between 0 and 1; depending on the content quality (possible scores were 0, .25, .50, .75 or 1). The researcher did not take points off for spelling errors or incomplete sentences.

The pilot data allowed the researcher to conduct an item analysis to see the item difficulty and item discrimination values for each question. The results showed that the distribution of the questions in terms of difficulty was reasonable, but there were some items with poor discrimination values. After some revisions and replacements, the final version of the test was used for data collection with 9 texts and 40 questions (20 literal, 20 inferential). Hence, the maximum score which could be obtained by the participants was 40. An analysis upon the completion of actual data collection revealed that the test had high levels of internal consistency reliability ($\alpha = .825$, calculated for 146 participants).

### 4.3.2 RAN tests in Turkish (HOTI)

Hızlı Otomatik İsimlendirme Testleri (HOTI) were developed for Turkish by Bakır and Babür (2018), and reported to have high levels of inter-rater reliability (.99 to 1.00) and test-retest reliability (.85 and .95). In this test, the participants are asked to name a series of familiar objects, colors, letters or numbers as quickly and accurately as possible. In the current study, alphanumeric RAN (i.e., letters and numbers) tests were used to collect data.

#### 4.3.2.1 Rapid letter naming

In this test, the participant is given a series of lowercase letters (*k, s, m, t, b*) repeated randomly ten times in five rows (50 items in total) and asked to name each letter as quickly and accurately as possible. Before the test, a trial page is presented to the child to make sure that he or she is already familiar with the items. As soon as the participant utters the name of the first item, the researcher starts a chronometer to keep time (in seconds). When the child names the last item, the researcher stops the chronometer. The time spent by the participants to name all the letters in the grid is recorded as their rapid letter naming score.

#### 4.3.2.2 Rapid digit naming

As in the rapid letter naming test, the participant is asked to name a series of digits *(2, 6, 9, 4,* and *7)* repeated randomly ten times in 5 rows as quickly and accurately as possible. The child is given a trial page prior to the test, and the same procedure is applied as in rapid letter naming. The score of the participant is the time needed (in seconds) to finish the test.

### 4.3.3 Comprehensive test of phonological processing in Turkish (KFFT)

Based on CTOPP (Wagner, Torgesen, & Rashotte, 1999), the battery of Kapsamlı Fonolojik Farkındalık Testleri (KFFT**)** was developed for Turkish by Babür, Haznedar, Erçetin, Özerman, and Erdat-Çekerek (2013). The test battery includes a variety of subtests for measuring different levels of PA. Two subtests, namely elision and phoneme reversal were chosen as the indices of PA in the current study. The rationale behind this selection was the assumption that Grade 4 students had already mastered basic phonemic skills in the consistent orthography of Turkish, and more complex measures of PA should be used to differentiate between their performances. This assumption was in line with previous research, which showed that elision and reversal tasks were stronger predictors of reading and spelling skills at later stages of elementary school (Kroese et al., 2000).

#### 4.3.3.1 Elision (Deletion)

In the elision test, the researcher reads aloud a word and asks the participant to delete a specific unit in this word. In the beginning, the participant is asked to delete words in compounds. The researcher says the word and gives a simple instruction: "*Alışveriş* 'shopping'. What do we have if we delete *alış* 'taking'?" The expected answer is *veriş* 'giving'. The same procedure is applied for the deletion of syllables and phonemes in the following items. At the phonemic level, the participant attempts to delete phonemes which are presented in initial, mid and final positions within each test item. Each correct answer is given 1 point, and the maximum score is 20. The internal consistency reliability measure of the test was .839 (calculated for 120 participants).

4.3.3.2 Phoneme reversal

In the phoneme reversal test, the researcher reads aloud a seemingly nonsense word, and asks the participant to say it backwards. The researcher says the word and prompts the participant to answer the question: "*Ipak*. What do we have if we say it backwards?" The expected answer is *kapı* 'door'. The test items are ordered in increasing difficulty, which is based on phonotactics and word frequency. Each correct answer is given 1 point, and the maximum score is 18. The internal consistency reliability measure of the test was .893 ($N$ = 120).

4.3.4 Test of vocabulary knowledge

This test is an adaptation from Wechsler Intelligence Scale for Children-Revised (WISC-R, 1974), developed for Turkish (Savaşır & Şahin, 1995). It measures expressive vocabulary knowledge, and includes 34 words which are ordered in increasing difficulty based on their frequency and abstractness.

At the beginning of the test, the researcher asks the child to verbally define words such as *tavşan* 'rabbit', or *mektup* 'letter' and the test continues with items such as *onur* 'honour', *insaf* 'mercy' and *rekabet* 'competition'. Since the test focuses on the quality of word definitions, it measures not only vocabulary breadth but also vocabulary depth, which is an important predictor of reading comprehension (Ouellette, 2006). As the participant speaks, the researcher takes notes and grades the answers (definitions receive 0, 1 or 2 points depending on their quality) with the help of a comprehensive rubric. In the current study, the researcher used a voice recorder in order not to miss any details in the oral definitions, and evaluated the answers after listening to the voice recordings carefully. The session is terminated upon five consecutive errors. When the child acknowledges that he or she does not know the meaning of a given word, the researcher skips that item and marks it as an error. The maximum score which could be obtained in the vocabulary test is 68. The internal consistency reliability measure of the test was .813 ($N$ = 120).

### 4.3.5 Tests of morphological awareness

Two different morphological tests were used in the current study. They were untimed tests measuring the knowledge of inflectional and derivational morphemes in which the participant was required to fill in the blanks with appropriate suffixes. In Turkish, the relationship between phonemic and morphemic structure of words is mostly transparent, and it would be very easy for Grade 4 students to work on real words. Therefore, they were asked to work on pseudowords by choosing the appropriate inflectional and derivational suffixes for them in accordance with the contextual information.

#### 4.3.5.1 Test of inflectional morphology

The test of inflectional morphology, which was adapted from Durgunoğlu's (2003) study, includes three short passages in which wild animals are introduced. Instead of animal names, however, some pseudowords (*peliz, kuna, mev*) are given with missing case morphology. The participant is asked to read the sentences carefully, and fill in the blanks with the required case markers. In the original study, Durgunoğlu compared the completion and correction tasks (between groups design) and the degree of complexity in the pseudowords (within groups design). The findings suggested that the completion task was more difficult than the correction task, and the complexity of the pseudowords (*mev* vs. *mevler* vs. *mevlerimiz*) did not affect the performance negatively. In the current study, the completion task was selected to provide a more challenging experience for Grade 4 students, who were assumed to have acquired a certain level of MA. The maximum possible score was 14, and the test's internal consistency reliability was .778 ($N$ = 120).

#### 4.3.5.2 Test of derivational morphology

This test was adapted from Kuzucu-Örge's (2018) study. In the original test, there were questions including pseudowords such as *Pitak satan kişiye ne denir?* 'What is a person who sells *pitaks* called?' and the participant was asked to choose between the two options: a) *pitakçı* (the correct option, meaning *pitak* seller) b) *pitaksız* (meaning someone without *pitak*). As this test was originally developed for Grade 2 students, the researcher of the current study modified the test so that it could become more challenging for Grade 4 students. Instead of choosing one of the two options, the participant was required to complete the missing derivational suffixes of the pseudowords in sentences such as *Pitak satan kişiye pitak__ denir.* There were 10 items and each correct answer received 1 point. The internal consistency reliability of the test's adapted version was found to be .785 ($N$ = 120).

### 4.3.6 Tests of executive functioning (EF)

To measure EF, tests of working memory (WM) and inhibitory control (IC) were conducted. WM was assessed through backward digit recall while IC was tested via the Stroop Color and Word Test.

#### 4.3.6.1 Test of working memory (WM)

The current study utilized the backwards digit recall subtest from the Turkish adaptation of WISC-R test battery (Savaşır & Şahin, 1995) in order to measure WM.

In the literature, digit recall is found to be closely related to short term memory (STM) while backwards digit recall is commonly associated with WM (Gathercole, Pickering, Ambridge, & Wearing, 2004) especially in the case of children (St Clair-Thompson, 2010). This distinction stems from the nature of the tasks: while children have to remember some numbers in a specific order in a digit recall task (storage of information), they have to remember the numbers and, at the same time, rearrange them in the reverse order in a backwards digit recall task (storage & manipulation of information). In this test, the researcher reads out some digits, and asks the participant to listen carefully and recite the digits in the reverse order. There are 7 levels ordered in increasing difficulty (i.e., the number of digits increases from 2 to 8), and each level has 2 trials. The test session is terminated when the participant fails to recall the digits in both of the trials at the same level. Each correct trial receives 1 point, and the maximum possible score is 14. The internal consistency reliability measure of the test was .545 ($N$ = 120).

#### 4.3.6.2 Test of inhibitory control (IC)

In order to measure IC, the Stroop Color and Word Test (TBAG Form) was selected from a cognitive test battery adapted for Turkish children (Karakaş & Doğutepe Dinçer, 2011). The Stroop test was previously standardized for Turkish-speaking children aged between 6 and 11 (Kılıç, Koçkar, Irak, Şener, and Karakaş, 2002). The test includes four cards which are used in five consecutive sessions, and a chronometer is used to record the time required for the completion of each session. First, the participant is asked to read some color names which are printed in black (Card 1) as accurately and rapidly as possible. Next, he or she is told to read the same color names which, this time, are printed in incongruent colors (red, blue, yellow, or green) (Card 2). During the third session, the researcher uses another card with a grid of colored dots and asks the participant to name the colors accurately and rapidly (Card 3). In the following session, some neutral words (e.g., *kadar* 'until', *ise* 'if', *zayıf* 'weak') printed in different colors are presented, and the participant is asked to name the colors but not to read the words (Card 4). Lastly, the researcher picks Card 2 again, and asks the participant to name the colors of the words (i.e., color names printed in incongruent colors) by resisting the urge to read them (Card 2). At this final stage, the Stroop effect is observed as the participant needs more time to suppress the urge to read the printed stimuli and focus on the ink color. For each session, the score is the time needed (in seconds) by the participant to complete the task. The final session's score is taken as the index of IC.

#### 4.3.7 Test of text reading fluency

Research suggests that the fluent reading of connected text is a better predictor of RC when compared to reading words in isolation (Jenkins et al., 2003). For this reason, text-level reading was utilized as the fluency measure in the current study. Two passages from the reading comprehension test were used to assess the participants' reading fluency. The researcher asked the participant to read aloud Text 1 and later Text 2 as quickly and accurately as possible and used a chronometer to keep the time (in seconds) needed for the completion of each reading task. The scores from the two tasks were combined to elicit a composite score for text reading fluency.

#### 4.3.8 Test of processing speed (Decision Speed)

This test is from the Woodcock-Johnson III test battery (Woodcock, McGrew, & Mather, 2001), and functions as a matching pairs activity. It includes 40 rows, each presenting drawings of seven familiar objects. The participant is asked to find and circle two items that are similar or conceptually associated (e.g., a spider and a web) in each of the given rows within a time frame (i.e., 3 minutes). Before the administration, the researcher provides the participants with a practice sheet to familiarize them with the test design. If the participants notice that they make a mistake during the test, they are allowed to cross out the wrong option and circle the correct one. In addition, if they have difficulty in finding the matching pairs in a specific row, they are allowed to skip that row and move forward. Each correct match receives 1 point, and the maximum score is 40. The internal consistency reliability measure of the test was .819 ($N$ = 120).

Overall, the participants took part in 13 different tasks, including the subtests from each measure (see Appendix A for sample items). Figure 1 illustrates the tests and subtests which were used in the current study.

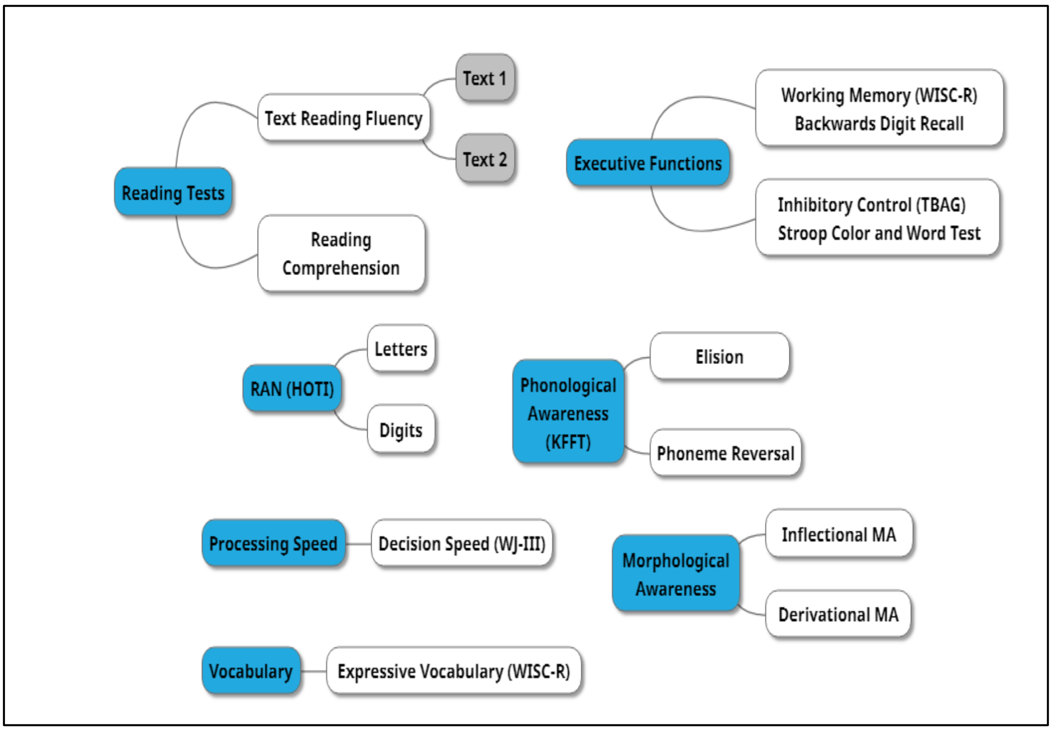



Figure 1. Tests used in the current study

## 4.4 Procedure

In January 2019, the researcher applied to the Provincial Directorate of National Education for an official permission in order to collect data from a state school in central Burdur. It took about two weeks to receive the confirmation (see Appendix B). In February, she prepared a detailed proposal to get an ethical approval from The Ethics Committee for Master and PhD Theses in Social Sciences and Humanities at Boğaziçi University. In March, she received the approval from the committee (see Appendix C), and after getting the consents of the principal, teachers and parents, she started to collect data from the students at the sample school.

The data collection procedure started with the administration of the reading comprehension test, which was developed, piloted and revised by the researcher earlier. The test was administered collectively in the classrooms with the teachers' help and supervision. In general, the students needed 55-60 minutes to complete the test. However, there were some students who needed extra time because they wanted to write their answers in complete, well-formed sentences although the researcher announced that short and relevant answers were sufficient. With the help of the teachers, the researcher made sure that all the students worked individually in a silent atmosphere. The administration of the test was completed in three days.

Starting from the last week of March, the researcher worked with the students individually ($N$ = 120) until the end of May. The individual tests were administered in a silent environment (i.e., in one of the science laboratories at the school), and it took the researcher about 40 minutes to complete the test sessions for each participant. The tests were administered to the students in different orders to minimize the possibility of fatigue effect on a particular test.

## 4.5 Research questions

1. To what extent do processing speed (PS), inhibitory control (IC), working memory (WM) and phonological awareness (PA) contribute to the variance in RAN?
2. To what extent do PS, IC, WM, PA, morphological awareness (MA), vocabulary (VOC) and RAN contribute to the variance in text reading fluency (TRF)?
3. To what extent do PS, IC, WM, PA, MA, VOC, RAN and TRF contribute to the variance in reading comprehension (RC)?

## 4.6 Research hypotheses

1. Evidence shows that RAN is a composite measure, which entails the coordination of several cognitive and linguistic variables such as PA (Wagner & Torgesen, 1987), PS (Badian, 1996; Kail & Hall, 1994), WM (Amtmann et al., 2007) and IC (Bexkens et al., 2015; Papadopoulos et al., 2016). Therefore, it is hypothesized that these four variables will make direct and significant contributions to RAN in the current study.
2. There is robust evidence suggesting that RAN is a strong predictor of reading speed across different languages (Norton & Wolf, 2012). Given that children quickly master decoding accuracy with the help of regular phoneme-grapheme correspondence rules in transparent orthographies, fluency measures become more relevant in the prediction of reading skills in these languages (de Jong & van der Leij, 1999). For this reason, it is hypothesized that RAN will have the strongest direct influence on TRF in Turkish (Babayiğit & Stainthorp, 2010; Durgunoğlu, 2017). On the other hand, it is

documented that the contribution of PA to reading is time-limited in transparent orthographies (Durgunoğlu, 2017; Georgiou et al., 2016; Öney & Durgunoğlu, 1997). Still, it is likely that PA will account for a small amount of variance in TRF since children, albeit with increasing automaticity at later stages, rely on phoneme-level information due to the consistent letter-sound mappings in Turkish (Ziegler & Goswami, 2005). In addition, the utilization of more advanced PA tasks (i.e., elision and phoneme reversal) in the current study is likely to differentiate between Grade 4 students' PA, and consequently, their performances in TRF (Kroese et al., 2000).

As reading fluency is closely associated with speeded processing of visual information, it is predicted that PS will have a direct and significant influence on TRF (Christopher et al., 2012). Regarding IC, it is predicted that decoding under time pressure might involve attentional control (Altemeier et al., 2008), as readers are likely to suppress activated cohorts of possible letter strings or word meanings when they focus on the target item. In addition, evidence shows that IC is highly relevant for lower-level reading skills such as decoding (Altemeier et al., 2008; Jacobson et al., 2017; Nouwens et al., 2020). As for WM, although decoding sentences in a transparent orthography might not create substantial amounts of cognitive load, it is likely WM will be involved in TRF (Jacobson et al., 2017; Nouwens et al., 2020) due to the semantic processes and the increased effect of EF on the speeded measures of literacy at the later stages of schooling (Altemeier et al., 2008).

It is also hypothesized that MA will have a direct and significant effect on TRF because Turkish is a morphologically rich language (Carlisle, 1995), and students rely more on morphological units to recognize words at more advanced stages of reading development (Anglin, 1993; Carlisle, 2000). Lastly, as vocabulary knowledge facilitates word recognition (Perfetti, 1998), and words are recognized faster when they are presented in a meaningful context (Adams, 1990; Rumelhart, 1994), it is hypothesized that vocabulary will make a direct and significant contribution to TRF. It is likely that readers with richer vocabulary knowledge will utilize top-down processes such as activating and retrieving the meanings of target words faster, and benefit from the contextual information to a greater extent.

3. Reading fluency allows readers to allocate larger amounts of cognitive resources for higher-order processing and reading comprehension (LaBerge & Samuels, 1974). Therefore, it is hypothesized that TRF will be a significant predictor of RC in the current study. Likewise, vocabulary knowledge, as a critical component between word identification and semantic processing (Perfetti, 2007; Perfetti & Hart, 2001), is predicted to have a direct and significant effect on RC in Turkish (Babayiğit & Stainthorp, 2011, 2014).

   It is also hypothesized that MA will make a direct and significant contribution to RC in the morphologically rich structure of Turkish because the ability to analyze morphological units plays a central role in the meaning making processes (Deacon & Kirby, 2004). Given that the connections between MA and reading become stronger at the later stages of elementary school (Carlisle, 2000; Kuo & Anderson, 2006; Singson et al., 2000), the effect of MA on RC is likely to become more evident in Grade 4.

