

# The examination of the working memory capacity and the visual perception levels of kindergarten children

Anaokuluna devam eden çocukların çalışma belleği kapasitesi ve görsel algı düzeylerinin incelenmesi

Hülya Tokuç<sup>1</sup>, Neriman Aral<sup>2</sup>

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## Makale Türü

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**Abstract:** The research, conducted in the relational screening model, was conducted with 107 children attending the kindergarten affiliated with Ankara Provincial Directorate of National Education. General information form, Working Memory Scale and Frostig Visual Perception Test were used in the research. In the analysis of data collected between May and June 2021; t-test, ANOVA and Pearson Correlation Test were performed for independent groups. As a result of the research, it was found that children's working memory and verbal memory capacities, visual perception levels, and scores obtained from the areas of eye motor coordination, figure-ground discrimination and shape constancy differed significantly in favor of girls. It was determined that the average score obtained from the figure-ground discrimination sub-dimension, one of the visual perception areas, differs according to the duration of attendance at pre-school education, and the average score obtained increases as the duration of attendance at pre-school education increases. It was found that there was a moderate and significant relationship between children's working memory capacity and visual perception level. Based on the results, it can be said that it is important to conduct studies that support working memory capacity and visual perception skills together.

**Keywords:** Working memory, visual perception, motor skills, development, learning and memory

**Öz:** İlişkisel tarama modelinde gerçekleştirilen araştırma Ankara İl Milli Eğitim Müdürlüğü'ne bağlı anaokuluna devam eden 107 çocuk ile gerçekleştirilmiştir. Araştırmada Genel bilgi formu, Çalışma Belleği Ölçeği ve Frostig Görsel Algı Testi kullanılmıştır. Mayıs-Haziran 2021 tarihi arasında toplanan verilerin analizinde; bağımsız gruplar için t-testi, ANOVA ve Pearson Korelasyon Testi yapılmıştır. Araştırma sonucunda, çocukların çalışma belleği ile sözel bellek kapasitelerinin ve görsel algı düzeyleri ile göz motor koordinasyonu, şekil-zemin ayrımı ve şekil sabitliği alanlarından elde edilen puanlarının kızlar lehine anlamlı olarak farklılaştığı bulunmuştur. Görsel algı alanlarından şekil-zemin ayrımı, alt boyutundan elde edilen puan ortalamasının okul öncesi eğitime devam etme süresine göre farklılaştığı, eğitime devam etme süresi arttıkça elde edilen puan ortalamasının da arttığı belirlenmiştir. Çocukların çalışma belleği kapasitesi ile görsel algı düzeyi arasında orta düzeyde ve anlamlı bir ilişki olduğu bulunmuştur. Sonuçlara dayanarak, çalışma belleği kapasitesi ile görsel algı becerilerini destekleyen çalışmaların birlikte yapılmasının önemli olduğu söylenebilir.

**Anahtar Kelimeler:** Çalışma belleği, görsel algı, motor beceriler, gelişim, öğrenme ve bellek

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Başlıca Yazar: Hülya Tokuç

<sup>1</sup> Hacettepe Üniversitesi, Beytepe Anaokulu, htokuc70@gmail.com, ORCID: <https://orcid.org/0000-0001-8308-9124>,

<sup>2</sup> Ankara Üniversitesi, Sağlık Bilimleri Fakültesi, aralneriman@gmail.com, ORCID: <https://orcid.org/0000-0002-9266-938X>

## GENİŞ ÖZET

### Giriş

Erken çocukluk, temel becerilerin edinildiği ve öğrenme potansiyelinin her zamankinden daha yüksek olduğu hızlı bir gelişim dönemidir (Sunar, 2019). Bu dönemde meydana gelen tüm öğrenme yaşantılarında çalışma belleği ve görsel algılama önemli görevler üstlenmektedir. Çalışma belleği, bilginin geçici olarak depolandığı ve eş zamanlı olarak kodlanıp işlendiği sınırlı bir kapasiteyi ifade etmektedir. Çalışma belleğinin kapasitesi ve işleyişi, öğrenmenin miktarını ve kapsamını önemli düzeyde belirlemektedir (Alloway ve Archibald, 2008; Baddeley ve Hitch, 1974; Baddeley, 2006; Chiapper ve ark., 2000; Dehn, 2007; Tokuç ve Aral, 2020).

Frostig (1968), görsel algılamayı; görsel uyarıyı ayırt etme ve önceki deneyimlerle ilişkilendirerek anlamlandırabilme becerisi olarak tanımlamaktadır. Görsel algılama; göz motor koordinasyonu, şekil-zemin ayrımı, şekil sabitliği, mekânda konumun algılanması ve mekânsal ilişkilerin algılanması olmak üzere beş alanda incelenmektedir (Akt. Aral, 2010). Baddeley ve Hitch (1994) çalışma belleği ile ilgili fonolojik döngü, görsel-mekansal kopyalama ve bu iki alt sistemi kontrol eden merkezi yönetim sistemi olmak üzere üç bileşenli bir model önermiştir. Daha sonra sisteme, bölümsel ara bellek (episodic buffer) denen başka bir alt bileşeni ekleyerek önerdikleri modeli genişletmişlerdir (Dehn, 2010). Sözel kısa süreli bellek olarak da adlandırılan fonolojik döngü, sözel bilgilerin (Baddeley, 1986, 2003, 2006), kısa süreli depolanmasından sorumludur. Görsel kısa süreli bellek olarak adlandırılan görsel mekansal kopyalama ise görsel ve mekansal bilgilerin kısa süreli depolanmasından sorumludur. Fonolojik döngü ile görsel mekansal kopyalama, pasif-geçici depolama ve aktif bir tekrar süreci içerir. Fonolojik döngüde algısal uyarıcılar, fonolojik kodlara çevrilir (Gilliam ve VanKleeck, 1996). Görsel kopyalama; nesnelerin şekil ve renk gibi pasif görsel bilgilerinin, mekansal kopyalama ise nesnelerin hareket ve yön gibi aktif görsel bilgilerinin depolanmasını sağlamaktadır (Baddeley, 2006; Van Der Sluis vd., 2005). Fonolojik döngü ile görsel mekansal kopyalama alt sistemlerini kontrol eden ve sınırlı dikkat kapasitesi bulunan merkezi yönetici ise bilişsel süreçleri düzenlemek ve koordine etmekten sorumludur (Baddeley, 2003; Dehn, 2007; Torgesen, 2001).

Erken çocukluk yıllarında zayıf çalışma belleği kapasitesine sahip olan çocukların; talimatları takip etme, karmaşık görevleri tamamlama, bilgilerin eşzamanlı olarak işlenmesi ve depolanmasını içeren durum ve görevlerde akranlarına oranla belirgin düzeyde zorluklar yaşadıkları görülmektedir (Kyttala vd., 2019, Tokuç ve Aral, 2021). Görsel-uzaysal algı gelişiminde bellek, düzenleyici bir rol oynamakta ve görsel uzaysal algı, bellek görevlerindeki performansı etkilemektedir (West vd. 1985). Görsel algılama sürecine ilişkin yaşanan tüm sorunlar dil, motor, sosyal- duygusal gelişim alanları ve akademik öğrenmeye ilişkin öğrenme süreçlerinin de aksamasına neden olabilmektedir (Aral, 2021).

### Yöntem

Araştırma, İlişkisel tarama modelinde gerçekleştirilmiştir. Ankara İl Milli Eğitim Müdürlüğü'ne bağlı anaokuluna devam eden çocuklarla yürütülen çalışmaya tipik gelişim gösteren 107 çocuk amaçlı örnekleme yöntemiyle dahil edilmiştir. Araştırmaya dahil edilen çocukların %57'si kız, %43'ü erkektir; çocukların yaş ortalamaları 69,5 aydır; Çocukların; %45,8'i 17 ay ve üstünde okul öncesi eğitime devam etmektedir.

Araştırmada Genel bilgi formu, Çalışma Belleği Ölçeği ve Frostig Görsel Algı Testi kullanılmış, veriler Mayıs-Haziran 2021 tarihinde toplanmıştır. Verilerin analizinde parametrik testler kullanılmıştır. Çalışma Belleği Ölçeği ve Frostig Görsel Algı Testi ile bu testlerin alt faktörlerinden elde edilen verilerin cinsiyet ve okul öncesi eğitime devam etme süresine göre incelenmesinde bağımsız örneklem için t-Testi ve ANOVA TESTİ kullanılmıştır. Çalışma Belleği Ölçeği ve alt faktörleri olan sözel bellek ve görsel bellek ile Frostig Görsel Algı Testi arasındaki ilişkileri incelemek için de Pearson Momentler Çarpımı Korelasyon Katsayısı kullanılmıştır.