   Regarding WM, it is predicted that WM will make a unique contribution to RC (Georgiou, Das & Hayward, 2008; Jacobson et al., 2017) as RC is a higher-order skill which relies on the storage and efficient use of textual information and background knowledge. Furthermore, WM is reported to play a more prominent role in RC as the grade level increases (Seigneuric & Ehrlich, 2005), which is a relevant finding for Grade 4 students. As for IC, it is predicted that IC will not have a direct effect on RC as it is more relevant for lower-level processing (Altemeier et al., 2008).

It is also hypothesized that although PS and RAN are more likely to predict RC through the mediating role of TRF, they might also make independent contributions to RC (Joshi & Aaron, 2000; Kirby et al., 2003; Manis et al., 1999; Plaza & Cohen, 2003). Similarly, although PA is a foundational skill which is mastered very quickly in Turkish (Durgunoğlu, 2017) and more closely associated with skills such as decoding, it could still make an independent contribution to RC (Engen & Høien, 2002; Holsgrove, 2003), given that tasks measuring more advanced levels of PA might index some of the metacognitive processes involved in RC (Engen & Høien, 2002) and differentiate between the reading skills of children at the later stages of elementary school (Kroese et al., 2000).

### 4.7 A proposed model of reading

Based on the evidence from the literature and the hypotheses of the current study, a multicomponent model of reading was developed (see Figure 2) to reflect the direct and indirect relationships among the variables. The model was tested through classical path analysis to reveal possible contributions of the predictors to RC. It was predicted that some of the associations in the path model could turn out to be significant while others could be nonsignificant. In addition, it should be acknowledged that such a model would be far from complete without supporting evidence from further studies. Still, the results might provide valuable insights into the underlying processes of reading ability for normally developing Grade 4 students, who are at the stage of "reading to learn new information" in Turkish.

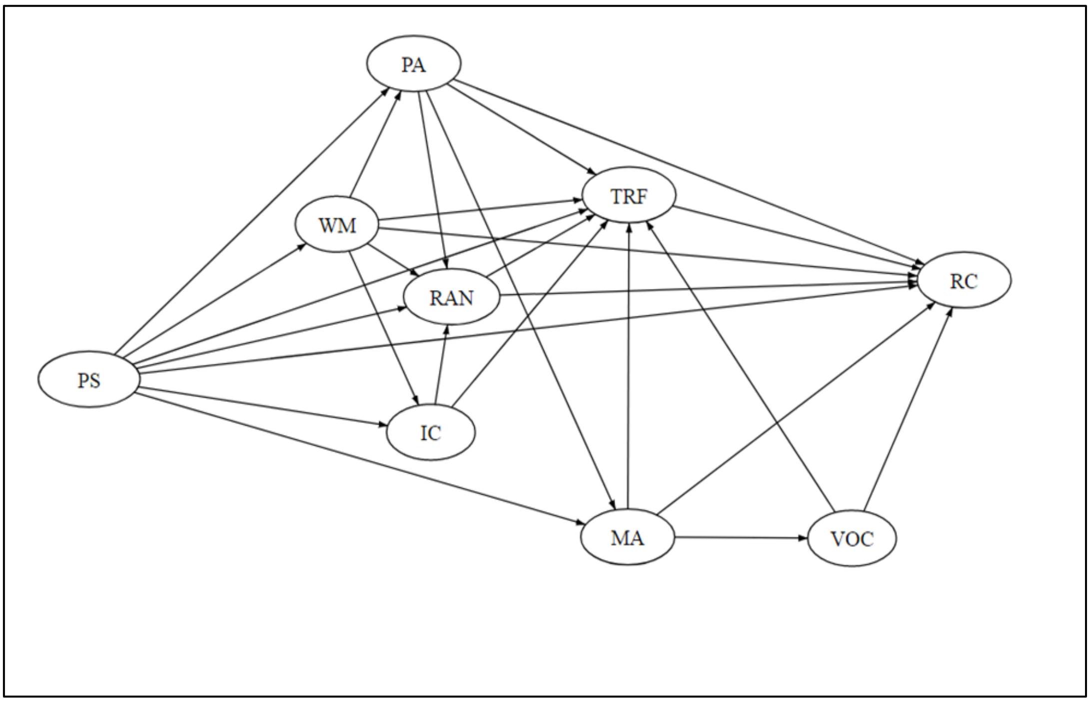



Figure 2. A proposed model of reading

4.8 Statistical analyses

Before the data analysis, each variable in the dataset was checked for normality. Except for the elision subtest, all the test scores had reasonably normal distributions in which skewness and kurtosis values ranged between -2 and +2 (Bachman, 2004). The elision subtest had a negatively skewed distribution, with most of the scores reaching the maximum. This was probably because the subtest was very easy for Grade 4 students who had already mastered phoneme-grapheme correspondences in the transparent orthography of Turkish. Once the elision and phoneme reversal subtests were added together for a composite score of PA, it was observed that the new variable was in accordance with the acceptable normality levels.

During data screening, 8 students were found to be univariate outliers (i.e., with z scores excessing ± 3.29, $p < .001$) in different measures (Tabachnick & Fidell, 2007), and they were removed from the sample. Further examination in which the Mahalanobis distances were calculated and checked against the critical value for $\chi 2$ ($p < .001$) revealed that there were no multivariate outliers in the sample. The dataset was further screened for linearity, homoscedasticity, normally distributed and independent errors, and multicollinearity. The examination of Tolerance, VIF, Durbin-Watson statistics and plots revealed that there were no violations of assumptions for conducting multiple regression analyses.

An additional analysis (i.e., a one-way, within-subjects ANOVA) was conducted for the Stroop test scores (Stages 1-5) to see the performance differences across different times and whether there was a true Stroop effect at Step 5 (i.e., significantly longer reaction times when compared to Stages 1-4).

To examine the roles of RAN, PA, MA, PS, vocabulary, WM, IC and TRF in predicting reading comprehension (RC), several statistical analyses were conducted via IBM Statistical Package for Social Sciences (SPSS) 21.0. First, descriptive statistics for all of the measures were elicited. Next, Pearson product-moment correlations were calculated to see the relationships among the variables. In the following step, simultaneous multiple regression analyses were conducted as part of a comprehensive classical path analysis.

In the path analysis, standardized beta weights were used to examine whether the proposed model was appropriate to reflect the direct and indirect effects of the independent variables on the dependent variables. Based on the results, the proposed path model was revised so that it could illustrate the important relationships between the variables more clearly.

### 4.8.1 Classical Path Analysis

Classical path analysis, which functions as an extension of multiple regression, is used in order to examine potential relationships among different variables through causal pathways (Babür, 2003). The analysis allows the researcher to see and evaluate direct and indirect effects of several independent variables on a variety of dependent variables. Rather than testing a whole model for fit as in Structural Equation Modeling, classical path analysis is used to test individual path coefficients especially with small sample sizes (Babür, 2003).

Before conducting path analysis, a path diagram is formulated by the researcher to show the hypothesized relationships among the variables on a theoretical foundation (Pedhazur, 1997). In the proposed model, the causal relationships are represented by a set of path lines, and the researcher tests the strength of these relationships by conducting a series of multiple regression analyses based on the hypotheses of the study (Babür, 2003). Although the variables are connected to each other via “causal pathways”, they do not have an inherently causal relationship since path analysis serves to test the researcher’s hypotheses on causal models rather than discover causality and establish direction of effects between the variables (Babür, 2003; Pedhazur, 1997).

In a path diagram, causal relationships are unidirectional. To show direction of effects among the variables, single-headed arrows are used (Pedhazur, 1997). Double-headed arrows, on the other hand, represent unanalyzed relationships indicating that a covariance between the two variables has no implied direction of effects (Tabachnick & Fidell, 2007, p. 678). Lack of a line between the variables indicates that there are no direct relationships hypothesized by the researcher.

Standardized beta weights ($\beta$) elicited in the multiple regression analyses function as the path coefficients in the diagrams, and they are used to show the hypothesized direct effects of the independent variables on the dependent variables (Pedhazur, 1997). In the next step, indirect effects are calculated based on the standardized beta weights, and the total effects are elicited upon the combination of direct and indirect effects.

4.8.2. Calculating direct and indirect effects: Path tracing

In classical path analysis, direct effect refers to the effect of a certain variable on another variable with no mediation by other variables. Indirect effect refers to the part of a variable's effect which is mediated by one or more additional variables. The sum of direct and indirect effects is defined as the total effect of a variable (Pedhazur & Schmelkin, 1991). Figure 3 presents an exemplary path diagram showing direct and indirect effects among three variables along with their path coefficients.

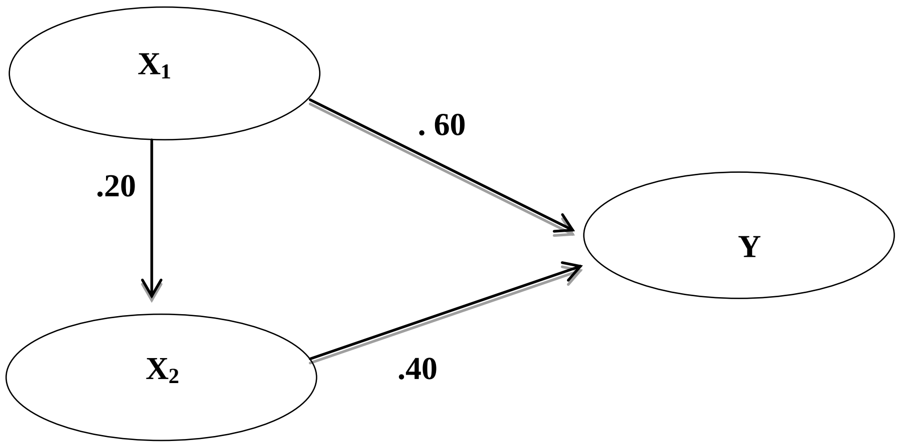



Figure 3. An exemplary path diagram (adapted from Babür, 2003)

The relationships among the variables in Figure 3 could be summarized as follows:

$X_1 \rightarrow Y = .60$ (direct effect of $X_1$ on Y),

$X_2 \rightarrow Y = .40$ (direct effect of $X_2$ on Y),

$X_1 \rightarrow X_2 = .20$ (direct effect of $X_1$ on $X_2$),

$X_1 \rightarrow X_2 \rightarrow Y$ is .20 (.40) = .08 (indirect effect of $X_1$ on Y through $X_2$)

Accordingly, both $X_1$ and $X_2$ have direct effects on Y, and these effects are not mediated by any other variable in the model. On the other hand, $X_1$ has an additional indirect effect on Y via $X_2$. This means that $X_2$ has a mediating role in the relationship between $X_1$ and Y. The calculation of direct, indirect and total effects of this exemplary model is illustrated in Table 5.

Table 5. The Calculation of Direct, Indirect and Total Effects in a Path Diagram

| | Direct effect | Indirect effect | Total effect |
|---|---|---|---|
| $X_1$ | .60 | .20(.40) = .08 | .60 + .08 = .68 |
| $X_2$ | .40 | - | .40 |

This chapter has provided the details of the research design, participants, data collection instruments, procedure, research questions, hypotheses and statistical analyses used in the current study. In the next chapter, the results of the data analyses will be presented.

# CHAPTER 5

# RESULTS

This chapter presents the results of the data analyses in light of the research questions and hypotheses of the current study. Statistical outcomes include descriptive statistics, Pearson-product moment correlations, a within-subjects-design ANOVA, multiple regression analyses, and classical path analyses.

## 5.1 Preliminary findings

As the first step of data analysis, descriptive statistics were elicited for each data collection instrument. The results are demonstrated by Table 6.

Table 6. Descriptive Statistics

| Measure | *M* | *SD* | *Min* | *Max* | *Max Possible* |
|---|---|---|---|---|---|
| RAN | 46.05 | 7.7 | 31 | 69 | - |
| TRF | 126.53 | 32.3 | 81 | 219 | - |
| WM | 4.34 | 1.2 | 2 | 8 | 14 |
| PS | 25.77 | 4.4 | 17 | 36 | 40 |
| MA | 13.50 | 5.2 | 2 | 23 | 24 |
| PA | 33.08 | 5.2 | 16 | 38 | 38 |
| IC | 37.28 | 10.3 | 20 | 69 | - |
| VOC | 45.09 | 7.3 | 24 | 60 | 68 |
| RC | 26.76 | 4.3 | 14.25 | 37.5 | 40 |

Note: *N* = 112. RAN = Rapid Automatized Naming (Composite of letters and digits), TRF = Text Reading Fluency (Composite of text 1 and 2), WM = Working Memory, PS = Processing Speed, MA = Morphological Awareness (Composite of inflections and derivations), PA = Phonological Awareness (Composite of elision and reversal), IC = Inhibitory Control, VOC = Vocabulary Knowledge, RC = Reading Comprehension. RAN, TRF, and IC scores illustrate the time (in seconds) needed to complete the tasks.

Although the Stroop test used in the present study is a standardized measure for Turkish speaking children (Kılıç et al., 2002), a one-way, within-subjects ANOVA was conducted to see the performance differences across Stages 1-5 in the current sample, and whether the anticipated Stroop effect was observed at Stage 5. As Mauchly's test for sphericity was found to be significant [$\chi^2$ (9) = 428.278, $p < .001$], the degrees of freedom were corrected using the Greenhouse-Geisser correction $\epsilon = .397$. The results of ANOVA revealed a statistically significant difference among the five stages with a large effect size $F(1.588, 176.264) = 712.049$, $p < .001$, partial $\eta^2 = .865$. An adjusted Bonferroni post hoc comparison yielded specific differences across Stages 1-5 as shown in Table 7.

Table 7. Results of the Stroop Test

| Stage | Card | Task | *M* | *SD* | *p* |
|---|---|---|---|---|---|
| 1 | 1 | Reading the color names printed in black | 9.45 | 1.638 | < .001 |
| 2 | 2 | Reading the color names printed in incongruent colors | 10.39 | 2.132 | < .001 |
| 3 | 3 | Naming the colors of dots | 16.44 | 3.497 | < .001 |
| 4 | 4 | Naming the colors of neutral words | 24.80 | 6.610 | < .001 |
| 5 | 2 | Naming the colors of incongruent color names | 37.28 | 10.341 | < .001 |

Accordingly, each stage required significantly longer reaction times (RT) than the previous stage(s); and as anticipated, Stage 5 required the longest RT due to the cognitive interference defined as the Stroop effect. The means and patterns across the stages were in line with the normative data reported for Grade 4 students in the Stroop test examiner's manual (Karakaş, 2011, p. 33-34).

As the next step of the analyses, intercorrelations among the variables were calculated. Table 8 illustrates the correlational findings ($N = 112$). It should be noted here that the measures showing how fast a task was completed in seconds had negative correlations with the accuracy measures in the dataset. In others words, the participants who completed the tasks faster had lower time scores, which, in turn, correlated with their higher performances in the accuracy tasks in a negative way.

An overview of the correlations between the reading measures (TRF and RC) and the other variables revealed that TRF had the strongest correlations with RC ($r$ =

-.515, $p < .01$). This was followed by RAN ($r = .482$, $p < .01$), PA ($r = -.437$, $p < .01$), and MA ($r = -.432$, $p < .01$). TRF demonstrated similar correlations with WM, ($r = -.347$, $p < .01$), PS ($r = -.346$, $p < .01$), IC ($r = .395$, $p < .01$) and vocabulary ($r = -.322$, $p < .01$).

Table 8. Intercorrelations Among the Measures

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. RAN | -- | | | | | | | | |
| 2. TRF | .482** | -- | | | | | | | |
| 3. WM | -.204* | -.347** | -- | | | | | | |
| 4. PS | -.269** | -.346** | .399** | -- | | | | | |
| 5. MA | -.083 | -.432** | .326** | .180 | -- | | | | |
| 6. PA | -.255** | -.437** | .391** | .200* | .591** | -- | | | |
| 7. IC | .515** | .395** | -.363** | -.143 | -.247** | -.501** | -- | | |
| 8. VOC | -.054 | -.322** | .138 | .210* | .541** | .167 | -.074 | -- | |
| 9. RC | -.161 | -.515** | .324** | .248** | .679** | .554** | -.318** | .473** | -- |

Note: $N = 112$. *$p < .05$, ** $p < .01$. TRF = Text Reading Fluency (Composite of text 1 and text 2), WM = Working Memory, PS = Processing Speed, MA = Morphological Awareness (Composite of inflections and derivations), PA = Phonological Awareness (Composite of elision and phoneme reversal), IC = Inhibitory Control, VOC = Vocabulary Knowledge, RC = Reading Comprehension.

RC was significantly correlated with all of the variables with the exception of RAN. It had the highest correlation with MA ($r = .679$, $p < .01$), which was followed by TRF ($r = -.515$, $p < .01$) and PA ($r = .554$, $p < .01$). On the other hand, RC had a weaker but significant correlation with PS ($r = .248$, $p < .01$).

When the correlations were examined for each of the predictor variables, it was observed that RAN correlated moderately and significantly with IC ($r = .515$, $p < .01$) while it had weaker correlations (significant, yet mostly around .20) with WM, PA and PS. WM had significant correlations with most of the variables (mostly around .30) except for vocabulary. With the exceptions of MA and IC, PS had significant yet relatively weak correlations with the other variables. It had the highest correlations with WM ($r$ = .399, $p$ < .01) and TRF ($r$ = -.346, $p$ < .01).

MA had the strongest correlation with RC ($r$ = .679, $p$ < .01). This was followed by PA ($r$ = .591, $p$ < .01) and vocabulary ($r$ = .541, $p$ < .01). It had moderate and significant correlations with the other variables with the exception of RAN and PS. PA had moderate and significant correlations with most of the variables, and demonstrated the strongest correlations with MA ($r$ = .591, $p$ < .01), RC ($r$ = .554, $p$ < .01), and IC ($r$ = -.501, $p$ < .01). It had lower but significant correlations with WM ($r$ = .391, $p$ < .01) and PS ($r$ = .200, $p$ < .05) while it did not correlate with vocabulary knowledge.

IC was significantly and moderately correlated with most of the measures except for PS and vocabulary. It had the strongest correlations with RAN ($r$ = .515, $p$ < .01). Vocabulary had significant and moderate correlations with MA ($r$ = .541, $p$ < .01) and RC ($r$ = .473, $p$ < .01). It had weaker but significant correlations with TRF ($r$ = -.322, $p$ < .01) and PS ($r$ = .210, $p$ < .05). On the other hand, it did not demonstrate noteworthy associations with the remaining variables.

Overall, the correlational analyses showed that there were reasonable relationships between the reading measures (i.e., TRF and RC) and the cognitive and linguistic variables which were utilized in the current study. The following part will report the results of the multiple regression analyses and classical path analyses with a focus on the research questions.

## 5.2 Main findings

### 5.2.1 Research question 1

"To what extent do processing speed (PS), inhibitory control (IC), working memory (WM) and phonological awareness (PA) contribute to the variance in RAN?"

To see the direct and indirect contributions of the predictor variables to a variety of outcome variables, a series of simultaneous multiple regression analyses were conducted as part of the classical path analysis in the current study. In the first layer of the analyses, RAN was included as the outcome variable, and the possible contributions of PS, IC, WM and PA were investigated.