### Etik Konular

“Anaokuluna devam eden Çocukların Çalışma Belleği Kapasiteleri ile Görsel Algı Düzeylerinin İncelenmesi” başlıklı araştırma projesi Hacettepe Üniversitesi Senatosu Etik Komisyonunun 23 Şubat 2021 tarihinde yapmış olduğu toplantıda incelenmiş olup, etik açıdan uygun bulunmuştur. Karar rektörlük makamının 10.03.2021 tarih ve E-35853172-755.02.06-00001492378 sayılı resmi yazısı ile tebliğ edilmiştir.

### Bulgular

Çocukların cinsiyetlerine göre Sözel Bellek alt faktörü ile toplam çalışma belleğinden elde ettikleri ortalama puanlar arasında kızların lehine anlamlı farklılık olduğu belirlenmiştir. Görsel bellek açısından kız ve erkeklerin puan ortalamaları incelendiğinde anlamlı farklılık olmadığı belirlenmiştir. Frostig Görsel Algı Testi alt boyutlarından göz motor koordinasyonu, şekil zemin ayırımı ve şekil sabitliği alt boyutları ile Frostig Görsel Algı Testi toplam puan ortalamalarının cinsiyete göre kızların lehine anlamlı olarak farklılaştığı görülmektedir. Görsel algılama alt boyutlarından mekanda konumun algılanması ve mekânsal ilişkilerin algılanması alt boyutlarından elde edilen puan ortalamaları arasındaki farkın cinsiyete göre anlamlı olmadığı belirlenmiştir. Çocukların okul öncesi eğitime devam etme süresine göre görsel bellek, sözel bellek ve toplam çalışma belleğinden elde ettikleri ortalama puanlar arasında anlamlı farklılık olmadığı belirlenmiştir. Frostig Görsel Algı Testi alt boyutu olan şekil-zemin ayırımı okul öncesi eğitime devam etme süresine göre anlamlı olarak değişmektedir. Daha uzun süre okul öncesi eğitim alan çocukların puan ortalamalarının daha yüksek olduğu tesbit edilmiştir. Frostig Görsel Algı Testi puanları ile Çalışma Belleği Ölçeği puanları arasında orta düzey pozitif yönde anlamlı ilişki olduğu görülmektedir. Çalışma belleğinin alt faktörlerinden olan sözel bellek ile Frostig Görsel Algı testinin alt faktörü olan göz motor koordinasyonu ve mekânsal konumun algılanması arasında düşük düzeyde anlamlı; şekil zemin ayırımı, şekil sabitliği ve mekânsal ilişkilerin algılanması arasında orta düzeyde anlamlı ilişkiye rastlanmıştır. Çalışma belleğinin bir diğer alt faktörü olan görsel bellek ile Frostig Görsel Algı testinin alt boyutları olan göz motor koordinasyonu, şekil zemin ayırımı ve mekânsal ilişkilerin algılanması arasında düşük düzeyde anlamlı ilişkiye rastlanmıştır.

### Sonuç ve Tartışma

Çocukların çalışma belleği kapasitesi ile görsel algı düzeyi arasında orta düzeyde ve anlamlı bir ilişki olduğu bulunmuştur. Yapılan araştırmada bellek becerileri, akademik beceriler ve üst biliş becerilerinde sorun

yaşayan çocukların görsel algı becerilerinde de başarısız olduğu belirlenmiştir (Beery ve Beery, 2004; Case Smith 2002; Marr ve diğerleri, 2001; Oliver, 1990; Ratzon ve diğerleri, 2007; Sanghavi ve Kelkar, 2005).

Mevcut çalışmada, çocukların çalışma belleği ile sözel bellek kapasitelerinin ve görsel algı düzeyleri ile göz motor koordinasyonu, şekil-zemin ayrımı ve şekil sabitliği alanlarından elde edilen puanlarının cinsiyete göre anlamlı olarak farklılaştığı ve bu anlamlı farkın kız çocuklarının lehine olduğu bulunmuştur. Yapılan araştırmalar çocukların çalışma belleği kapasitelerinin (Pauls ve diğerleri, 2013) ve görsel algı becerilerinin (Altun Ekiz ve Özdere, 2020; Başkurt, 2018) cinsiyet durumlarına göre farklılaştığını göstermektedir.