The analysis revealed that IC [$t(107) = 5.463$, $p < .001$, $\beta = .519$] and PS [$t(107) = -2.573$, $p < .05$, $\beta = -.226$] were significant predictors of RAN while PA and WM failed to account for a significant amount of variance in RAN. In the following step, PA, the variable with the highest p value, was excluded from the equation, and the analysis was re-run to see whether WM would become a significant predictor of RAN. However, it was found that WM remained as a nonsignificant predictor of RAN. For this reason, the regression equation was re-estimated including IC and PS only. The final model showed that IC accounted for 23 % of the variance in RAN [$t(109) = 6.034$, $p < .001$, $\beta = .487$]. It was also found that PS made an additional unique contribution to RAN (nearly 4 %) [$t(109) = -2.475$, $p < .05$, $\beta = -.200$], and the final model explained 29 % of the total variance in RAN [$R^2 = .305$, $R^2_{adj} = .292$, $F(2, 109) = 23.884$, $p < .001$]. The summary of the regression analyses are presented in Table 9.

Table 9. Direct Effects of PS, IC, WM and PA on RAN

| Dependent Variable | Independent Variable | *B* | *β* | Squared Semi-Partial Correlation | *t*-value | *p* |
|---|---|---|---|---|---|---|
| | Model 1 | | | | | |
| RAN | PS | -.395 | -.226 | .042 | -2.573 | .011 |
| | WM | .391 | .065 | .002 | .677 | .500 |
| | PA | .037 | .025 | .000 | .260 | .795 |
| | IC | .390 | .519 | .192 | 5.463 | .000 |
| | Model 2 | | | | | |
| RAN | IC | .366 | .487 | .232 | 6.034 | .000 |
| | PS | -.349 | -.200 | .039 | -2.475 | .015 |

Note: *B* = unstandardized beta coefficient, *β* = standardized beta coefficient. Model 1: $R^2 = .309$, $R^2_{adj} = .283$, $F(4, 107) = 11.951$ , $p < .001$. Model 2: $R^2 = .305$, $R^2_{adj} = .292$, $F(2, 109) = 23.884$, $p < .001$.

To examine the effects of PS on WM, IC and PA, three separate regression analyses were conducted. The results revealed that PS accounted for a significant amount of unique variance in WM [$t(110) = 4.567$, $p < .001$, $\beta = .399$] and PA [$t(110) = 2.144$, $p < .05$, $\beta = .200$] but not in IC. Similarly, additional analyses were carried out to examine the effects of WM on PA and IC. The analyses showed that WM was a unique predictor of both IC [$t(110) = -4.080$, $p < .001$, $\beta = -.363$] and PA [$t(110) = 4.451$, $p < .001$, $\beta = .391$].

Overall, the results revealed both direct and indirect effects of the predictor variables on RAN. Figure 4 presents the path model for the first layer of the analysis. In the path diagram, significant paths ($p < .05$) are represented by bold lines while nonsignificant paths are shown by dashed lines.

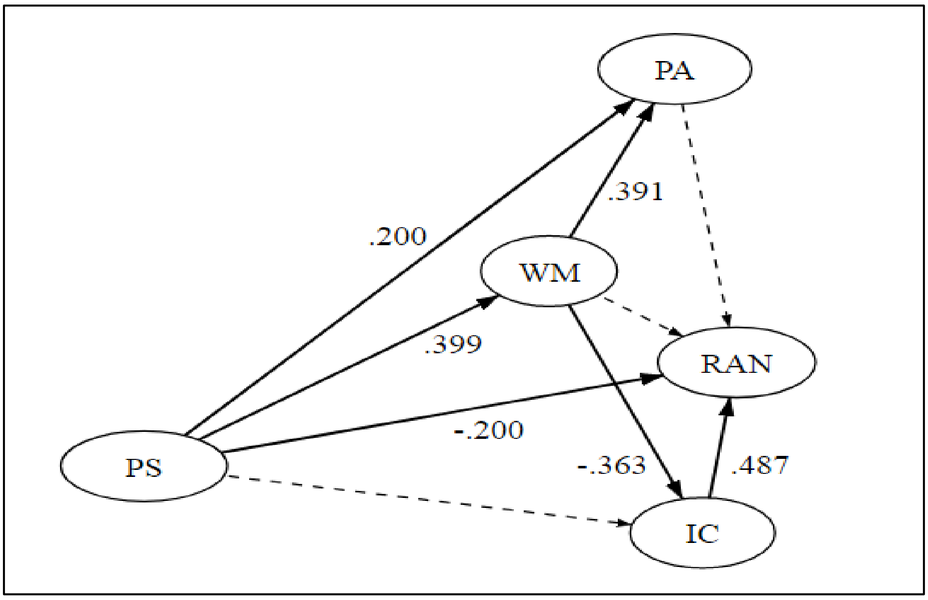



Figure 4. Direct and indirect predictors of rapid automatized naming

According to the path model, WM had an indirect effect on RAN through IC. Another finding was that in addition to its direct effect, PS also had an indirect effect on RAN through the connection between WM and IC. The calculations for the total effects of the predictor variables are demonstrated in Table 10.

Table 10. Summary of Causal Effects on RAN

| Outcome | Determinants | Direct Effect | Indirect Effect | Total Effect |
|---|---|---|---|---|
| RAN | IC | .48 | -- | .48 |
| | PS | -.20 | (.39)(-.36)(.48) = -.06 | (-.06) + (-.20) = -.26 |
| | WM | -- | (-.36)(.48) = -.17 | -.17 |
| | PA | -- | -- | -- |

Overall, IC had the largest effect on RAN, which was followed by PS and WM. Although WM was not a direct precursor of RAN, it had a reasonable amount of total effect (.17), which indicated its important role in the speeded retrieval and naming of alphanumeric stimuli (i.e., letters and digits).

### 5.2.2 Research question 2

"To what extent do PS, IC, WM, PA, morphological awareness (MA), vocabulary (VOC) and RAN contribute to the variance in text reading fluency (TRF)?"

In the second layer of the analysis, the direct effects of PS, IC, WM, PA, MA, vocabulary and RAN on TRF were investigated in a number of simultaneous regression analyses. First, all the variables were entered into the equation simultaneously, and then, nonsignificant predictors were excluded from the analysis one by one (starting with the one with the highest p value) to eliminate the possible suppressive effects, and to reveal other significant predictors.

The first regression model which included all of the independent variables revealed that RAN was the only significant predictor of TRF in Turkish [$t(104) = 3.988$, $p < .001$, $\beta = .352$]. When the analysis was re-run with the exclusion of the nonsignificant variables one by one, it was found that RAN, MA and PS emerged as the unique predictors of TRF. Therefore, the regression equation was re-estimated including RAN, MA and PS only. The results showed that RAN, which was the most powerful precursor of reading fluency, explained 15 % of the total variance in TRF [$t(108) = 5.285$, $p < .001$, $\beta = .405$]. This was followed by MA, which accounted for 13 % of the variance [$t(108) = -4.901$, $p < .001$, $\beta = -.368$]. Lastly, PS explained nearly 3 % of the remaining variance in TRF [$t(108) = -2.204$, $p < .05$, $\beta = -.171$]. Overall, the model accounted for 39 % of the total variance in TRF [$R^2 = .413$, $R^2_{adj} = .397$, $F(3, 108) = 25.333$, $p < .001$]. The summary of the analyses are illustrated in Table 11.

Table 11. Direct Effects of PS, IC, WM, PA, MA, VOC and RAN on TRF

| Dependent Variable | Independent Variable | *B* | *β* | Squared Semi-Partial Correlation | *t*-value | *p* |
|---|---|---|---|---|---|---|
| | Model 1 | | | | | |
| TRF | PS | -.910 | -.125 | .011 | -1.491 | .139 |
| | IC | .134 | .043 | .001 | .437 | .663 |
| | WM | -1.895 | -.075 | .003 | -.854 | .395 |
| | PA | -.846 | -.136 | .008 | -1.287 | .201 |
| | MA | -1.187 | -.191 | .015 | -1.721 | .088 |
| | VOC | -.605 | -.137 | .012 | -1.507 | .135 |
| | RAN | 1.469 | .352 | .085 | 3.988 | .000 |
| | Model 2 | | | | | |
| TRF | RAN | 1.687 | .405 | .152 | 5.285 | .000 |
| | MA | -2.286 | -.368 | .130 | -4.901 | .000 |
| | PS | -1.247 | -.171 | .026 | -2.204 | .030 |

Note: *B* = unstandardized beta coefficient, *β* = standardized beta coefficient. Model 1: $R^2 = .442$, $R^2_{adj} = .404$, $F(7, 104) = 11.766$, $p < .001$. Model 2: $R^2 = .413$, $R^2_{adj} = .397$, $F(3, 108) = 25.333$, $p < .001$.

To investigate the connections of MA with PS, PA and vocabulary, additional regression analyses were conducted. The results showed that PS did not make a significant contribution to MA. On the other hand, PA was a strong predictor of MA [$t(110) = 7.674$, $p < .001$, $\beta = .591$]. Another finding was that MA made a significant contribution to the variance in vocabulary knowledge [$t(110) = 6.740$, $p < .001$, $\beta = .541$]. Figure 5 presents the path model for the second layer of the analysis.

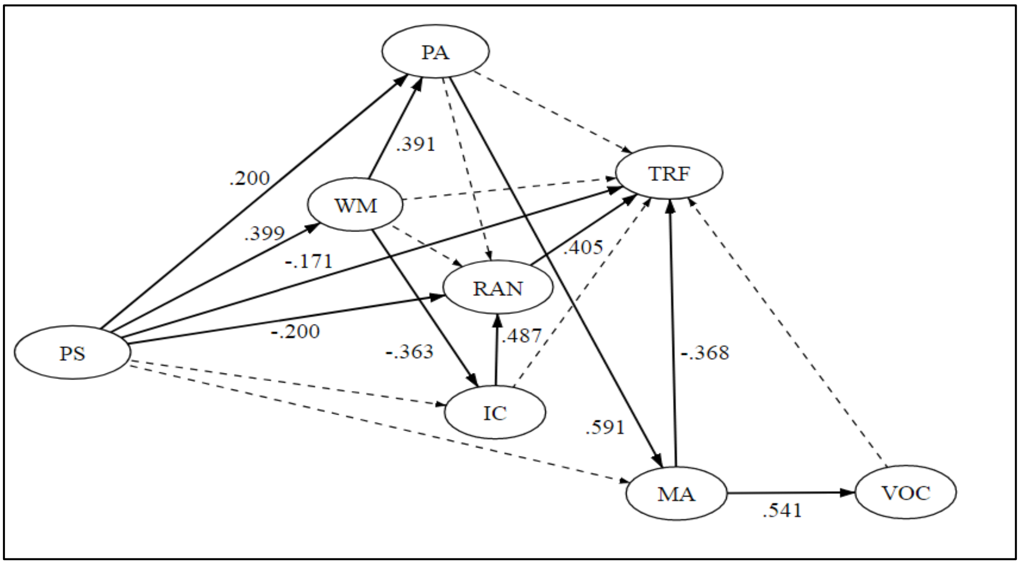



Figure 5. Direct and indirect predictors of text reading fluency

After the analyses, several direct and indirect pathways emerged between the predictor variables and TRF. It was observed that PS had both direct and indirect contributions to TRF. The indirect contribution of PS followed several different routes. In the first one, PS contributed to TRF through RAN. In the second one, it followed a more indirect route through PA and then through MA. In the third one, it started with the mediating role of WM, which was followed by PA and MA. Lastly, it started with WM, followed by IC and RAN. These complex connections also revealed that PA, WM and IC were indirect precursors of TRF in Turkish. Another finding was that PA had an indirect contribution to vocabulary through the mediating effect of MA. The calculations for the total effects on TRF are illustrated in Table 12.

Table 12. Summary of Causal Effects on TRF

| Outcome | Determinants | Direct Effect | Indirect Effect | Total Effect |
|---|---|---|---|---|
| TRF | RAN | .40 | -- | .40 |
| | MA | -.36 | -- | -.36 |
| | VOC | -- | -- | -- |
| | PA | -- | (.59)(-.36) = -.21 | -.21 |
| | IC | -- | (.48)(.40) = .19 | .19 |
| | WM | -- | (-.36)(.48)(.40) +<br>(.39)(.59)(-.36) = -.15 | -.15 |
| | PS | -.17 | (-.20)(.40) +<br>(.20)(.59)(-.36) +<br>(.39)(.39)(.59)(-.36) +<br>(.39)(-.36)(.48)(.40) = -.18 | (-.17) + (-.18) = -.35 |

The findings showed that RAN had the largest effect on TRF, which was followed by MA and PS. Among the indirect predictors of TRF, PA had the largest total effect, which was followed by IC and WM.

### 5.2.3 Research question 3

"To what extent do PS, IC, WM, PA, MA, VOC, RAN and TRF contribute to the variance in reading comprehension (RC)?"

In order to complete the reading model, RC was taken as the ultimate dependent variable, and the contributions of PS, IC, WM, PA, MA, VOC, RAN and TRF were examined in a number of simultaneous regression analyses.

As in the previous layers of the path analysis, all of the predictor variables were entered into the equation in the first model. The results showed that MA, [$t(103) = 3.647$, $p < .001$, $\beta = .365$], PA [$t(103) = 2.036$, $p < .05$, $\beta = .193$], vocabulary [$t(103) = 2.005$, $p < .05$, $\beta = .164$], and TRF [$t(103) = -2.452$, $p < .05$, $\beta = -.214$], were the significant predictors of RC in Turkish. The elimination of the nonsignificant predictors from the model one by one did not reveal any other significant predictors. Therefore, the equation was re-estimated with MA, PA, vocabulary and TRF in the final model. Accordingly, MA explained 6 % of the variance in RC [$t(107) = 3.849$, $p < .001$, $\beta = .371$]. This was followed by TRF, which accounted for 3 % of the remaining variance [$t(107) = -2.735$, $p < .01$, $\beta = -.205$]. The results also showed that while PA explained nearly 3 % of the variance in RC [$t(107) = 2.539$, $p < .05$, $\beta = .217$], vocabulary accounted for nearly 2 % of the remaining variance [$t(107) = 2.130$, $p < .05$, $\beta = .170$]. Overall, the final model explained 54 % of the total variance in RC ($R^2 = .558$, $R^2_{adj} = .541$, $F(4, 107) = 33.718$, $p < .001$). The summary of the analyses are illustrated in Table 13.

Table 13. Direct Effects of PS, IC, WM, PA, MA, VOC, RAN and TRF on RC

| Dependent Variable | Independent Variable | *B* | *β* | Squared Semi-Partial Correlation | *t*-value | *p* |
|---|---|---|---|---|---|---|
| | Model 1 | | | | | |
| RC | PS | .043 | .044 | .001 | .580 | .563 |
| | IC | -.028 | -.066 | .002 | -.754 | .453 |
| | WM | .025 | .007 | .000 | .092 | .927 |
| | PA | .162 | .193 | .017 | 2.036 | .044 |
| | MA | .307 | .365 | .056 | 3.647 | .000 |
| | VOC | .098 | .164 | .017 | 2.005 | .048 |
| | RAN | .044 | .077 | .003 | .917 | .361 |
| | TRF | -.029 | -.214 | .025 | -2.452 | .016 |
| | Model 2 | | | | | |
| RC | MA | .312 | .371 | .061 | 3.849 | .000 |
| | PA | .183 | .217 | .026 | 2.539 | .013 |
| | TRF | -.028 | -.205 | .030 | -2.735 | .007 |
| | VOC | .102 | .170 | .018 | 2.130 | .035 |

Note: *B* = unstandardized beta coefficient, *β* = standardized beta coefficient. Model 1: $R^2 = .563$, $R^2_{adj} = .529$, $F(8, 103) = 16.606$, $p < .001$. Model 2: $R^2 = .558$, $R^2_{adj} = .541$, $F(4, 107) = 33.718$, $p < .001$.

The results of the analyses revealed several direct and indirect effects on RC. Among the direct predictors (i.e., MA, TRF, PA and vocabulary), MA and PA were also related to RC via indirect pathways. In addition, PS, WM, RAN and IC emerged as indirect predictors of RC in a complex network of relationships. The ultimate model which illustrates the direct and indirect predictors of RC is demonstrated by Figure 6.

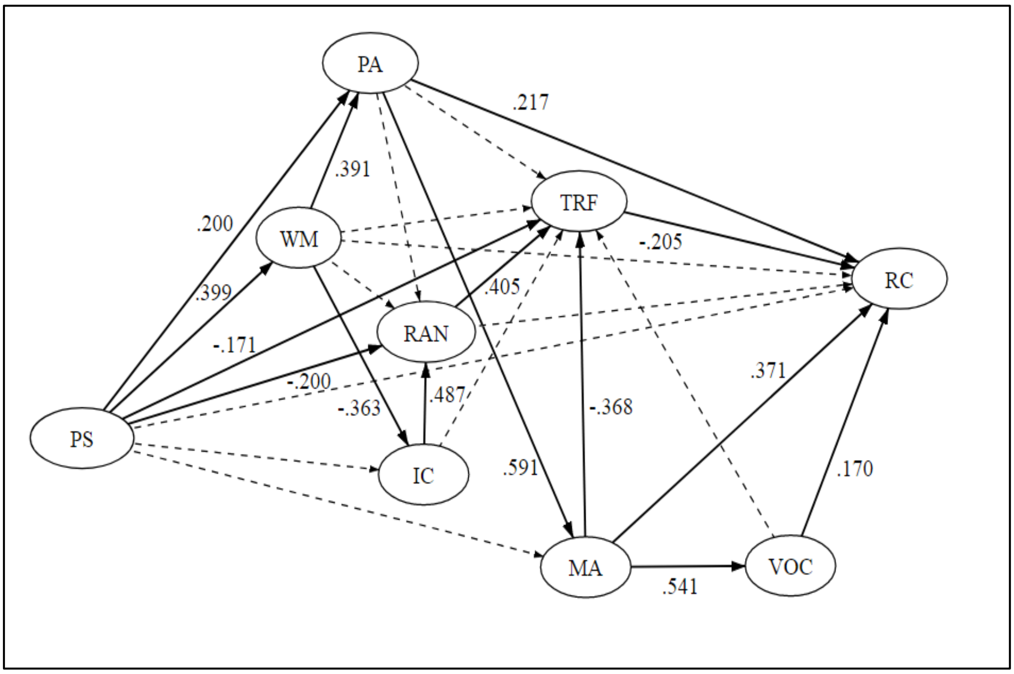


Figure 6. Direct and indirect predictors of reading comprehension

When the indirect effects on RC were examined in the complete model, MA was found to predict RC through vocabulary and TRF. PA had indirect connections with RC in three different pathways: through the mediating role of MA, through the connection between MA and vocabulary, and lastly, through the connection between MA and TRF. RAN made an indirect contribution to RC through TRF, and IC had an indirect effect on RC through the connection between RAN and TRF.

WM and PS were more indirectly related to RC, and had more complex relationships with the other variables. WM made indirect contributions to RC through PA, and through its connections with the mediating variables. WM was also related to RC through the connections of IC with RAN and TRF. Similarly, PS was found to have indirect effects on RC through PA, TRF, and through several indirect connections of PA, WM and RAN. The calculations for the total effects on RC are shown by Table 14.

Table 14. Summary of Causal Effects on RC

| Outcome | Determinants | Direct Effect | Indirect Effect | Total Effect |
|---|---|---|---|---|
| RC | MA | .37 | (.54)(.17) + (-.36)(-.20) = .16 | (.37) + (.16) = .53 |
| | TRF | -.20 | -- | -.20 |
| | VOC | .17 | -- | .17 |
| | RAN | -- | (.40)(-.20) = -.08 | -.08 |
| | IC | -- | (.48)(.40)(-.20) = -.03 | -.03 |
| | PA | .21 | (.59)(.37) + (.59)(-.36)(-.20) + (.59)(.54)(.17) = .31 | (.21) + (.31) = .52 |
| | WM | -- | (.39)(.21) + (.39)(.59)(.37) + (.39)(.59)(-.36)(-.20) + (.39)(.59)(.54)(.17) = .20 | .20 |
| | PS | -- | (.20)(.21) + (-.17)(-.20) + (-.20)(.40)(-.20) + (.20)(.59)(.37) + (.20)(.59)(-.36)(-.20) + (.20)(.59)(.54)(.17) + (.39)(.39)(.21) + (.39)(.39)(.59)(.37) + (.39)(.39)(.59)(-.36)(-.20) + (.39)(.39)(.59)(.54)(.17) + (.39)(-.36)(.48)(.40)(-.20) = .24 | .24 |

The calculations revealed that MA had the largest total effect on RC in Turkish. This was followed by PA, PS, TRF, WM, vocabulary knowledge, RAN and IC. Although IC was hypothesized not to have a direct causal effect on RC, it had a small indirect contribution to RC through the connection between RAN and TRF. For this reason, it was included in the calculation results.

In this chapter, the findings of the current study have been documented. The following chapter will present a detailed discussion on the research outcomes in light of the literature.

# CHAPTER 6

# DISCUSSION AND CONCLUSION

This chapter presents a discussion of the research findings in the current study. In the first part, the relationships between the variables will be discussed based on the correlational analyses. Next, the results of the regressions and the path analysis will be reviewed with some explanations on how the involvement of several cognitive and linguistic processes might shape reading ability in a transparent orthography. The following part will provide some pedagogical implications for the literacy education in the Turkish school settings; present the limitations of the current study and offer some suggestions for further research.

## 6.1 Relationships among the variables

In the current study, RAN had the strongest correlation with IC ($r$ = .515, $p$ < .01). As suggested by Bexkens et al. (2015), IC might be related to RAN due to the interference experienced by the participants while trying to disengage their attention from naming one item to another under time pressure. To this end, attentional control is likely to play an important role in explaining the RAN-reading relationship as suggested by Papadopoulos et al. (2016). RAN was also substantially and significantly associated with TRF ($r$ = .482, $p$ < .01), as a powerful and consistent precursor of reading fluency across languages (Norton & Wolf, 2012) including Turkish (Babayiğit & Stainthorp, 2010). On the other hand, RAN had relatively weak but significant correlations with WM ($r$ = -.204, $p$ < .05), PS ($r$ = -.269, $p$ < .01) and PA ($r$ = -.255, $p$ < .01).

The significant connections of RAN with WM, PS and PA were in line with the evidence (Amtmann et al., 2007; Badian, 1996; Bexkens et al., 2015; Kail & Hall, 1994; Papadopoulos et al., 2016; Wagner & Torgesen, 1987) showing that RAN is a highly complex, multicomponent construct. The finding that RAN and PA did not demonstrate a very strong relationship (as reported by Georgiou et al., 2008), provides supporting evidence for the view that RAN and phonological processing are two separate measures of reading ability (Savage & Frederickson, 2005; Wolf & Bowers, 1999).

The results also showed that RAN did not correlate with MA ($r = -.083$, $p > .05$) vocabulary ($r = -.054$, $p > .05$) and RC ($r = -.161$, $p > .05$) in the current study. This might suggest that RAN is more closely linked to lower-level processing which eventually contributes to reading fluency while MA, vocabulary and RC reflect higher-level processing in the reading system.

As for reading fluency, it was observed that TRF was substantially and significantly correlated with all of the variables. Among these, it had the strongest correlation with RC ($r = -.515$, $p < .01$). As fluency is an important prerequisite for reading comprehension (LaBerge & Samuels, 1974), the participants who completed reading the texts in a shorter period of time tended to have higher scores in the test of RC. TRF had similar correlations with MA ($r = -.432$, $p < .01$) and PA ($r = -.437$, $p < .01$). This might indicate that the students relied both on smaller (i.e., phonemes) and larger (i.e., morphemes) grain size units as they decoded sentences in Turkish. Although the orthographic transparency of Turkish seems to facilitate the utilization of phonemic information in general (Ziegler & Goswami, 2005), it is also likely that morphological units help readers decode or recognize words faster (Carlisle & Stone, 2005) given that Turkish-speaking children have high levels of morphological sensitivity due to the complex suffixation procedure in Turkish. This finding supports the notion that readers of transparent languages could switch between smaller and larger grain size units based on the requirements of a reading task, especially when they are involved in speeded reading (Georgiou et al., 2008). The association between MA and TRF might also point to the semantic processes which are activated for the reading of meaningful sentences presented in a contextual integrity. Likewise, the significant correlation of TRF with vocabulary ($r$ = -.322, $p$ < .01) suggest that although the participants were simply asked to read the paragraphs as fast as they could, they went beyond decoding, and relied on their vocabulary knowledge for meaning making. In other words, the readers with richer vocabulary knowledge were more likely to utilize contextual cues to understand the message, recognize the upcoming words, and read the text faster.

TRF demonstrated similar correlations with IC ($r$ = .395, $p$ < .01), WM ($r$ -.347, $p$ < .01) and PS ($r$ = -.346, $p$ < .01). In the current study, IC might have become relevant for reading fluency when the readers tried to suppress possible alternatives of the target words, syllables or sounds which were readily activated under time pressure. This relationship was in line with the suggestions of Altemeier et al. (2008), who argued that inhibition is closely associated with the task of combining letters and sounds. As for WM, its connection with TRF might be addressing the cognitive processes during which graphemes are mapped onto corresponding phonemes, and the retrieved phonemes are retained in storage for efficient word recognition (Just & Carpenter, 1992). Similarly, the significant relationship between TRF and PS highlights the importance of domain-general factors in the speeded processing of visual information given in a reading task (Babür, 2003; Christopher et al., 2012). Taken together, the moderate and significant correlations between TRF and all of the other variables could indicate that reading fluency is an intersection where lower-order skills are integrated into higher-order skills that are required for successful reading comprehension.

RC had moderate and significant correlations with most of the other variables. Among these, MA was found to be the strongest correlate of RC ($r = .679$, $p < .01$). Given the highly agglutinative structure of Turkish, this outcome is critical in showing that meaning making processes rely on the ability to understand the relationships between morphological units in Turkish (Durgunoğlu, 2017). RC also had a relatively high correlation with PA ($r = .554$, $p < .01$). This result seems to contradict with the finding that PA is foundational for lower-level reading skills (i.e., decoding), and loses its effect on reading earlier in transparent orthographies (Georgiou et al., 2016). However, the PA tasks used in the current study (phoneme reversal, in particular) might have indexed some other skills beyond phonemic awareness (e.g., working memory, orthographic processing), which, to some extent, could have influenced the comprehension process. The noteworthy correlations of PA with IC ($r = -.501$, $p < .01$) and WM ($r = .391$, $p < .01$) provide supporting evidence for this assumption.

RC and vocabulary had a stronger correlation ($r = .473$, $p < .01$) than the one between TRF and vocabulary ($r = -.322$, $p < .01$). This finding shows that as an important component of reading comprehension (Perfetti, 2007), vocabulary plays a more critical role in the integration of meaning into the mental text model (Perfetti & Stafura, 2014). RC also had significant correlations with IC ($r = -.318$, $p < .01$) and WM ($r = .324$, $p < .01$), indicating the possible role of EF in reading, especially when readers focus on the relevant parts in a text, store and process textual information, and rely on their background knowledge (Cain, 2006; Cain et al., 2004).

It was also found that RC had a relatively weak but significant correlation with PS ($r = .248$, $p < .01$), while it barely correlated with RAN ($r = -.161$, $p > .05$). This finding suggests that PS and RAN are connected to RC in more indirect ways.

Apart from the correlational findings for RAN, TRF and RC, there were also noteworthy relationships between some of the predictor variables. To begin with, PA and MA were moderately and significantly related to each other ($r = .591$, $p < .01$). This relationship might indicate that the complex suffixation in Turkish could support the development of phonological sensitivity at earlier stages, which, in turn, contributes to morphological processing skills in the highly agglutinative Turkish language (Durgunoğlu & Öney, 1999).

Another finding was that WM and IC were significantly correlated, but their correlation was lower than expected ($r = -.363$, $p < .01$). Although evidence shows that WM and IC are separable indices of EF, they tend to demonstrate moderate correlations (Miyake et al., 2000). This finding might have resulted from the fact that only a single measure of WM (i.e., backward digit span) was utilized in the current study. It is likely that a composite measure of WM including a series of different tasks could demonstrate stronger associations with the inhibitory component of EF.

Findings also showed that vocabulary was closely associated with MA ($r = .541$, $p < .01$), but not with PA ($r = .167$, $p > .05$). Although MA and PA are reported to have similar relationships with vocabulary in Grade 2 across languages (McBride-Chang et al., 2005), this was not the case for Turkish-speaking Grade 4 children in the current study. The reason behind this finding could be that PA plays a more central role in the earlier years of vocabulary development (Gillon, 2007) while MA plays a more important role in the learning of new vocabulary items or inferring the meanings of unfamiliar words in the later stages of literacy acquisition. Given the highly rich morphological system in Turkish, it is likely that MA overshadows the role of PA in vocabulary knowledge at this stage of literacy development.

The correlational data in the current study have provided valuable insight into the complexities of reading ability in Turkish. In the following part, findings from the regression analyses and the classical path analysis will be discussed separately for RAN, TRF and RC.

## 6.2 Predictors of rapid automatized naming

RAN is a powerful, consistent precursor of reading fluency (Wolf et al., 2000). As a central component of reading, it involves processing visual stimuli, retrieving its phonological representation from the long term memory, focusing on the target item while retaining the previously processed item in the working memory, and suppressing the urge to name already activated options. For this reason, it was hypothesized in the current study that PS (Kail & Hall, 1994), PA (Wagner & Torgesen, 1987), WM (Amtmann et al., 2007), and IC (Bexkens et al., 2015; Papadopoulos et al., 2016) would all make unique contributions to RAN.

The findings showed that IC had the strongest direct effect on RAN ($\beta$ = .48), and accounted for 23 % of the total variance in RAN. This result confirmed the related research hypothesis, and supported the earlier findings which reported a strong connection between RAN and IC (Bexkens et al., 2015; Papadopoulos et al., 2016). As suggested by Papadopoulos et al. (2016), the examination of IC as a predictor of RAN revealed its indirect effects on reading fluency, which is often overlooked in the literature.

PS was found to be another significant predictor of RAN, as hypothesized. It contributed to RAN both directly and indirectly through WM ($\beta$ = -.26), and explained nearly 4 % of the remaining variance in RAN. This finding showed that a domain-general mechanism (Badian, 1996; Kail & Hall, 1994) could, at least partially, account for the consistent relationship between RAN and reading

Unlike IC and PS, WM did not make an independent contribution to RAN in the current study. Instead, it was indirectly related to RAN through IC ($\beta$ = -.17). This might indicate that during RAN, the urge to suppress the activated options to name the target item is more critical than the temporary storage of the given stimuli.

Despite the fact that RAN requires the participants to access and retrieve the phonological units corresponding to the visual items (Wagner & Torgesen, 1987), PA did not contribute to RAN in the present study. Although this finding was not in line with the related research hypothesis, the correlational data had previously confirmed that PA was weakly but significantly related to RAN.

## 6.3 Predictors of text reading fluency

Fluency is an important component of reading which spares cognitive resources for the utilization of higher-order skills involved in reading comprehension (LaBerge & Samuels, 1974; Perfetti & Hogaboam, 1975; The National Reading Panel, 2000). Therefore, understanding which sub-skills contribute to reading fluency is likely to offer important pedagogical implications for literacy education at earlier stages of development. In the following part, the effects of the predictor variables on TRF are discussed based on the evidence from the literature.

### 6.3.1 The role of RAN in text reading fluency

The close relationship between RAN and reading is commonly attributed to their similarities in nature: both RAN and reading requires the serial processing of printed material and the rapid connection between visual information and phonological representations (Norton & Wolf, 2012; Wolf, 1991). RAN is reported to be a powerful index of reading fluency across different languages regardless of the orthographic depth (Norton & Wolf, 2012). In transparent orthographies, reading accuracy is relatively easy to acquire with the help of the highly regular phoneme-grapheme correspondence rules (Durgunoğlu & Öney, 1999). For this reason, reading fluency, rather than accuracy, emerges as an important measure of reading achievement in languages such as Turkish (Durgunoğlu, 2017). Therefore, the role of RAN becomes more pronounced in the examination of reading skills in transparent languages. To this end, in the current study, RAN was hypothesized to be the strongest predictor of TRF in Turkish. The results confirmed this hypothesis, and corroborated the findings from the previous studies including the ones conducted in Turkish (Albuquerque, 2012; Babayiğit & Stainthorp, 2010; 2011; Bektaş, 2017; Furnes & Samuelsson, 2011; Georgiou et al., 2016; Landerl & Wimmer, 2008; Norton & Wolf, 2012; Özata, 2018; Sönmez, 2015; Verhagen, et al., 2008). Accordingly, RAN had a direct and significant effect on TRF ($\beta$ = .40), explaining 15 % of the total variance in TRF as a unique predictor when entered into the equation simultaneously with MA and PS.

The independent contributions of RAN and PS to TRF suggest that a domain-general processing mechanism alone does not suffice to explain the consistent relationship between RAN and reading fluency (Badian, 1996; Kail & Hall, 1994). It could be argued that RAN, in its own right, is more important in explaining fluent reading than its association with other measures of literacy (Georgiou et al., 2016). For this reason, further research is needed for an in-depth exploration of what makes RAN such a unique predictor of reading fluency.

### 6.3.2 The role of MA in text reading fluency

Evidence shows that MA plays an important role in reading (Adams, 1990; Carlisle, 1995, 2000; Deacon & Kirby, 2004; Nunes & Bryant, 2006). Knowledge of morphemes enables readers to infer the meanings of novel words (Carlisle, 2000), and facilitates word recognition speed (Kirby et al., 2012). In addition, once readers master and store derivational/inflectional morphemes in their mental lexicon as chunks (Carlisle, 2010), they might rely on these units, which are generally larger than phonemes and graphemes. Therefore, the processing of larger units allows for speeded recognition of words (Carlisle & Stone, 2005).

The role of MA in reading is often documented to increase towards the later stages of reading acquisition (Carlisle, 2000; Deacon & Kirby, 2004; Kuo & Anderson, 2006; Singson et al., 2000). Kirby et al. (2012) suggest that it is easier for children to understand the function of morphemes through phonologically transparent relationships. In the current study, it was hypothesized that MA would make a significant contribution to TRF, given the agglutinative nature of Turkish (Babayiğit & Stainthorp, 2010), in which morphological structures reflect phonologically transparent relationships. It was predicted that the role of MA would be more pronounced in reading as the participants were Grade 4 students, who were expected to have higher sensitivity towards morphological units in Turkish.

The results showed that MA had a direct effect on TRF ($\beta$ = -.36), and explained 13 % of the total variance in TRF at a statistically significant level. This finding was in line with the related research hypothesis, and supported the previous findings reported for a variety of languages (Kirby et al., 2012; Kuo & Anderson, 2006; Kuzucu-Örge, 2018; Lyster, 2002). It is likely that the participants relied on their MA skills to a great extent when they attempted to decode derived and inflected words under time pressure.

On the other hand, this finding did not fully corroborate the results of some other studies conducted in transparent languages including Turkish (e.g., Babayiğit & Stainthorp, 2010; Bektaş, 2017; D'Alessio et al., 2019; Özata, 2018). D'Alessio et al. (2019) informed that MA predicted comprehension but not accurate and fluent word reading in Grade 4 as children relied on the regularity of phoneme-grapheme correspondence rules in the transparent orthography of Spanish. Although Turkish is similar to Spanish in terms of orthographic transparency, its morphology is richer, and the suffixation process is relatively complicated. For this reason, although Turkish-speaking students tend to rely on smaller units as they read words, it is likely that they also make use of morphemic units to some extent.

In Turkish, Babayiğit and Stainthorp, (2010) did not find a significant contribution of grammatical knowledge (including MA) to word and text reading fluency in a group of children followed from Grade 1 to 2. However, they acknowledged that grammatical knowledge might not exert any influence at the early stages of literacy acquisition and its connection with reading is likely to get stronger at later stages. In another study, Bektaş (2017) found that MA predicted word reading fluency in Turkish in the whole sample ($N$ = 87), but this effect was not observed across Grades 2 and 4. Similarly, Özata (2018) reported that while MA predicted comprehension through vocabulary in Turkish, it did not account for any variance in reading fluency across Grades 2 and 4. One reason behind the inconsistency between the findings of the current study and the others could be the use of different MA tasks. In the current study, MA was assessed through the use of completion tasks, in which the participants were asked to fill in the blanks with the appropriate derivational/inflectional suffix coming after a variety of pseudowords. On the other hand, Babayiğit and Stainthorp (2010) used a grammaticality judgement test (GJT) along with a correction task to assess the participants' morphological knowledge. Similarly, Bektaş (2017) used a GJT, in which the participants evaluated a list of sentences in terms of their morphological structures. Özata (2018) used Kuzucu-Örge's (2018) original versions of MA tasks, in which the participants were given two options and asked to choose the correct one. While MA was measured through recognition in these two studies, it was measured through production in the current study. The production task might be relatively challenging as reported by Durgunoğlu (2003) since children have no options and have to rely on their morphological inventory for the completion of novel items (i.e., pseudowords) based on the contextual cues. Hence, unlike other versions of the task, the manipulation of morphological units at this level might have played a more critical role in the speeded recognition of words in Turkish.

### 6.3.3 The role of PS in text reading fluency

As a key factor which determines the speed of decoding, word recognition and meaning making (Babür, 2003; Christopher et al., 2012; Kail & Hall, 1994; Papadopoulos et al., 2016; Peter et al., 2011; Urso, 2008), PS was hypothesized to predict reading fluency in the current study. The findings revealed that PS made a small but statistically significant unique contribution to TRF (around 3 %), as expected. PS also made several indirect contributions to TRF through its complex network of relationships with RAN, PA, and WM. Overall, it had a considerable amount of total effect on reading fluency ($\beta$ = -.35) in Turkish. This finding was in line with Akdemir's (2018) results, which showed that PS had a significant direct effect on text reading fluency in a group of adequate readers in Grade 5. On the other hand, it did not parallel the findings of Özata (2018), who reported that the inclusion of RAN and orthographic knowledge as the primary predictors of reading fluency might have masked the potential direct contribution of PS to reading fluency in Turkish. As orthographic knowledge was not measured in the current study, the results are not directly comparable to the ones in Özata's study (2018).

Another issue which should be noted here is that utilization of different PS tests could result in inconsistent findings in the explanation of the PS-reading relationship. Using a composite measure which includes different tasks of PS (Urso, 2008) might offer deeper insights as to the role of PS in reading fluency.