Benzer şekilde okulöncesi eğitime dahil olma süresinin de çocukların çalışma belleği kapasitesi (Karakelle ve Ertuğrul, 2012; Passolunghia ve ark., 2015) ve görsel algı becerileri (Uyanık, 2015; Başkurt, 2018) üzerinde farklılık yaratıldığını gösteren çalışmalar mevcuttur.

Çalışma belleğindeki eksiklikler ve görsel algılamada yaşanan problemlerin erken çocukluk yıllarında değerlendirilmesi ileri yıllarda ortaya çıkabilecek sorunlara ilişkin gerekli önlemlerin alınması açısından önemli görülmektedir. Ayrıca çocukların bilişsel becerilerini daha etkin kullanması için uygun yöntemlerin geliştirilmesine ve etkili müdahale programların hazırlanmasına da önemli katkılar sağlayacaktır.

## INTRODUCTION

The early childhood, in which children acquire the essential skills and development of children is quicker than ever, and also their potential to learn is higher than ever, is a critical period for humans. A child's skills acquired in this period form the base for all skills to be developed in the future (Sunar, 2019). Working memory and visual perception undertake essential duties in all the learning experiences in this period. Working memory, which has a different neurological structure and function and undertakes a vital role in learning, refers to a limited capacity in which information is stored temporarily and encoded and processed simultaneously. The capacity and operation of working memory determine the quantity and scope of the learning substantially (Alloway and Archibald, 2008; Baddeley and Hitch, 1974; Baddeley, 2006; Chiapper et al., 2000; Dehn, 2007; Tokuç and Aral, 2020). Frostig defines visual perception as the skill of discriminating visual stimuli and giving them meaning by associating with prior experiences and examines visual perception in five areas: eye-motor coordination, figure-ground discrimination, form constancy, perception of position in space, and perception of spatial relationships (As cited in Aral, 2010). Baddeley and Hitch (1994) proposed a three-compound working memory model comprised of the phonological loop, visuospatial sketchpad, and the central executive that controls these two sub-systems. Afterward, another subcomponent called episodic buffer was added to the system, and the model was enlarged (Dehn, 2010).

The phonological loop, also called verbal short-term memory, is responsible for the short-term storage of verbal information (Baddeley, 1986, 2003, 2006), visuospatial sketchpad, on the other hand, is responsible for short-term storage of visual and spatial information. The phonological loop and visuospatial sketchpad include passive-temporal storage and active repetition. Perceptual stimuli are transformed into phonological codes in the phonological loop (Gilliam and VanKleeck, 1996). Visual sketchpad enables the storage of passive visual information of objects such as their form and color, and spatial sketchpad enables the storage of active visual information of them such as their movements and direction (Baddeley, 2006; Van Der Sluis et al., 2005). Visual information stored in memory has spatial features that facilitate keeping in mind and recalling them (Rao et al., 1997). Visual memory is the essential component that makes human cognition compatible and flexible in complex environments (Olivers and Stigchel, 2020). Moreover, as the visuospatial sketchpad encodes printed letters and words visually, it functions crucially also during reading (Baddeley, 1986; Gathercole et al., 2004). The central executive controls phonological loop and visuospatial sketchpad sub-systems, creates limited attention capacity, and regulates and coordinates cognitive processes. The episodic buffer connects the working memory with the long-term memory (Baddeley, 2003; Dehn, 2007; Torgesen, 2001). Studies show that working memory

skills are effective in acquiring some complex skills, which may directly affect the school success of school-age children (Alloway et al., 2009; Gathercole et al., 2004; Jarvis and Gathercole, 2003).

Besides learning, working memory capacity may also be effective in cognitive tasks that include the development of academic skills such as in-class performance, reading decoding, reading comprehension, maths, and written and verbal expression (Engle, 2002). In the early childhood period, it is seen that children with low working memory capacity have distinct difficulty in following instructions, completing complex duties, and situations and duties that include synchronous processing and storage of information, compared to their peers with good working memory capacity (Kyttala et al., 2019, Tokuç and Aral, 2021).