#### 6.3.4 The role of vocabulary in text reading fluency

As high-quality items in the mental lexicon facilitate rapid identification of words (Perfetti, 2007), it was hypothesized in the current study that vocabulary knowledge would contribute to reading fluency in Turkish. Although Turkish-speaking readers are reported to identify words and pseudowords in a similar way (Durgunoğlu, 2017) due to the highly regular phoneme-grapheme correspondence rules, they could also use word specific knowledge, especially when reading connected text. More specifically, it was assumed that reading sentences in a meaningful context might also require semantic processing beyond efficient decoding. However, the findings showed that vocabulary failed to predict TRF in Turkish. This result corroborated the findings of Babayiğit and Stainthorp (2010, 2011), who found no particular role of vocabulary in the prediction of reading fluency in Turkish. On the other hand, it did not parallel some of the earlier findings reported for Dutch (Verhoeven et al., 2011) and English (Ouellette, 2006). Verhoeven et al. (2011) found that early vocabulary knowledge predicted decoding fluency in Dutch, which is another transparent language. However, the researchers acknowledged that the contribution of vocabulary to reading fluency was rather small in comparison to its significant effect on reading comprehension. Ouellette (2006) found that receptive vocabulary breadth contributed to decoding while expressive vocabulary breadth predicted visual word recognition in English. Given the opaque orthography of English, it is likely that English-speaking children rely more on word-specific orthographic information provided by their vocabulary knowledge in order to identify words more efficiently. This was not the case for the Turkish-speaking children in the current study, who probably utilized sublexical strategies for efficient word identification in the transparent orthography of Turkish. It is also likely that the TRF measure, which simply required the participants to read the sentences as rapidly and accurately as possible did not engage them in a considerable amount of semantic activation. Using an oral fluency task which also measured the participants' prosodic skills (Kuhn & Stahl, 2003; Rasinski et al., 2002) might have revealed different results regarding the role of vocabulary in fluent reading as an index of semantic processing.

### 6.3.5 The role of PA in text reading fluency

PA is a foundational skill in literacy acquisition (Adams, 1990; Anthony & Francis, 2005; Babayiğit & Stainthorp, 2007), and an important predictor of decoding across languages (e.g., Bradley & Bryant, 1983; Caravolas et al., 2005; Seymour et al., 2003). Although PA is reported to have a time-limited effect on reading skills in transparent languages (Georgiou et al., 2016), it was hypothesized that PA could make a small but statistically significant contribution to TRF in the present study. This assumption was based on the fact that the participants would rely on phoneme-level information, which is highly reliable for efficient word decoding in transparent orthographies (Ziegler & Goswami, 2005). In addition, it was believed that the more advanced measures of PA which were used for Grade 4 students would differentiate between their performances in TRF. However, the findings showed that PA failed to make a unique contribution to TRF in Turkish. This finding is not surprising as PA plays a more critical role at the earlier stages of reading development in transparent languages (Georgiou et al., 2008). Since accuracy is mastered very quickly in these languages, fluency becomes more relevant for the assessment of reading ability (de Jong & van der Leij, 1999). For this reason, RAN, rather than PA, was found to be the strongest precursor of TRF in the current study (Babayiğit & Stainthorp, 2011). On the other hand, PA, as an index of reading accuracy, did not have a direct and significant effect on TRF. This result was in line with some of the earlier findings in Turkish (e.g., Bektaş, 2017; Kuzucu-Örge, 2018; Özata, 2018), which reported that the effect of PA on reading fluency was much weaker when compared to the effect of RAN.

The finding that PA had no direct effect on TRF does not necessarily mean that PA is irrelevant for fluent reading. It could be the case that how PA interacts with reading ability changes as children become more experienced readers. The results of the path analysis showed that PA made an indirect contribution to TRF through MA ($\beta$ = -.21). This means that the participants with higher levels of PA were more competent in understanding, producing and manipulating morphological units, which, in turn, facilitated their fluency in reading.

### 6.3.6 The role of EF in text reading fluency

In the current study, the role of EF in reading was investigated in relation to WM and IC. WM was hypothesized to make an independent contribution to TRF as reading connected text, rather than isolated words, could require the storage and integration of textual information to a greater extent. It was also assumed that WM might have a direct effect on TRF as EF tends to play a more important role in the speeded measures of reading in the later years of elementary school (Altemeier et al., 2008). However, the results showed that WM was not a direct predictor of TRF in Turkish, and failed to confirm the related research hypothesis. This finding provided supporting evidence for the findings of Georgiou, Das and Hayward (2008), who reported that WM failed to predict decoding in the presence of RAN and PA, which were two critical components of reading ability in English. On the other hand, it was not in line with some of the earlier studies, which reported that WM made a unique contribution to word identification skills in English and Dutch (e.g., Christopher et al., 2012; Jacobson et al., 2017; Nouwens et al., 2020; Welsh et al., 2010).

Recent studies in Turkish mostly focused on the role of STM or PM rather than WM in reading speed (Babayiğit & Stainthorp, 2007; Bektaş, 2017; Kuzucu-Örge, 2018; Özata, 2018). As these studies utilized memory tasks such as forward digit span, word span, nonword repetition, or a combination of forward and backward digit recall, their results are not directly comparable to the one in the current study. Still, their findings might shed light on the involvement of memory systems in the processing of written information in Turkish. In their study, Babayiğit and Stainthorp (2007) reported that preschool STM was the strongest predictor of word and text reading speed in Grades 1 and 2. They explained that the operationalization of STM and variations in research methodology could have yielded inconsistent findings across different studies. They also suggested that STM might be important especially at earlier stages of reading acquisition, when children attempt to read multimorphemic words with complex suffixation. In other studies, (Bektaş, 2017; Kuzucu-Örge, 2018; Özata, 2018), PM was not significantly related to reading fluency in Turkish, or it did not predict word and text-level reading (in Grades 2 and 4) in the presence of other variables such as RAN and PA.

In the current study, WM had a significant correlation with TRF ($r$ = -.347, $p$ < .01), which echoed the one reported for WM and decoding ($r$ = .35, $p$ < .05), in the transparent orthography of Brazilian Portuguese (Engel de Abreu et al., 2014). Despite this connection, WM did not emerge as a unique predictor of TRF in Turkish. It is likely that the TRF task did not impose a substantial amount of burden on the WM thanks to the highly regular mappings between phonemes and graphemes in Turkish. Therefore, it could be suggested that in languages with more opaque orthographies, readers are more likely to rely on their memory systems for decoding and/or recognizing words when compared to their Turkish-speaking peers. When the indirect connections between WM and TRF were examined, it was found that WM contributed to TRF through two indirect pathways. In the first one, WM was related to TRF through the IC-RAN connection. In the second one, WM predicted TRF through its association with the PA-MA connection. Overall, it had a noteworthy total effect on TRF ($\beta$ = -.15). These results suggest that WM could be more relevant for the lower-level skills (i.e., phonemic processing and attentional control) which contribute to reading fluency in Turkish.

As a primary component of EF, IC is less researched in relation to reading skills. In the current study, it was hypothesized that IC might play a direct role in the prediction of TRF based on the evidence that linking letters and sounds under time pressure entails attentional control (Altemeier et al., 2008). However, the results showed that IC failed to make a unique contribution to TRF in Turkish, which was not in line with the previous findings documented for other languages (Altemeier et al., 2008; Nouwens et al., 2020; Jacobson et al., 2017; Welsh et al., 2010).

In English, Altemeier et al. (2008) reported that EF was a better predictor of decoding accuracy in earlier grades. As the grade level increased, EF became a better predictor of decoding fluency. The authors explained that decoding words accurately was an effortful task for beginning readers and they might have tried to inhibit irrelevant cues during the task. At later stages (i.e., Grade 4), EF was more closely associated with fluency measures. In the current study, it could be argued that unlike their English-speaking peers, Turkish-speaking children did not need to rely on the IC mechanism as they read words and sentences thanks to the orthographic transparency of Turkish. Instead, IC was found to be an indirect predictor of TRF ($\beta$ = .19), which was primarily related to RAN. Like WM, IC was also more relevant for the foundational skills that contributed to reading fluency.

The indirect connection of IC with TRF through the mediating role of RAN should not be underestimated. This finding suggests that along with WM (Amtmann et al., 2007), IC plays an important role in the explanation of the RAN-reading relationship (Papadopoulos et al., 2016). At this point, it is not possible to draw clear-cut conclusions as to the role of IC in Turkish-speaking children's reading ability given the lack of research on this specific connection in Turkish.

## 6.4 Predictors of reading comprehension

Reading comprehension (RC) is the ultimate goal of every reading act and a key trait for personal and academic development in life (Duke & Carlisle, 2011). It is a highly complex construct which entails the coordination of several cognitive and linguistic components (Adams, 1990; Kintsch; 2005; Paris & Hamilton, 2009; Snow, 2002). In order to understand how each of these components contribute to RC, the current study explored the roles of TRF, MA, PA, vocabulary, PS, WM and RAN in a group of Turkish-speaking Grade 4 children. In the following subsections, the findings for each component will be discussed in detail.

### 6.4.1 The role of TRF in reading comprehension

Fluency is central for reading comprehension (LaBerge & Samuels, 1974; Perfetti & Hogaboam, 1975; The National Reading Panel, 2000). So far, numerous studies have documented that fluent reading makes a significant contribution to reading comprehension (e.g., Akdemir, 2018; de Jong & van der Leij, 2002; Jenkins et al., 2003; Klauda & Guthrie, 2008; Özata, 2018). Based on these findings, it was hypothesized in the current study that TRF would make a unique contribution to RC in Turkish. The results confirmed this hypothesis, and showed that TRF was a significant and direct predictor of RC ($\beta$ = -.20).

The unique contribution of TRF to RC was quite small (3 %) when entered into the equation simultaneously with MA, PA and vocabulary knowledge. Similar findings were reported by Babayiğit and Stainthorp (2011, 2014), who found that listening comprehension was a stronger longitudinal predictor of RC when compared to reading fluency (and accuracy) in Turkish. The researchers explained this finding with the relatively early acquisition of basic decoding skills in the transparent orthography of Turkish. They also suggested that in line with the simple view of reading, the role of linguistic comprehension became stronger as the effects of decoding skills faded away over time. This explanation seems to account for the reading outcomes of the Grade 4 students in the current study, who had high levels of mastery in decoding. Although their listening comprehension was not measured, MA and vocabulary could be viewed as parts of linguistic comprehension; and their inclusion in the regression model might have reduced the amount of unique variance explained by TRF in RC.

Overall, it could be stated that the significant contribution of TRF to RC in the current study supported the automaticity theory (LaBerge & Samuels, 1974), and emphasized the importance of efficient decoding for RC as proposed by the simple view of reading (Gough & Tunmer, 1986) in the context of Turkish.

### 6.4.2 The role of MA in reading comprehension

MA is documented to predict different aspects of reading such as word recognition, reading fluency and comprehension in a variety of languages (Carlisle, 1995; Carlisle, 2000; Carlisle & Stone, 2005; D'Alessio et al., 2019; Deacon & Kirby, 2004; Kirby et al., 2012; Kuo & Anderson, 2006; Singson et al., 2000; Nagy et al., 2006; Nunes & Bryant, 2006). Some studies report that MA has a greater influence on RC than on single word reading (e.g., D'Alessio et al., 2019; Deacon & Kirby, 2004) as the knowledge of how morphemes are manipulated to derive and inflect words plays a major role in the meaning making processes. This knowledge could be more relevant for reading skills in agglutinative languages such as Turkish since readers often deal with complex suffixation procedures (Durgunoğlu, 2017). To this end, it was hypothesized in the current study that MA would be a significant predictor of RC in Turkish. The results confirmed this hypothesis and showed that MA made a direct and significant contribution to RC ($\beta$ = .37), and uniquely explained 6 % of the total variance in RC. In addition, MA made indirect contributions to RC through vocabulary and TRF. Overall, MA had the largest total effect on RC in Turkish ($\beta$ = .53).

Given the strong effect of MA on vocabulary knowledge ($\beta$ = .54), it is likely that the simultaneous inclusion of MA and vocabulary in the regression model might have reduced the amount of unique variance explained by MA in RC. However, as unique predictors of RC, MA and vocabulary were observed to increase the model’s overall predictive power. At this point, it could be argued that what is shared between morphological knowledge and vocabulary plays a central role in the comprehension skills of Turkish-speaking Grade 4 children. This result supports some of the previous findings reported for Turkish (e.g., Akdemir, 2018; Özata, 2018), which showed that MA contributed to RC through vocabulary in Grades 2, 4 and 5. However, different from the finding in current study, MA failed to make a direct contribution to RC in Özata's (2018) study while it directly contributed to RC in poor readers but not in adequate readers in Akdemir's (2018) study. This discrepancy might have resulted from the utilization of different MA measures in these studies. Still, it could be concluded from the findings that MA is a critical component of RC in the highly agglutinative and morphologically rich structure of Turkish.

### 6.4.3 The role of PA in reading comprehension

As an important predictor of reading ability (Adams, 1990; Anthony & Francis, 2005; Bradley & Bryant, 1983; Caravolas et al., 2005; Gillon, 2007; Seymour et al., 2003; Ziegler & Goswami, 2005), PA is often reported to have a transient effect in transparent languages (Georgiou et al., 2016) due to the earlier mastery of decoding skills (Babayiğit & Stainthorp, 2007; de Jong & van der Leij, 1999; Landerl & Wimmer, 2008). However, studies often focus on the effects of early PA skills on reading outcomes in longitudinal research designs. For this reason, relatively simple tasks (e.g., syllable deletion, rhyme recognition) are used to assess PA between kindergarten and Grades 1-2.

In the present study, the concurrent effect of PA on reading was measured via the tasks of elision and phoneme reversal, which were assumed to be challenging enough to differentiate between the phonological skills of Grade 4 students. To this end, it was hypothesized that PA could have a direct effect on RC in Turkish. The results confirmed this hypothesis, and showed that PA accounted for a small but statistically significant amount of variance (nearly 3 %) in RC. This finding showed that PA could be closely associated with RC beyond its contributions to decoding accuracy and fluency. In addition to its direct effect, PA was also found to have indirect contributions to RC through its connection with MA. Overall, PA had a substantial amount of total effect on RC ($\beta$ = .52).

Although such a result was not reported for Turkish, several studies found that PA was directly related to RC in other languages (Cárnio et al., 2017; Edwards & Taub, 2016; Engen & Høien, 2002; Holsgrove, 2003; Kroese et al., 2000). The inconsistent findings are likely to result from the utilization of different types of PA measures in the field. For instance, Edwards and Taub (2016) reported that phoneme blending had a greater influence on RC from Grade 1 to 4 when compared to phoneme segmenting in English. Likewise, Engen and Høien (2002) found that phoneme awareness had a greater influence on RC when compared to syllable awareness in Norwegian. The researchers explained that in addition to its connections with vocabulary and STM, PA might be reflecting some of the metacognitive processes involved in RC. Similarly, Kroese et al. (2000) reported that phoneme elision and phoneme reversal were stronger predictors of reading (word attack and reading comprehension) when compared to blending and segmenting in a group of English-speaking readers.

When compared to the elision task, phoneme reversal was found to be a more efficient measure which differentiated between the participants in the current study. Tunmer (1989) explains that phoneme reversal not only requires phoneme segmentation, but also high levels of phonemic coding in the working memory. In order to reduce the burden of such an additional cognitive task, Tunmer (1989) suggests, readers are likely to generate "an orthographic image of the word, mentally reordering the word's letters and then reading the result in their mind's eye" (p. 108). Accordingly, phoneme reversal could play a more complex role in its relationship with reading than relatively simple tasks of PA (e.g., phoneme recognition). The significant effect of WM on PA ($r$ = .391, $p < .01$) was in line with this suggestion. Hence, the use of phoneme reversal task in the current study might account for the unique contribution of PA in RC, which was not reported for Turkish in the previous studies (e.g., Özata, 2018). To this end, this finding could offer new insights into the multifaceted role of PA in the prediction of reading ability in transparent languages.

### 6.4.4 The role of vocabulary in reading comprehension

Vocabulary knowledge is a major component of oral language skills, which make considerable contributions to reading ability (Nation & Snowling, 1999; Scarborough, 2005; Stanovich, 1990). Although vocabulary predicts reading through lower-level skills at earlier stages, its direct effect on reading comprehension is reported to increase at later stages of literacy development (Storch & Whitehurst, 2002). To this end, it was hypothesized in the present study that vocabulary would emerge as a significant predictor of RC in Turkish. The results confirmed this hypothesis, and showed that vocabulary had a direct, independent effect on RC ($r$ = .473, $p < .01$; $\beta = .17$), explaining a small but statistically significant amount of unique variance (nearly 2 %) in RC.

As discussed earlier, the inclusion of vocabulary in the analyses along with MA, PA and TRF diminished the unique contributions of each independent variable while it increased the predictive power of the regression model as a whole. It was observed that the shared variance between vocabulary and MA was an important factor in the explanation of RC in Turkish, which supported the suggestions of Mc-Bride et al. (2005). Unlike MA, PA barely correlated with vocabulary knowledge in the current study. This result might suggest that Grade 4 students have moved to a stage where they rely on their morphological processing skills (Carlisle, 2000; Deacon & Kirby, 2004) more than their phonological knowledge as they learn, manipulate and reflect on vocabulary items.

The unique role of vocabulary in the prediction of RC corroborated the previous findings in the literature (Babayiğit & Stainthorp, 2011, 2014; Ouellette, 2006; Özata, 2018; Roth et al., 2002; Tannenbaum et al., 2006; Verhoeven & van Leeuwe, 2008; Verhoeven et al., 2011). It also provided supporting evidence for the lexical quality hypothesis (Perfetti, 2007; Perfetti & Stafura, 2014), which proposes that high-quality orthographic information in the mental lexicon is a critical component for successful reading comprehension.

### 6.4.5 The role of EF in reading comprehension

Evidence shows that EF is associated with reading comprehension in different age groups (Follmer, 2018). Based on the evidence in the literature, it was hypothesized that IC would predict lower-level reading skills (TRF) (Altemeier et al., 2008; Jacobson et al., 2017) while WM was expected to predict both lower (TRF) and higher-level reading skills (RC) in Turkish (Cain et al., 2004; Chang, 2020; Christopher et al., 2012; Daneman & Carpenter, 1980; Daneman & Merikle, 1996; Engel de Abreu et al., 2014; Georgiou, Das & Hayward, 2008; Nouwens, et al., 2020; Oakhill et al., 2005; Seigneuric & Ehrlich, 2005).

The findings revealed that in line with the related hypothesis, IC did not make a unique contribution to RC. Instead, it made a very small indirect contribution to RC through its connection with RAN, and the following pathway through TRF ($\beta$ = -.03). This result highlights the important role of IC at the foundational levels of reading, which is conceptualized as a multilayered system in the current study. As for the role of WM, it was assumed that construction of meaning based on the storage and integration of information coming from different sources would require the involvement of WM. However, WM did not uniquely contribute to RC in the current study. Instead, it had an indirect effect on RC through its associations with PA and IC, followed by several other pathways ($\beta$ = .20).

Given the higher-order processes involved in RC, WM was more likely to have larger effects on RC (Seigneuric & Ehrlich, 2005) than on TRF. Nevertheless, WM demonstrated similar correlations (around .30, $p < .01$) with TRF and RC. These correlational patterns were in line with the ones reported in Babayiğit and Stainthorp's (2011) study; and failed to differentiate between the cognitive aspects of reading fluency and reading comprehension in Turkish.

The nonsignificant role of WM in RC could be explained by four possible factors. First, the effects of EF could be more visible on the speeded measures of reading at later stages of schooling (Altemeier et al., 2008). Given that each participant was allowed to finish the RC test at their own pace, they might have demonstrated less reliance on their cognitive resources than expected. Including a timed measure of RC could have yielded different results regarding the effects of WM on RC. Second, the complexity of orthography might have played a role in these findings. In line with the suggestions of Lan et al. (2011), who found that WM had stronger connections with reading in a logographic orthography than in an alphabetic one, reading in an alphabetic and highly transparent orthography might have eased the comprehension process in Turkish. Third, utilizing a series of different WM tasks could have revealed the potential contributions of WM more clearly. To exemplify, Nouwens et al. (2020) used a backward digit span and a language processing task in which the participants were asked to recall the final words of sentences after they decided whether the sentences were semantically correct or not. Their findings showed that WM had both direct and indirect (through decoding) effects on RC in Dutch-speaking children who were followed from Grade 4 to Grade 5. In the current study, however, backward digit recall was used as the sole measure of WM. Finally, given that WM is more relevant for answering inferential questions in a reading text, it is likely that the possible direct effects of WM were concealed as the RC test was a combined measure including both literal and inferential questions.

### 6.4.6 The role of PS and RAN in reading comprehension

In the literature, both RAN and PS are documented to be consistent predictors of reading fluency (Albuquerque, 2012; Babayiğit & Stainthorp, 2010; 2011; Christopher et al., 2012; Furnes & Samuelsson, 2011; Georgiou et al., 2016; Kail & Hall, 1994; Landerl & Wimmer, 2008; Norton & Wolf, 2012; Papadopoulos et al., 2016; Urso, 2008). On the other hand, evidence showing their direct effect on RC is more limited (Christopher et al., 2012; Kirby et al., 2003; Manis et al., 1999; Joshi & Aaron, 2000; Plaza & Cohen, 2003). Based on the model proposed by Joshi and Aaron (2000), it was hypothesized in the current study that PS and RAN could make significant contributions to RC in Turkish. However, the results showed that both PS and RAN were indirect predictors of RC. While RAN had a very small effect on RC through the mediating role of TRF ($\beta$ = -.08); PS had a much larger total effect on RC ($\beta$ = .24), as a result of its connections with PA, WM, RAN and TRF.

The indirect role of RAN in the explanation of RC indicates that foundational skills such as speeded retrieval of word-specific orthographic information pave the way for better outcomes in RC. Similar findings were reported by Özata (2018), who found that RAN predicted RC through word reading fluency while PS was connected to RC in a more indirect way (through orthographic knowledge and its effect on reading fluency).

Unlike RAN, PS is a domain-general factor, which coordinates the processing of different types of stimuli (Peter et al., 2011). For this reason, it is involved in the execution of several cognitive and linguistic tasks, which consequently contribute to the construction of meaning in a reading activity (Christopher et al., 2012). It is likely that PS not only improves with age (Kail & Hall, 1994), but also is utilized to a greater extent to deal with the requirements of different literacy measures.

The findings of the current study failed to support the model proposed by Joshi and Aaron (2000), who found that PS (measured as rapid letter naming) made a unique contribution to RC beyond decoding and listening comprehension, and hypothesized that the predictive value of the model was likely to increase starting from Grade 4. In their study, the researchers utilized the word attack test to measure decoding skills, in which the participants were asked to read 30 nonwords as rapidly and accurately as possible. Although word attack measured fluency and accuracy at the same time, it was an untimed test, which focused on the total number of correctly read items. For this reason, PS might have emerged as a significant predictor of RC in their model. In the current study, TRF was included in the analyses as a timed measure, which focused on the time needed to complete the reading task. Therefore, the potential direct effects of RAN and PS might have been subsumed under TRF as the main component of speed and decoding, which emerged as a unique predictor of RC in the current study.

## 6.5 Conclusion

The present study aimed to shed light on the concurrent predictors of reading skills in Turkish-speaking Grade 4 children. The findings showed that at this critical stage of literacy development, several cognitive and linguistic factors contributed to reading fluency and reading comprehension in Turkish.

The findings showed that IC and PS were the significant predictors of RAN, which made the strongest contribution to TRF. On the other hand, WM had an indirect effect on RAN through the mediating role of IC while PA did not make any direct or indirect contributions to RAN.

The significant effect of RAN on TRF provided supporting evidence for the consistent role of RAN in fluent reading especially in transparent languages. This might indicate that Turkish-speaking children who are well beyond the beginning stages of literacy acquisition make use of sight word reading efficiently by relying on word-specific orthographic information for familiar words in Turkish. As it is not possible to assume that RAN is an index of orthographic processing only, one could also speculate that children are involved in a highly automatized processing of sublexical information, which parallels what is defined as sight word reading in the transparent Turkish orthography.

Besides RAN, MA and PS were found to make unique contributions to TRF in Turkish. Given that Turkish is an agglutinative and morphologically rich language, it is likely that the participants relied on their morphological processing skills when they had to recognize words (especially those with derivational and inflectional suffixes) under time pressure. Despite the independent contribution of PS to TRF, what was unique to RAN explained most of the unique variance in reading fluency. In addition, PA, WM, IC and PS made indirect contributions to TRF in a network of complex relationships.

As for RC, the results showed that TRF was a significant predictor of RC in the current study. This finding emphasized the key role of fluency for successful RC in Turkish, and provided supporting evidence for the automaticity theory. Accordingly, the participants who could read the texts more fluently had the chance to spare greater amounts of cognitive resources for higher-order reading skills and performed better in the test of RC.

Despite the important role of fluency in RC, it was MA which had the strongest direct contribution to RC in the present study. It also had indirect effects on RC through the mediating roles of vocabulary and TRF. At this point, it could be suggested that the ability to construct meaning out of morphological units extends to the overall comprehension in a given reading activity. In addition, the significant effect of MA on vocabulary might indicate that Grade 4 children relied on MA to retrieve and manipulate lexical information, which is critical for successful RC. These findings show that the examination of MA could offer valuable insights into the complex nature of reading ability especially in morphologically rich languages.

Although PA is mostly reported to predict lower-level reading skills and to have longer lasting effects in opaque orthographies, it made a unique contribution to RC in the current study. This result was explained by the selection of the PA measure, which was a composite of elision and phoneme reversal tasks. More specifically, it was suggested that the time-limited effects of PA on reading might have resulted from the use of relatively simpler tasks to assess early PA skills in the literature. In the present study, phoneme reversal might have tapped more complex processes such as the interaction of WM with orthographic processing, which, in turn, contributed to RC in Turkish. This finding could indicate that what is measured by more complex PA tasks could go beyond the assessment of phonological processing skills, and different levels of PA could have varying effects on reading outcomes throughout the school years. More research is needed to understand which sub-skills are involved in phoneme reversal and to examine its concurrent and longitudinal contributions to reading ability.

Vocabulary was another significant predictor of RC in the current study. This finding suggested that children with larger and richer vocabulary knowledge performed better in the test of RC. The important role of vocabulary in RC provided empirical evidence for the lexical quality hypothesis in the context of Turkish. In addition, the independent contributions of vocabulary (as an index of oral language and linguistic comprehension) and reading fluency (as an indicator of efficient decoding/word recognition) to RC supported the component model which was proposed by the simple view of reading.

The results also showed that RAN, IC, PA, PS and WM made indirect contributions to RC through a multitude of connections. Based on this finding, it could be argued that these components play a foundational role in the coordination of higher-level reading skills in Turkish.

The current study was an exploratory attempt to portray the predictors of reading in Turkish-speaking Grade 4 children. Overall, it showed that several factors contributed directly and/or indirectly to different aspects of reading ability in Turkish. While some of the measures were significant predictors of reading, others failed to make unique contributions. Still, important relationships were documented among the variables. These relationships provide valuable information for a better understanding of the componential nature of reading ability and the creation of a more comprehensive model of reading in Turkish.

### 6.6 Pedagogical implications

The findings of the current study point to the importance of several components in the prediction of reading fluency and reading comprehension in Turkish. While RAN, MA and PS were the significant and direct predictors of reading fluency; MA, PA, TRF and vocabulary made direct and significant contributions to reading comprehension. These findings suggest that activities related to the teaching of vocabulary, rapid naming, phonological and morphological skills could prepare students for more successful outcomes in reading. In addition, the indirect contributions of WM and IC to reading highlight the importance of integrating cognitive activities (e.g., memory and attention games) into literacy instruction.

Regarding vocabulary, the practitioners should prioritize activities which focus on improving their students' depth of vocabulary knowledge. Vocabulary depth is an important index of the quality of lexical representations in memory, which could explain the dissociation between good and poor comprehenders who are matched for their decoding efficiency (Ouellette, 2006). Therefore, in addition to word meanings, students should also learn different uses of words in a variety of contexts, their multiple meanings and other vocabulary items related to the target words. Furthermore, the strong connection between vocabulary and MA suggests that the teaching of vocabulary should be supported with activities involving morphological analysis of words. As morphemes are the building blocks of meaning, being knowledgeable about these units could allow children to make better inferences about the possible meanings of unfamiliar words, engage in a deeper level of semantic processing and consequently succeed in reading comprehension.

It is possible to teach and improve reading comprehension explicitly (Paris & Hamilton, 2009). By taking each of the key components into consideration, teachers could help their students make progress in their reading ability. As decoding is mastered very quickly in Turkish, educators could take this advantage to focus on the cognitive and linguistic foundations of reading at earlier stages of development.

## 6.7 Limitations

The current study had several limitations which should be acknowledged. First, it had a small number of participants who were conveniently available for the researcher. In addition, the participants were all attending the same school. For this reason, it is not possible to generalize the results of the study to the population of Turkish-speaking Grade 4 children. Including larger samples across different schools located in different parts of the city (thus, including a wider array of participants with different socioeconomic profiles) would have provided the researcher with a more comprehensive portrait about the predictors of reading skills in the Turkish context.

Second, although the present study focused on Grade 4, which is a critical threshold for reading development, including participants from Grades 1, 2 and 3 could have offered the researcher an opportunity to compare the developmental patterns of reading ability across grade levels.

Another limitation of the present study was that some of the data collection instruments were in the process of standardization for Turkish. Following the completion of test development and standardization studies, these measures could provide normative data for Turkish-speaking populations, and contribute to the credibility of findings to a greater extent. It should be also noted that there could be some suitability issues with the WM measure (i.e., backward digit recall) used in the current study. Contrary to expectations, WM failed to make a unique contribution to RC, and its correlation with IC was lower than expected. Utilizing more than one WM measure could have provided a clearer picture as to nature of WM as a component of EF and its unique role in the prediction of RC.

Although the present study included several important predictors of reading, it did not utilize any measure of orthographic knowledge. This was due to the lack of testing materials designed for the assessment of orthographic awareness in Turkish. Besides, when compared to the well-established components of reading (e.g., PA, RAN), orthographic awareness is a relatively new concept in the field of literacy research. For this reason, it is more difficult to define, operationalize and measure orthographic awareness in relation to reading (Holland, McIntosh & Huffman, 2004).

Another limitation of the present study was that text reading fluency was measured based on how quickly the participants could read the given paragraphs. Including an additional criterion about the application of prosodic cues during oral reading could provide further insights into the connections between reading fluency and reading comprehension (Kuhn & Stahl, 2003).

Lastly, the present study aimed to develop and test a reading model based on the findings in the literature. Due to the exploratory nature of the study, the ultimate model might not have portrayed all of the complex relationships among the variables. Still, it could provide a basic understanding about the interplay of different factors in the prediction of reading skills, and contribute to the foundations of a more advanced model of reading in Turkish.

## 6.8 Recommendations for further research

The present study attempted to explore the concurrent predictors of reading skills in Turkish-speaking Grade 4 children. Further research could investigate the components of reading in a longitudinal design to see how each predictor contributes to reading in the long term. In addition, future studies could include participants from different grade levels to follow the trajectory of reading development throughout the school years. It is also recommended that future studies should compare different reader groups (i.e., normally developing children vs. children with dyslexia) and the effects of different instructional methods on reading achievement in Turkish.

# APPENDIX A

## SAMPLE TEST ITEMS

### TEST OF READING COMPREHENSION

Cuma günü son ders beden eğitimiydi. Can, arkadaşlarıyla basketbol oynadıktan sonra evin yolunu tuttu. Omuzlarında bir hafiflik hissediyordu. Birden durdu. Çantasını okulda unutmuştu! Koşarak geri döndü. Merdivenleri çıkarken öğretmenini gördü. Ona, çantasını unuttuğunu söyledi. Sınıfa girdiğinde Hasan Bey yerleri süpürüyordu. Can, sırasına baktı ama çantasını göremedi. Hasan Bey gülümseyerek ona doğru yaklaştı ve "Çantanı arıyorsan, az evvel kayıp eşya dolabına bıraktım." dedi. Can teşekkür etti ve dolaptan çantasını aldı.

*(The last class on Friday was physical education. Can headed home after playing basketball with his friends. His shoulders felt so light. Suddenly he stopped. He had left his bag at school! He went to school running back. He saw his teacher as he climbed the stairs. He told him he had left his bag. Hasan Bey was sweeping the floor when he entered the classroom. Can looked at his desk, but could not see his bag. Hasan Bey approached him with a smile and said, "If you're looking for your bag, I just left it in the lost and found locker." Can thanked him and took his bag from the locker.)*

SORULAR *(QUESTIONS)*

1. Can beden eğitimi dersinde ne yaptı?
   *(What did Can do during the physical education class?)*

   ……………………………………………………………………………………

2. Hasan Bey kim olabilir?
   *(Who could Hasan Bey be?)*

………………………………………………………………………………………..

RAN (HOTI) LETTERS

| | | | | |
|---|---|---|---|---|
| k | s | m | b | t |
| s | k | m | b | t |

RAN (HOTI) DIGITS

| | | | | |
|---|---|---|---|---|
| 2 | 6 | 9 | 4 | 7 |
| 6 | 2 | 9 | 7 | 4 |

PHONOLOGICAL AWARENESS: ELISION

tara(k) → tara *(comb → to comb)*

kar(g)a → kara *(crow → black)*

ka(r)t → kat *(card → floor)*

PHONOLOGICAL AWARENESS: REVERSAL

lüt → tül (pseudoword → *tulle*)

ıpak → kapı (pseudoword → *door*)

taas → saat (pseudoword → *watch*)

WORKING MEMORY: BACKWARD DIGIT RECALL

2-5

3-7-4

7-2-9-6

VOCABULARY

Top nedir? *(What is a ball?)*

Uçurtma nedir? *(What is a kite?)*

MORPHOLOGICAL AWARENESS: DERIVATIONAL MORPHOLOGY

Pitak satan kişiye pitak__denir.

*(Someone who sells pitaks is called pitak__ .)*

Palemleri koyduğumuz yere palem__denir.

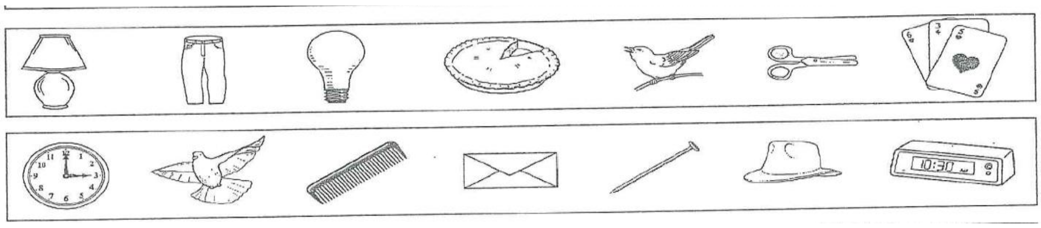
(*Where we put palems is called palem__.)*

MORPHOLOGICAL AWARENESS: INFLECTIONAL MORPHOLOGY

Mev sıcak bölgelerde yaşayan uzun boylu bir hayvandır. Diğer hayvanlar mev__ görünce kaçarlar. Mev__ yaklaşmak istemezler.

*(Mev is a long-necked animal which lives in hot places. Other animals run away when they see mev__. They do not want to approach mev__.*

PROCESSING SPEED



INHIBITORY CONTROL: THE STROOP COLOR AND WORD TEST

Cards 1 and 2

APPENDIX B

APPROVAL OF THE

PROVINCIAL DIRECTORATE OF NATIONAL EDUCATION

**T.C.**
**BURDUR VALİLİĞİ**
**İl Millî Eğitim Müdürlüğü**

**Sayı :** 39958266-605.01-E.1676278 24.01.2019
**Konu :** Araştırma İzni (Ecehan CANDAN)

BURDUR MEHMET AKİF ERSOY ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Öğrenci İşleri Daire Başkanlığına)

İlgi: a) 15/01/2019 tarihli ve E.639 sayılı yazınız,
b) 23/01/2019 tarihli ve 1592222 sayılı Valilik Oluru.

Üniversiteniz Yabancı Diller Bölümü Öğretim Elemanı Arş. Gör. Ecehan CANDAN'ın "Anadili Türkçe Olan Çocukların Okuma Becerilerinde Yürütücü İşlevlerin Rolü" konulu doktora tez çalışması kapsamında Müdürlüğümüze bağlı merkez ilkokullarda öğrenim gören 4. Sınıf öğrencilerine veri toplamak için ölçek uygulamak istemesi ile ilgili ilgi (a) yazınıza istinaden alınan ilgi (b) Valilik Onayı ekte gönderilmiştir.

Ölçeğin, Bakanlığımız Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2017/25 sayılı Genelgesi doğrultusunda, eğitim öğretimi aksatmayacak şekilde bağlı merkez ilkokullarda öğrenim gören 4. Sınıf öğrencilerine gönüllülük esasına göre uygulanması, uygulama sonucunda elde edilen verilerin CD ortamında Müdürlüğümüze gönderilmesi hususunda;

Gereğini arz ederim.

Mahmut BAYRAM
Millî Eğitim Müdürü

Ek: Olur (1 Sayfa)

Bu evrakın 5070 sayılı Kanun gereğince
'E-İMZA' ile imzalandığı tasdik olunur
24/01/2019
Serkan AKSU
Şef

Burdur Valiliği İl Millî Eğitim Müdürlüğü
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**T.C.**
**BURDUR VALİLİĞİ**
**İl Millî Eğitim Müdürlüğü**

**Sayı** : 39958266-605.01-E.1592222 23/01/2019
**Konu** :Araştırma İzni (Ecehan CANDAN)

VALİLİK MAKAMINA

Burdur Mehmet Akif Ersoy Üniversitesi Yabancı Diller Bölümü Öğretim Elemanı Arş. Gör. Ecehan CANDAN'ın "Anadili Türkçe Olan Çocukların Okuma Becerilerinde Yürütücü İşlevlerin Rolü" konulu doktora tez çalışması kapsamında Müdürlüğümüze bağlı merkez ilkokullarda öğrenim gören 4. Sınıf öğrencilerine veri toplamak için ölçek uygulamak istemesi ile ilgili Burdur Mehmet Akif Ersoy Üniversitesi Rektörlüğü Öğrenci İşleri Daire Başkanlığının 15.01.2019 tarihli ve E.639 sayılı yazısı ve ekleri ilişikte sunulmuştur.

Ölçeğin, Bakanlığımız Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2017/25 sayılı Genelgesi doğrultusunda, eğitim öğretimi aksatmayacak şekilde merkez ilkokullarda öğrenim gören 4. Sınıf öğrencilerine gönüllülük esasına göre uygulanması Müdürlüğümüzce uygun görülmektedir.

Makamlarınızca da uygun görülmesi durumunda Olurlarınıza arz ederim.