Memory plays a regulating role in the development of visuospatial perception, and the visuospatial perception affects the performance in the duties of the memory (West et al. 1985). Academic skills are acquired after visual perception and developmental areas can be supported in parallel to this. All problems faced regarding the visual perception process may also cause problems in cognitive skills such as attention, balance, coordination, daily life skills, planning and implementing attitudes, reasoning, and inference as well as in language, motor, social-emotional development areas, and academic learning. They may also cause a delay in the learning process (Aral, 2021). It was found out in the studies that children having difficulty in memory skills, academic skills, and metacognitive skills are also unsuccessful in visual perception skills. Moreover, as a result of this, attention was drawn to the fact that these children may face negative social labeling by society as children who have low self-esteem and are unhappy and shy (Beery and Beery, 2004; Case Smith 2002; Marr et al., 2001; Oliver, 1990; Ratzon et al., 2007; Sanghavi and Kelkar, 2005).

Evaluation in the early childhood years of the deficiencies in working memory and the problems faced in visual perception is considered essential for early diagnosis of possible problems and taking necessary measures timely before the rise of problems in children. Evaluation in the early period will contribute significantly to the development of suggestions for children's use of their cognitive skills more efficiently and the preparation of intervention programs. It is thought that this study, which was conducted to examine whether working memory capacity and visual perception skills, which are highly efficient in academic learning, change by sex and the duration of preschool education attendance, to determine the relationship between working memory capacity and visual perception skills, to put forward the potential problems early within this context, and to contribute to the development of prediction mechanism for early intervention, will be a pioneering one for further studies in the field. In this context, the following research questions are answered in this study:

- Does the sex of children cause any difference in their working memory and visual perception skills?
- Does the duration of preschool education attendance of children cause any difference in their working memory and visual perception skills?
- Is there a significant relationship between working memory and visual perception skills?

## METHOD

This section presents the model, study group, data collection tools, data collection process, and statistical analyses used to analyze the data.

### Research Model

This study utilized the relational screening model to examine the relationship between 5-6-year-old children's working memory capacity and visual perception skills. The relational screening model is a research model that aims at identifying the existence and extent of simultaneous change between two or more variables (Creswell, 2012; Karadağ, 2010).

### Study Group

The study was conducted with children attending independent kindergartens located in the center of Ankara province. Within this scope, necessary ethical permissions were obtained. Accordingly, the necessary permissions were taken from the independent kindergartens that are affiliated with the Ankara Provincial Directorate of National Education, and the children attending the kindergartens that gave permission were included in the study. In this respect, the study group comprises 107 voluntary children whose parents submitted their consent, who had no developmental diagnosis, had typical development, and were determined through the purposive sampling method. It is identified that out of the children included in the study, 57% is girl, 43% is boy; age average is 69.5 months; 29.9% is 11-month-old or younger, 24.3% is between 12 to 16 months, 45.8% is 17-month-old or older, and they continue their preschool education. It is also identified that of the children who attended the study, mothers of 38.3% and fathers of 14.9% are 35 years old and younger; mothers of 61.7% and fathers of 85.1% are 36 years old and older; mothers of 85% and fathers of 88.7% are university graduates.

### Data Collection Tools

The data were collected utilizing *General Information Form*, *the Working Memory Scale (WMS)*, and *the Frostig Visual Perception Test* in the study.

**General Information Form** is a form that contains the questions asked to obtain information about the child and his/her parents.

**The Working Memory Scale;** *The Working Memory Scale* was developed by Ergül et al. (2017) to determine the working memory performance of 5-10-year-old children. The working memory scale, including verbal and visual working memories, consists of nine sub-tests with 43 items. Verbal working memory consists of five sub-tests (digit recall, word recall, non-word recall, backward digit recall, and the first-word recall) and the visual working memory consists of four sub-tests (pattern matrix, block recall, odd-one-out, spatial recall). Each sub-test comprises a growing number of series, and a child needs to succeed in at least one of two attempts in a series so that s/he can move on to the next series. The validity and reliability study conducted on the scale with 1494 children resulted that the item factor-load values vary between .49 and .93, item-total correlation values vary between .21 and .60, and item discrimination varies between .32 and .82. The criterion validity of the scale is found to be between .62 and .94. The internal consistency coefficient is between .74 and .99, and the test-retest correlation is between .41 and .75 (Ergül et al., 2021). Class level standard scores were obtained from the scale for verbal working memory and visual working memory. In this study, standard scores are used both for verbal working memory and visual working memory. The scale is applied to the children individually, and if the score obtained by a child is high, this means that his/her working memory capacity is high.

Cronbach's alpha internal consistency coefficients calculated based on the data obtained from the study group of this study, including 107 children, vary between 0.31 and 0.74. Confirmatory Factor Analysis was carried out to prove the scale's validity, and the model fit is found to be at an acceptable level according to  $X^2/df=2.55$  value examined as the model fit index.