Mahmut BAYRAM
İl Millî Eğitim Müdürü

O L U R
…./01/2019

Mehmet YILDIZ
Vali a.
Vali Yardımcısı

Eki: Yazı ve ekleri (6 sayfa)

Burdur Valiliği İl Millî Eğitim Müdürlüğü
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APPENDIX C

APPROVAL OF THE ETHICS COMMITTEE

**T.C.**
**BOĞAZİÇİ ÜNİVERSİTESİ**
**Sosyal ve Beşeri Bilimler Yüksek Lisans ve Doktora Tezleri Etik İnceleme Komisyonu**

Sayı: 2019-26

7 Mart 2019

Ecehan Candan
İngiliz Dili Eğitimi

Sayın Araştırmacı,

"Anadili Türkçe Olan Çocukların Okuma Becerilerinde Yürütücü İşlevlerin Rolü" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2019/17 sayılı başvuru komisyonumuz tarafından 7 Mart 2019 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Dr. Öğr. Üyesi İnci Ayhan

Prof. Dr. Feyza Çorapçı

Doç. Dr. Mehmet Yiğit Gürdal

Doç. Dr. Ebru Kaya

Dr. Öğr. Üyesi Şebnem Yalçın

## REFERENCES


Aaron, P. G., Joshi, R. M., Palmer, H., Smith, N., & Kirby, E. (2002). Separating genuine cases of reading disability from reading deficits caused by predominantly inattentive ADHD behavior. *Journal of Learning Disabilities, 35*(5), 425-436.

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

Aidinis, A., & Nunes, T. (2001). The role of different levels of phonological awareness in the development of reading and spelling in Greek. *Reading and Writing: An Interdisciplinary Journal, 14*, 145-177.

Akdemir, Z. G. (2018). *Fifth graders' comprehension of expository texts: Performance differences between poor and adequate readers* (Unpublished MA thesis). Boğaziçi University, Istanbul, Turkey.

Akman, E., & Aşkın, İ. (2012). Ses temelli cümle yöntemine eleştirel bir bakış. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi, 32*(1), 1-18.

Aksu-Koç¸ A., & Slobin, D. I. (1985). The acquisition of Turkish. In D. I. Slobin (Ed.), *The cross-linguistic study of child language acquisition* (pp. 839-878). Hillsdale, NJ: Lawrence Erlbaum Associates.

Akyol, H., & Temur, T. (2008). Ses temelli cümle yöntemi ve cümle yöntemi ile okuma yazma öğrenen öğrencilerin okuma becerilerinin öğretmen görüşlerine göre değerlendirilmesi. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 5*(9), 79-95.

Albuquerque, C. P. (2012). Rapid naming contributions to reading and writing acquisition of European Portuguese. *Reading and Writing: An Interdisciplinary Journal, 25*, 775-797.

Altani, A., Protopapas, A., & Georgiou, G. (2017). The contribution of executive functions in naming words, digits, and objects. *Reading and Writing: An Interdisciplinary Journal, 30,* 121-141.

Altemeier, L., Abbott, R., & Berninger, V. (2008). Executive functions for reading and writing in typical literacy development and dyslexia. *Journal of Clinical and Experimental Neuropsychology, 30,* 588-606.

Amtmann, D., Abbott, R. D., & Berninger, V. W. (2007). Mixture growth models of RAN and RAS row by row: Insight into the reading system at work over time. *Reading and Writing: An Interdisciplinary Journal, 20*(8), 785-813.

Anglin, J. M. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society for Research in Child Development, 58,* 1-166.

Anthony, J. L., & Francis, D. J. (2005). Development of phonological awareness. *Current Directions in Psychological Science*, *14*(5), 255-259.

Arrington, C. N., Kulesz, P. A., Francis, D. J., Fletcher, J. M., & Barnes, M. A. (2014). The contribution of attentional control and working memory to reading comprehension and decoding. *Scientific Studies of Reading,18*(5), 325-346.

Arslantaş, H. İ., & Cinoğlu, M. (2010). Comparing sound-based sentence method and analysis method in literacy education. *İnönü Uniersity Journal of the Faculty of Education, 11*(1), 81-92.

Aslan, E., & Altan A. (2006). The role of -(s)I in Turkish indefinite nominal compounds. *Dil Dergisi, 131*, 57-75.

Aşlıyan, R., Günel, K., & Filiz, A. (2006, February). *Türkçe otomatik heceleme sistemi ve hece istatistikleri*. Paper presented at Akademik Bilişim '06 + BilgiTek IV, Pamukkale Üniversitesi, Denizli, Turkey. Retrieved from https://ab.org.tr/ab06/bildiri/195.pdf

Babayiğit, S. (2009). Reading and spelling development in transparent alphabetic orthographies: Points of convergence and divergence. In C. Wood & V. Connelly (Eds.), *Contemporary perspectives on reading and spelling* (pp.133-148). London, England: Routledge.

Babayiğit, S., & Stainthorp, R. (2007). Preliterate phonological awareness and early literacy skills: Evidence from Turkish. *Journal of Research in Reading,* 30, 394-413.

Babayiğit, S., & Stainthorp, R. (2010). Component processes of early reading, spelling and narrative writing skills in Turkish: A longitudinal study. *Reading and Writing: An Interdisciplinary Journal, 23,* 539-568.

Babayiğit, S., & Stainthorp, R. (2011). Modeling the relationships between cognitive-linguistic skills and literacy skills: New insights from a transparent orthography. *Journal of Educational Psychology, 103*(1). 169-189.

Babayiğit, S., & Stainthorp, R. (2014). Correlates of early reading comprehension skills: A componential analysis. *Educational Psychology, 34*(2), 185-207.

Babür, N. (2003). *Exploring the relationships among RAN, linguistic/cognitive variables and early reading skills in first- and second-grade students* (Unpublished doctoral dissertation). The University of Arizona, USA.

Babür, N., Haznedar, B., Erçetin, G., Özerman, D., & Erdat-Çekerek, E. (2013). Türkçede Kelime Okuma Bilgisi Testi'nin (KOBİT) geliştirilmesi. *Boğaziçi Üniversitesi Eğitim Dergisi*, *28*(2), 2-21.

Bachman, L. F. (2004). *Statistical analyses for language assessment*. Cambridge, England: Cambridge University Press.

Baddeley, A. D. (2000).The episodic buffer: A new component of working memory? *Trends in Cognitive Science, 4,* 417-423.

Badian, N. A. (1996). Dyslexia: A validation of the concept at two age levels. *Journal of Learning Disabilities, 29*(1), 102-112.

Bakır, H., & Babür, N. (2018). Hızlı Otomatik İsimlendirme Testi'nin Türkçeye uyarlanması. *Boğaziçi Üniversitesi Eğitim Dergisi, 35*(2), 35-51.

Ball, E. W., & Blachman, B. (1991). Does phoneme awareness training in kindergarten make a difference in early word recognition and developmental spelling? *Reading Research Quarterly, 26*, 49-66.

Bay, Y. (2010). Ses temelli cümle yöntemiyle ilk okuma-yazma öğretiminin değerlendirilmesi. *Kuramsal Eğitimbilim, 3*(1), 164-181.

Baydık, B., & Bahap-Kudret, Z. (2012). The views of teachers on the effects of sound based sentence method and their instructional practices. *Ankara University Journal of Faculty of Educational Sciences, 45*(1), 1-22.

Bektaş, S. (2017). *Cognitive and linguistic components of reading acquisition in Turkish: Evidence from second and fourth graders* (Unpublished MA thesis). Boğaziçi University, Istanbul, Turkey.

Berninger, V.W. (2001). Understanding the 'lexia' in dyslexia: A multidisciplinary team approach to learning disabilities. *Annals of Dyslexia, 51,* 21-48.

Berninger, V., Abbott, R., Vermeulen, K., & Fulton, C. (2006). Paths to reading comprehension in at-risk second-grade readers. *Journal of Learning Disabilities, 39*(4), 334-351.

Bexkens, A., van den Wildenberg, W. P. M., & Tijms, J. (2015). Rapid automatized naming in children with dyslexia: Is inhibitory control involved? *Dyslexia, 21*, 212-234.

Booth, J. N., Boyle, J., & Kelly, S. (2010). Do tasks make a difference? Accounting for heterogeneity of performance of children with reading difficulties on tasks of executive function: Findings from a meta-analysis. *British Journal of Developmental Psychology, 28*(1), 133-176.

Bowers, P. G. (1993). Text reading and rereading: Determinants of fluency beyond word recognition. *Journal of Reading Behavior, 25,* 133-153.

Bowers, P. G. (1995). Tracing symbol naming speed's unique contribution to reading disabilities over time. *Reading and Writing: An Interdisciplinary Journal*, *7,* 189-216.

Bowey, J. A. (2001). Nonword repetition and young children's receptive vocabulary: A longitudinal study. *Applied Psycholinguistics, 22*(3), 441-469.

Bradley, L., & Bryant, P. (1983). Categorizing sounds and learning to read: A causal connection. *Nature, 301,* 419-421.

Bryant, P. E., MacLean, M., Bradley, L., & Crossland, J. (1990). Rhyme and alliteration, phoneme detection and learning to read. *Developmental Psychology, 26,* 429-438.

Cain, K. (2006). Individual differences in children's memory and reading comprehension: An investigation of semantic and inhibitory deficits. *Memory, 14,* 553-569.

Cain, K., Oakhill, J., & Bryant, P. (2004). Children's reading comprehension ability: Concurrent prediction by working memory, verbal ability, and component skills. *Journal of Educational Psychology, 96*(1), 31-42.

Caravolas, M., Volín, J., & Hulme, C. (2005). Phoneme awareness is a key component of alphabetic literacy skills in consistent and inconsistent orthographies: Evidence from Czech and English children. *Journal of Experimental Child Psychology, 92,* 107-139.

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189-209). Hillsdale, NJ: Erlbaum.

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing: An Interdisciplinary Journal, 12,*169-190.

Carlisle, J. F. (2003). Morphology matters in learning to read: A commentary. *Reading Psychology, 24*(3-4), 291-322.

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly, 45*(4), 464-487.

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly, 40*(4), 428-449.

Cárnio, M. S., Vosgrau, J. S., & Soares, A. J. C. (2017). The role of phonological awareness in reading comprehension. *Revista Centro de Especialização em Fonoaudiologia Clínica, 19*(5), 590-600.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* Cambridge, England: Cambridge University Press.

Cartwright, K. B. (2012). Insights from cognitive neuroscience: The importance of executive function for early reading development and education. *Early Education and Development, 23,* 24-36.

Chall, J. S. (1983). *Stages of reading development.* Newyork, NY: McGraw-Hill.

Chang, I. (2020). Influences of executive function, language comprehension, and fluency on young children's reading comprehension. *Journal of Early Childhood Research, 18*(1), 44-57.

Christopher, M. E., Miyake, A., Keenan, J. M., Pennington, B., DeFries, J. C., Wadsworth, S. J., . . . Olson, R. K. (2012). Predicting word reading and comprehension with executive function and speed measures across development: A latent variable analysis. *Journal of Experimental Psychology General*, *141*(3), 470-488.

Coltheart, M. (2005). Modeling reading: The dual-route approach. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 6-23). Oxford, England: Blackwell.

Cutting, L. E., & Denckla, M. B. (2001). The relationship of rapid automatized naming and word reading in normally developing readers. *Reading and Writing: An Interdisciplinary Journal, 14,* 673-704.

Cutting, L. E., Materek, A., Cole, C. A. S., Levine, T. M., & Mahone, E. M. (2009). Effects of fluency, oral language, and executive function on reading comprehension performance. *Annals of Dyslexia, 59,* 34-54.

D'Alessio, M. J., Jaichenco, V., & Wilson, M. A. (2019). The relationship between morphological awareness and reading comprehension in Spanish-speaking children. *Scandinavian Journal of Psychology, 60,* 501-512.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19,* 450-466.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin and Review, 3*(4), 422-433.

Deacon, S. H., & Kirby, J. R. (2004). Morphological awareness: Just "more phonological"? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*, *25*(2), 223-238.

De Beni, R., & Palladino, P. (2000). Intrusion errors in working memory tasks: Are they related with reading comprehension ability? *Learning and Individual Differences, 12,* 131-143.

de Jong, P. F., & van der Leij, A. (1999). Specific contributions of phonological abilities to early reading acquisition: Results from a Dutch latent variable longitudinal study. *Journal of Educational Psychology, 91*(3), 450-476.

de Jong, P. F., & van der Leij, A. (2002). Effects of phonological abilities and linguistic comprehension on the development of reading. *Scientific Studies of Reading, 6,* 51-77.

Denckla, M. B., & Rudel, R. G. (1974). Rapid ''automatized'' naming of pictured objects, colors, letters and numbers by normal children. *Cortex, 10,* 186-202.

Denckla, M. B., & Rudel, R. G. (1976). Naming of objects by dyslexic and other learning disabled children. *Brain and Language, 3,* 1-15.

Duke, N. K., & Carlisle, J. (2011). The development of comprehension. In M. L. Kamil, P. D. Pearson, E. B. Moje, & P. P. Afflerbach (Eds.), *Handbook of reading research* (Vol. 4, pp. 199-228). New York, NY: Routledge.

Durgunoğlu, A. Y. (2003). Recognizing morphologically complex words in Turkish. In E. M. H. Assink & D. Sandra (Eds.), *Reading complex words: Cross-language studies* (pp. 81-92). New York, NY: Springer.

Durgunoğlu, A. Y. (2017). Learning to read Turkish. In L. Verhoeven & C. Perfetti (Eds.), *Learning to read across languages and writing systems* (pp.437-454). Cambridge, England: Cambridge University Press.

Durgunoğlu, A.Y., & Öney, B. (1999). A cross-linguistic comparison of phonological awareness and word recognition. *Reading and Writing: An Interdisciplinary Journal, 11,* 281-299.

Durukan, E., & Alver, M. (2008). Ses temelli cümle yönteminin öğretmen görüşlerine göre değerlendirilmesi. *Uluslararası Sosyal Araştırmalar Dergisi, 1*(5), 274-289.

Edwards, O. W., & Taub, E. G. (2016). The influence of specific phonemic awareness processes on the reading comprehension of African American students. *Journal of Research in Childhood Education, 30*(1), 74-84.

Ehri, L. (1992). Reconceptualizing the development of sight word reading and its relationship to recoding. In P. Gough, L. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 107-143). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Engel de Abreu, P. M. J., Abreu, N., NiKaedo, C. C., Puglisi, M. L., Tourinho, C. J., Miranda, M. C., … Martin, R. (2014). Executive functioning and reading achievement in school: A study of Brazilian children assessed by their teachers as "poor readers." *Frontiers in Psychology, 5,* Article 550.

Engen, L. & Høien, T. (2002). Phonological skills and reading comprehension. *Reading and Writing: An Interdisciplinary Journal, 15*(7-8), 613-631.

Ergenç, İ. (1991). <ğ> üzerine. In A. Sezer & S. Koç (Eds.), *Dilbilim yazıları* (pp. 51-56). Ankara, Turkey: Usem Yayınları.

Erguvanlı-Taylan, E. (2007). *TK 204: The structure of modern Turkish*. Manuscript. Boğaziçi University, İstanbul, Turkey.

Erkul, Ö., & Erdoğan, T. (2009). The problems and suggestions encountered during the implementation of the sound based sentence method. *Procedia Social and Behavioral Sciences, 1,* 2294-2300.

Follmer, D. J. (2018). Executive function and reading comprehension: A meta-analytic review. *Educational Psychologist, 53*(1), 42-60.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology General, 133,* 101-135.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface dyslexia*, (pp. 301-330). Hillsdale, NJ: Lawrence Erlbaum Associates.

Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences*, *21*, 85-95.

Gathercole. S. E., & Baddeley, A. D. (1993). *Working memory and language*. Hove, England: Lawrence Erlbaum Associates.

Gathercole, S. E., Pickering, S. J., Ambridge, B., & Wearing, H. (2004). The structure of working memory from 4 to 15 years of age. *Developmental Psychology, 40,* 177-190.

Georgiou, G. K., Das, J. P., & Hayward, D. (2008). Comparing the contribution of two tests of working memory to reading in relation to phonological awareness and rapid naming speed. *Journal of Research in Reading, 31*(3), 302-318.

Georgiou, G. K., Parrila, R., Cui, Y., & Papadopoulos, T. C. (2013). Why is rapid automatized naming related to reading? *Journal of Experimental Child Psychology*, *115*, 218-225.

Georgiou, G., Parrila, R., & Papadopoulos, T. C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology, 100*(3), 566-580.

Georgiou, G. K., Parrila, R., & Papadopoulos, T. (2016). The anatomy of the RAN-reading relationship. *Reading and Writing: An Interdisciplinary Journal, 29,* 1793-1815.

Geva, E., & Siegel, L. (2000). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and Writing: An Interdisciplinary Journal*, *12*, 1-30.

Gillon, G. T. (2007). *Phonological awareness: From research to practice*. New York, NY: Guilford.

Goodman, K. S. (1976). Reading: A psycholinguistic guessing game. *Journal of the Reading Specialist 6,* 126-135.

Goswami, U. (2001). Early phonological development and the acquisition of literacy. In D. K. Dickinson & S. B. Neuman (Eds.), *Handbook of early literacy research* (Vol. 1, pp. 111-125). New York, NY: Guilford Press.

Goswami, U. (2010). A psycholinguistic grain size view of reading development across languages. In N. Brunswick, S. McDougall, & D. P. de Mornay (Eds.), *Reading and dyslexia in different orthographies* (pp. 23-42). Hove, England: Psychology Press.

Goswami, U., & Bryant, P. (1990). *Phonological skills and learning to read.* East Sussex, England: Erlbaum.

Gough, P. B. (1972). One second of reading. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by ear and by eye: The relationship between speech and reading* (pp. 331-358). Cambridge, MA: MIT Press.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7,* 6-10.

Göksel, A., & Kerslake, C. (2006). *Turkish: A comprehensive grammar*. London, England: Routledge.

Hoffman, J. V. (2009). In search of the "simple view" of reading comprehension. In S. E. Israel & G. G. Duffy (Eds.), *Handbook of research on reading comprehension* (pp. 54-65). New York, NY: Routledge.

Holland, J., McIntosh, D., & Huffman, L. (2004). The role of phonological awareness, rapid automization, and orthographic processing in reading. *Journal of Psychoeducational Assessment, 22,* 233-260.

Holsgrove, J. V. (2003). *Phonological and syntactic processing, and the role of working memory in reading comprehension among high school students* (Unpublished BA thesis). Edith Cowan University, Perth, Australia.

Jacobson, L. A., Koriakin, T., Lipkin, P., Boada, R., Frijters, J., Lovett, M. W. C., . . . Mahone, E. M. (2017). Executive functions contribute uniquely to reading competence in minority youth. *Journal of Learning Disabilities, 50*(4), 422-433.

Jacobson, L. A., & Mahone, E. M. (2012). Educational implications of executive dysfunction. In S. J. Hunter & E. P. Sparrow (Eds.), *Executive function and dysfunction* (pp. 232–246). London, England: Cambridge University Press.

Jacobson, L. A., Ryan, M., Martin, R. B., Ewen J., Mostofsky S. H., Denckla, M. B., & Mahone, E. M. (2011). Working memory influences processing speed and reading fluency in ADHD. *Child Neuropsychology, 17,* 209-224.