**Frostig Visual Perception Test;** Marianne Frostig developed the *Frostig Visual Perception Test* in 1963. The test aims at determining the visual perception levels of 4-8-year-old children. The test comprises five sub-dimensions, namely eye-motor coordination, figure-ground discrimination, form constancy, perception of position in space, and perception of spatial relationships. A reliability study on the test was conducted by Sökmen (1994) for five-year-old children, and the test-retest method proved that the results of stability coefficients are significant at 0.01 level, the internal consistency coefficient of the test is at 0.5 level. The test has reliability close to the original one. Afterward, Aral and Bütün Ayhan (2016) adapted the Frostig Visual Perception Test to 4-8-year old Turkish children and identified the psychometric characteristics of the test. Expert opinion, confirmative factor analysis, and goodness-of-fit index were checked to provide evidence of the reliability of the test. As a result, it was seen that the expert opinion is appropriate, the error values in the sub-dimensions are low as a result of the factor analysis, and the factor load values are high.



It was found that there is a directly proportional relationship between the age and visual perception levels of the children, the correlation between the sub-dimensions is high, and the differences between the upper and lower 27% groups are also significant. In the analysis made regarding internal consistency, it is determined that the test-retest values are high. The Frostig Visual Perception Test is applied individually, raw scores are calculated for each sub-dimension, raw scores are converted to standard scores. A high score indicates that there is also high-level visual perception.

As a result of the analyses made with the study group of 107 children in this study, the Cronbach's alpha internal consistency coefficient for the reliability of the Frostig Visual Perception Test is calculated as 0.65. Confirmatory Factor Analysis was performed to provide evidence for the test validity and the model fit indexes were calculated as  $X^2/df=1.42$ ,  $RMSEA=0.06$ ,  $GFI=0.97$ ,  $NNFI=0.97$  as a result of the analysis. These values show that the model fits well.

### Data Collection Process

In line with the Ethics Committee Report approved by Hacettepe University's Ethics Committee on 23 February 2021, necessary permissions were obtained from independent kindergartens. An information text was presented to the families of the children in April 2021 and their consent was obtained. The Working Memory Scale and the Frostig Visual Perception Test were given between 17 May and 11 June 2021, individually in a quiet environment to the children included in the study with their families' consent, paying attention to the pandemic rules. The researcher, in person, implemented all the measurements. The working memory scale was completed for verbal and visual working memories in two sessions and approximately 20-30 minutes. The Frostig visual perception test, on the other hand, was completed in a single session and approximately 15-20 minutes.

### Analysis of the Data

IBM SPSS and LISREL programs have been the tools to conduct data analysis. Whether the data obtained using the Working Memory Scale and the Frostig Visual Perception Test showed normal distribution was determined by utilizing Kolmogorov-Smirnov test and descriptive statistics. The normality examinations made for the data analysis included examination of the skewness and kurtosis coefficients of the data obtained from the measurement tools. Accordingly, it is identified that the Frostig Visual Perception Test ( $SC_{FVPT}=-0.239$ ,  $KC_{FVPT}=0.357$ ) and Working Memory Scale ( $SC_{WMS}=0.392$ ,  $KC_{WMS}=-0.130$ ) had normal distribution, and parametric tests are used in data analysis. ANOVA TEST and t-Test were employed for independent samples in the analysis of the data obtained from the Working Memory Scale and the Frostig Visual Perception Test and the sub-factors of these tests by sex and duration of preschool education attendance; and Pearson Product-

Moment Correlation Coefficient was employed to examine the relationships between the Working Memory Scale and its sub-factors, namely the verbal memory and the visual memory, and the Frostig Visual Perception Test. Results were evaluated at 0.05 and 0.01 significance levels.

## FINDINGS

The findings obtained from the study conducted to examine the working memory performances and visual perception skill levels of kindergarten children are presented below in tables.