Jenkins, J. R., Fuchs, L. S., van den Broek, P., Espin, C., & Deno, S. L. (2003). Sources of ındividual differences in reading comprehension and reading fluency. *Journal of Educational Psychology, 95*(4), 719-729.

Joshi, R. M., & Aaron, P. G. (2000). The component model of reading: Simple view of reading made a little more complex. *Reading Psychology, 21,* 85-97.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 98,* 122-149.

Kail, R., & Hall, L. K. (1994). Processing speed, naming speed, and reading. *Developmental Psychology, 30,* 949-954.

Karakaş, S. (2011). *Stroop Testi TBAG Formu: Araştırma-Geliştirme çalışmaları ve kullanım kılavuzu.* Ankara, Turkey: Ayrıntı Yayınları.

Karakaş, S., & Doğutepe Dinçer, E. (2011). *BİLNOT Bataryası el kitabı: Nöropsikolojik testlerin çocuklar için araştırma ve geliştirme çalışmaları: BİLNOT-Çocuk*. İstanbul, Turkey: Nobel Tıp Kitabevleri.

Kılıç, B. G., Koçkar, A.İ., Irak, M., Şener, Ş., & Karakaş, S. (2002). Stroop Testi TBAG Formunun 6-11 yaş grubu çocuklarda standardizasyon çalışması. *Çocuk ve Gençlik Ruh Sağlığı Dergisi, 9*(2), 86-99.

Kintsch, W. (1998). *Comprehension: A framework for cognition*. New York, NY: Cambridge University Press.

Kintsch, W. (2005). An overview of top-down and bottom-up effects in comprehension: The CI perspective. *Discourse Processes, 39*(2-3), 125-128.

Kintsch, W., & Kintsch, E. (2005). Comprehension. In S. G. Paris & A. Stahl (Eds.), *Children's reading comprehension and assessment* (pp.71-92). Mahwah, NJ: Erlbaum.

Kirby, J. R., Deacon, S. H., Bowers, P. N., Izenberg, L., Wade-Woolley, L., & Parrila, R. (2012). Children's morphological awareness and reading ability. *Reading and Writing: An Interdisciplinary Journal, 25*(2), 389-410.

Kirby, J. R., Parrila, R. K., & Pfeiffer, S. L. (2003). Naming speed and phonological awareness as predictors of reading development. *Journal of Educational Psychology, 95*(3), 453-464.

Klauda, S. L., & Guthrie, J. T. (2008). Relationships of three components of reading fluency to reading comprehension. *Journal of Educational Psychology, 100*(2), 310-321.

Kornfilt, J. (1997). *Turkish.* London, England: Routledge.

Kroese, J. M., Hynd, G. W., Knight, D. F., Hiemenz, J. R., & Hall, J. (2000). Clinical appraisal of spelling ability and its relationship to phonemic awareness (blending, segmenting, elision, and reversal), phonological memory and reading in reading disabled, ADHD, and normal children. *Reading and Writing: An Interdisciplinary Journal, 13*,105-131.

Ktori, M., & Pitchford, N. J. (2008) Effect of orthographic transparency on letter position encoding: A comparison of Greek and English monoscriptal and biscriptal readers. *Language and Cognitive Processes, 23*(2), 258-281.

Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology, 95*(1), 3-21.

Kuo, L., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross language perspective. *Educational Psychologist, 41*, 161-180.

Kuzucu-Örge, E. (2018). *Differentiating poor and good readers in second grade: Cognitive and linguistic variables* (Unpublished MA thesis). Boğaziçi University, Istanbul, Turkey.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*(2), 293-323.

Lan, X., Legare, C. H., Ponitz, C. C., Li, S., Morrison, F. J. (2011). Investigating the links between the subcomponents of executive function and academic achievement: A crosscultural analysis of Chinese and American preschoolers. *Journal of Experimental Child Psychology, 108,* 677-692.

Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology, 100,* 150-161.

Langer, J. A. (2011). *Envisioning knowledge: Building literacy in the academic disciplines.* New York, NY: Teachers College Press.

Locascio, G., Mahone, E. M., Eason, S. H., & Cutting, L. E. (2010). Executive dysfunction among children with reading comprehension deficits. *Journal of Learning Disabilities, 43,* 441-454.

Lyster, S. A. H. (2002). The effects of morphological versus phonological awareness training in kindergarten on reading development. *Reading and Writing: An Interdisciplinary Journal, 15,* 261-294.

MacDonald, G. W., & Cornwall, A. (1995). The relationship between phonological awareness and reading and spelling achievement eleven years later. *Journal of Learning Disabilities, 28,* 523-527.

Manis, F., Seidenberg, M., & Doi, L. (1999). See Dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second graders. *Scientific Studies of Reading, 3*(2), 129-157.

McBride-Chang, C., Cho, J., Liu, H., Wagner, R. K., Shu, H., Zhou, A., . . . Muse, A. (2005). Changing models across cultures: associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States. *Journal of Experimental Child Psychology*, *92*(2), 140-160.

McBride-Chang, C., Tardif, T., Cho, J., Shu, H., Fletcher, P., Stokes, S.F., Leung, K. (2008). What's in a word? Morphological awareness and vocabulary knowledge in three languages. *Applied Psycholinguistics, 29,* 437-462.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review, 88*(5), 375-407.

McGrath, L. M., Pennington, B. F., Shanahan, M. A., Santerre-Lemmon, L. E., Barnard, H. D., Willcutt, E. G., . . . Olson, R. K. (2011). A multiple deficit model of reading disability and attention-deficit/hyperactivity disorder: Searching for shared cognitive deficits. *Journal of Child Psychology and Psychiatry, 52,* 547-557.

Messer, D., Henry, L. A., & Nash, G. (2016). The relation between executive functioning, reaction time, naming speed, and single word reading in children with typical development and language impairments. *British Journal of Educational Psychology, 3*(86), 1-17.

Metsala, J. L. (1999). Young childrens phonological awareness and nonword repetition as a function of vocabulary development. *Journal of Educational Psychology, 91,* 3-19.

Milli Eğitim Bakanlığı. (2009). *İlköğetim Türkçe dersi 1-5. sınıflar öğretim programı ve kılavuzu.* Retrieved from http://talimterbiye.mebnet.net/Ogretim%20 Programlari/ilkokul/2013-2014/Turkce1-5.pdf

Milli Eğitim Bakanlığı. (2012). *12 yıllık zorunlu eğitim sorular-cevaplar.* Retrieved from http://www.meb.gov.tr/duyurular/duyurular2012/12Yil_Soru_Cevaplar.pdf

Milli Eğitim Bakanlığı. (2019). *Türkçe dersi öğretim programı (ilkokul ve ortaokul 1., 2., 3., 4., 5., 6., 7. ve 8. sınıflar.* Retrieved from https://mufredat.meb.gov.tr/ ProgramDetay.aspx?PID=663

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41,* 49-100.

Moriguchi, Y., & Hiraki, K. (2013). Prefrontal cortex and executive function in young children: A review of NIRS studies. *Frontiers in Human Neuroscience, 7,* Article 867.

Muter, V., Hulme, C., Snowling, M. J., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: Evidence from a longitudinal study. *Developmental Psychology, 40,* 665-681.

Nagy, W., Berninger, V., & Abbott, R. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle school students. *Journal of Educational Psychology, 98,* 134-147.

Nation, K., & Snowling, M. (1999). Developmental differences in sensitivity to semantic relations among good and poor comprehenders: Evidence from semantic priming. *Cognition, 70,* b1-b13.

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction*. Washington, DC: National Institute for Child Health and Human Development.

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological Bulletin, 126,* 220-246.

Nikolopoulos, D., Goulandris, N., Hulme, C., & Snowling, M. (2006). The cognitive bases of learning to read and spell in Greek: Evidence from a longitudinal study. *Journal of Experimental Child Psychology, 94,* 1-17.

Norton, E. S., & Wolf, M. (2012). Rapid automatized naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. *Annual Review of Psychology, 63,* 427-452.

Nouwens, S., Groen, M. A., Kleemans, T., & Verhoeven, L. (2020). How executive functions contribute to reading comprehension. *British Journal of Educational Psychology, 91*(1), 169-192.

Nunes, T., & Bryant., P. (2006). *Improving literacy by teaching morphemes*. New York, NY: Routledge.

Oakhill, J., & Cain, K. (2000). Children’s difficulties in text comprehension: Assessing causal issues. *Journal of Deaf Studies and Deaf Education, 5,* 51-59.

Oakhill, J., Hartt, J., & Samols, D. (2005). Levels of comprehension monitoring and working memory in good and poor comprehenders. *Reading and Writing: An Interdisciplinary Journal, 18,* 657-686.

Ouellette, G. P. (2006). What’s meaning got to do with it: The role of vocabulary in word reading and reading comprehension. *Journal of Educational Psychology, 98*(3), 554-566.

Öney, B., & Durgunoğlu, A. Y. (1997). Beginning to read in Turkish: A phonologically transparent orthography. *Applied Psycholinguistics, 18,* 1-15.

Özata, H. (2013). *Reading acquisition in early bilingualism: Reading skills of Turkish-child L2 learners of English* (Unpublished MA thesis). Boğaziçi University, Istanbul, Turkey.

Özata, H. (2018). *Reading fluency and comprehension in a transparent orthography: Evidence from Turkish children* (Unpublished doctoral dissertation). Boğaziçi University, Istanbul, Turkey.

Papadopoulos, T. C., Spanoudis, G. C., & Georgiou, G. (2016). How is RAN related to reading fluency? A comprehensive examination of the prominent theoretical accounts. *Frontiers in Psychology, 7,* 1-15.

Paris, S. G., & Hamilton, E. E. (2009). The development of children's reading comprehension. . In S. E. Israel & G. G. Duffy (Eds.), *Handbook of research on reading comprehension* (pp. 32-53). New York, NY: Routledge.

Pearson, P. D., & Johnson, D. D. (1978). *Teaching reading comprehension.* New York, NY: Holt, Rinehart & Winston.

Pedhazur, E. J. (1997). *Multiple regression in behavioral research: Explanation and prediction* (3rd ed.). South Melbourne, Australia: Wadsworth Thomson Learning.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Perfetti, C. A. (1998). Two basic questions about reading and learning to read. In P. Reitsma & L. Verhoeven (Eds.), *Problems and interventions in literacy development* (pp. 15-48). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Perfetti, C. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading, 11,* 357-383.

Perfetti, C. A., & Hart, L. (2001). The lexical bases of comprehension skill. In D. Gorfien (Ed.), *On the consequences of meaning selection* (pp. 67-86). Washington, DC: American Psychological Association.

Perfetti, C. A., & Hogaboam, T. (1975). Relationship between single word decoding and reading comprehension skill. *Journal of Educational Psychology, 67*(4), 461-469.

Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 227-247). Oxford, England: Blackwell.

Perfetti, C. A., Marron, M. A., & Foltz, P. W. (1996). Sources of comprehension failure theoretical perspectives and case studies. In C. Cornoldi & J. V. Oakhill (Eds.), *Reading comprehension difficulties processes and remediation* (pp. 137-165). Mahwah, NJ: Erlbaum.

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22-37.

Peter, B., Matsushita, M., & Raskind, W. H. (2011). Global processing speed in children with low reading ability and in children and adults with typical reading ability: Exploratory factor analytic models. *Journal of Speech, Language, and Hearing Association, 54,* 885-889.

Plaza, M., & Cohen, H. (2003). The interaction between phonological processing, syntactic awareness, and naming speed in the reading and spelling performance of first-grade children. *Brain and Cognition, 53,* 287-292.

Rasinski, T. V., Reutzel, D. R., Chard, D., & Linan-Thompson, S. (2002). Reading fluency. In M. L. Kamil, P. D. Pearson, E. B. Moje, & P. P. Afflerbach (Eds.), *Handbook of reading research* (Vol. 4, pp. 286-319). New York, NY: Routledge.

Roth, F. P., Speece, D. L., & Cooper, D. H. (2002). A longitudinal analysis of the connection between oral language and early reading. *The Journal of Educational Research*, *95*(5), 259-272.

Rumelhart, D. E. (1977). Toward an interactive model of reading. In S. Dornic (Ed.), *Attention and performance VI,* (pp. 573-603). Hillsdale, NJ: Erlbaum.

Rumelhart, D. E. (1994). Toward an interactive model of reading. In R. B. Ruddell, M. Rapp-Ruddell, & H. Singer (Eds.), *Theoretical models and processes of reading* (4th ed., pp. 864-894). Newark, DE: International Reading Association.

Samuels, S. J. (1979). The method of repeated readings. *The Reading Teacher, 32,* 403–408.

Savage, R., & Frederickson, N. (2005). Evidence of a highly specific relationship between rapid automatic naming of digits and text-reading speed. *Brain and Language, 93*(2), 152-159.

Savaşır, I., & Şahin, N. (1995). *Wechsler Çocuklar için Zeka Ölçeği (WISC-R) uygulama kitapçığı.* Ankara, Turkey: Türk Psikologlar Derneği.

Scarborough, H. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97-110). New York, NY: Guilford Press.

Scarborough, H. S. (2005). Developmental relationships between language and reading: Reconciling a beautiful hypothesis with some ugly facts. In H. W. Catts & A. G. Kamhi (Eds.), *The connections between language and reading disabilities* (pp. 3-24). Mahwah, NJ: Erlbaum.

Schreiber, P. A. (1991). Understanding prosody’s role in reading acquisition. *Theory into Practice, 30,* 158-164.

Seigneuric, A., & Ehrlich, M. F. (2005). Contribution of working memory capacity to children's reading comprehension: A longitudinal investigation. *Reading and Writing: An Interdisciplinary Journal, 18*(7-9), 617-656.

Sesma, H. W., Mahone, E. M., Levine, T., Eason, S. H., & Cutting, L. E. (2009). The contribution of executive skills to reading comprehension. *Child Neuropsychology, 15,* 232-246.

Seymour, P., Aro, M., & Erskine, J. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology, 94,* 143-174.

Shankweiler, D. (1999). Words to meanings. *Scientific Studies of Reading, 3*, 113-127.

Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition, 55,* 151-218.

Singson, M., Mahony, D., & Mann, V. (2000). The relation between reading ability and morphologicalskills: Evidence from derivational suffixes. *Reading and Writing: An Interdisciplinary Journal, 12*, 219-252.

Snider, V. A. (1995). A primer on phonemic awareness: What it is, why it's important, and how to teach it. *School Psychology Review, 24*(3), 443-456.

Snow, C. E. (2002). *Reading for understanding: Toward an R & D program in reading comprehension*. Santa Monica, CA: RAND Corporation.

Sönmez, E. (2015). *An investigation of spelling skills in Turkish: The role of phonological encoding and rapid naming in the literacy skills of third and fourth graders* (Unpublished MA thesis). Boğaziçi University, İstanbul, Turkey.

St Clair-Thompson, H. L. (2010). Backwards digit recall: A measure of short term memory or working memory? *European Journal of Cognitive Psychology, 22*(2), 286-296.

Stanovich, K. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 16,* 32-71.

Stanovich, K. E. (1984). The interactive-compensatory model of reading: A confluence of developmental, experimental, and educational psychology. *Remedial and Special Education, 5*(3), 11-19.

Stanovich, K. E. (1990). Concepts in developmental theories of reading skill: Cognitive resources, automaticity, and modularity. *Developmental Review, 10*(1), 72-100.

Stanovich, K. E. (1993). Romance and reality. *The Reading Teacher, 47*, 280-291.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology, 38,* 934-947.

Sunseth, K., & Bowers, P. G. (2002). Rapid naming and phonemic awareness: Contributions to reading, spelling, and orthographic knowledge. *Scientific Studies of Reading, 6*(4), 401-429.

Swanson, H. L., Zheng, X., & Jerman, O. (2009). Working memory, short-term memory, and reading disabilities: A selective meta-analysis of the literature. *Journal of Learning Disabilities, 42*, 260-287.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). New York, NY: Allyn & Bacon.

Tannenbaum, K. R., Torgesen, J. K., & Wagner, R. K. (2006). Relationships between word knowledge and reading comprehension in third-grade children. *Scientific Studies of Reading, 10,* 381-398.

Tok, Ş., Tok, T., & Mazı, A. (2008). İlk okuma yazma öğretiminde çözümleme ve ses temelli cümle yöntemlerinin değerlendirilmesi. *Kuram ve Uygulamada Eğitim Yönetimi, 14*(53), 123-144.

Torgesen, J. K. (2000). Individual differences in response to early interventions in reading: The lingering problem of treatment resisters. *Learning Disabilities Research and Practice, 15,* 55-64.

Torgesen, J. K. (2002). The prevention of reading difficulties. *Journal of School Psychology, 40,* 7-26.

Torgesen, J. K., Rashotte, C. A., & Alexander, A. (2001). Principles of fluency instruction in reading: Relationships with established empirical outcomes. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 333–355). Parkton, MD: York Press.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities, 27,* 276-286.

Tunmer, W. (1989). The role of language-related factors in reading disability. In D. Shankweiler & I. Liberman (Eds.), *Phonology and reading disability: Solving the reading puzzle* (pp. 91-131). Ann Arbor, MI: University of Michigan Press.

Urso, A. (2008). *Processing speed as a predictor of poor reading* (Unpublished doctoral dissertation). The University of Arizona, USA.

van der Sluis, S., de Jong, P. F., & van der Leij, A. (2004). Inhibition and shifting in children with learning deficits in arithmetic and reading. *Journal of Experimental Child Psychology, 87*, 239-266.

Verhagen, W., Aarnoutse, C., & van Leeuwe, J. (2008). Phonological awareness and naming speed in the prediction of Dutch children's word recognition. *Scientific Studies of Reading, 12*(4), 301-324.

Verhoeven, L., & van Leeuwe, J. (2008). Prediction of the development of reading comprehension: A longitudinal study. *Applied Cognitive Psychology, 22*, 407-423.

Verhoeven, L., van Leeuwe, J., & Vermeer, A. (2011). Vocabulary growth and reading development across the elementary school years. *Scientific Studies of Reading, 15*(1), 8-25.

Wagner, R. K., & Torgesen, J. (1987). The nature of phonological processing and its casual role in the acquisition of reading skills. *Psychological Bulletin*, *101,* 192-212.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing.* Austin, TX: PRO-ED Publishing, Inc.

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children-Revised.* New York, NY: Psychological Corporation.

Welsh, J. A., Nix, R. L., Blair, C., Bierman, K. L., & Nelson, K. E. (2010). The development of cognitive skills and gains in academic school readiness for children from low-income families. *Journal of Educational Psychology, 102*(1), 43-53.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development*, *69*(3), 848-872.

Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: A specific disability in regular orthographies. *Journal of Educational Psychology*, *94*(2), 272-277.

Wolf, M. (1991). Naming speed and reading: The contribution of the cognitive neurosciences. *Reading Research Quarterly*, *26*(2), 123-141.

Wolf, M., & Bowers, P. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91,* 1-24

Wolf, M., Bowers, P. G., Biddle, K. (2000). Naming-speed processes, timing and reading: A conceptual review. *Journal of Learning Disabilities, 33,* 387-407.

Woodcock, R. W., McGrew, K., & Mather, N. (2001). *Woodcock–Johnson III Tests of Achievement.* Itasca, IL: Riverside

Wu, X., Anderson, R. C., Li, W., Wu, X., Li, H., Zhang, J., . . . Gaffney, J. S. (2009). Morphological awareness and Chinese children's literacy development: An intervention study. *Scientific Studies of Reading, 13*(1), 26-52.

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, *131*, 3-29.