Table 1. The averages of the Working Memory Scale and sub-factor scores and the t-test results by the sex of the children

Dependent Variable	Girl		Boy		t	df	p	$\eta^2$
	$\bar{X}$	SD	$\bar{X}$	SD				
Verbal Memory	13.60	5.35	11.43	4.21	2.272	105	<b>0.025</b>	0.05
Visual Memory	3.95	2.48	3.76	2.37	0.400	105	0.690	
<b>Total Working Memory</b>	17.55	6.42	15.19	5.50	2.001	105	<b>0.048</b>	0.04

According to Table 1, it has been determined that there is a significant difference by the sex of the children between the average scores obtained by children from Verbal Memory [ $t(105)=2.372$ ,  $p<0.05$ ,  $\eta^2=0.05$ ] sub-factor and Total Working Memory [ $t(105)=2.001$ ,  $p<0.05$ ,  $\eta^2=0.04$ ]. Average scores of girls for verbal memory ( $\bar{X}=13.60$ ) and total working memory ( $\bar{X}=17.55$ ) are higher than average scores of boys for verbal memory ( $\bar{X}=11.43$ ) and total working memory ( $\bar{X}=15.19$ ), and it is seen that difference caused by sex of the children is significant. When the average scores of girls and boys are examined in terms of visual memory, it is identified that there is not a significant difference ( $p>0.05$ ).

Table 2. The averages of the Frostig Visual Perception Test and sub-factor scores and the t-test results by the sex of the children

Dependent Variable	Girl		Boy		t	df	p	$\eta^2$
	$\bar{X}$	SD	$\bar{X}$	SD				
EMC	13.79	3.95	12.04	4.07	2.231	105	<b>0.028</b>	0.05
FGD	15.64	3.62	13.72	3.98	2.606	105	<b>0.010</b>	0.06
FC	10.74	3.04	9.04	2.83	2.938	105	<b>0.004</b>	0.08
PPS	6.74	1.03	6.48	1.46	1.079	105	0.283	
PSR	6.26	1.01	6.07	1.10	0.958	105	0.340	
<b>Frostig VPT</b>	52.85	8.47	47.47	9.56	3.073	105	<b>0.003</b>	0.08

When Table 2 is examined, it is seen that out of the Frostig Visual Perception Test sub-dimensions, average scores of the eye-motor coordination [ $t(105)=2.231$ ,  $p<0.05$ ,  $\eta^2=0.05$ ], figure-ground

discrimination [ $t(105)=2.606$ ,  $p<0.05$ ,  $\eta^2=0.06$ ], and form constancy [ $t(105)=2.938$ ,  $p<0.05$ ,  $\eta^2=0.08$ ] sub-dimensions, and the total of the Frostig Visual Perception Test [ $t(105)=3.073$ ,  $p<0.05$ ,  $\eta^2=0.08$ ] differ significantly by sex. When the total average score of girls for the Frostig Visual Perception Test ( $\bar{X}=52.85$ ) and the total average score of boys for the Frostig Visual Perception Test ( $\bar{X}=47.47$ ) are examined, it reveals that the significant difference is in favor of girls. The average scores of girls for each of the three sub-factors are significantly higher than the average scores of boys. It is identified that the difference between average scores obtained from the perception of position in space and the perception of spatial relationships sub-dimensions, out of the visual perception sub-dimensions, is not significant ( $p>0.05$ ) by sex.

Table 3. The averages of the Working Memory Scale and sub-factor scores by the duration of children's preschool education attendance and the ANOVA test results

Dependent Variable	0-6 months		7-11 months		12-16 months		17 months and older		F
	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	
	Visual Memory	5.33	3.00	3.83	2.40	3.08	2.38	4.04	
Verbal Memory	12.44	5.05	12.17	4.60	11.65	4.46	13.49	5.41	0.88
WMS	17.78	7.78	16.00	5.33	14.73	6.21	17.53	6.05	1.38

Table 3 presents that there is not a significant difference ( $p>0.05$ ) between the average scores obtained by children from visual memory, verbal memory, and total working memory *by the duration of preschool education attendance*.

Table 4. The averages of the Frostig Visual Perception Test and sub-dimension scores by the duration of children's preschool education attendance and the ANOVA test results

Dependent Variable	0-6 months		7-11 months		12-16 months		17 months and older		F	$\eta^2$	Significant Difference
	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>			
	EMC	12.11	3.79	12.39	3.88	12.19	5.03	13.96			
FGD	10.89	3.79	15.26	3.91	15.15	3.69	15.14	3.68	3.61*	0.11	7-11>0-6 12-16>0-6 17 and above>0-6
FC	9.22	2.49	9.74	2.68	9.61	2.98	10.49	3.35	0.80		
PPS	6.22	0.67	6.30	1.18	6.69	0.97	6.82	1.42	1.27		
PSR	5.67	1.32	5.96	0.93	6.15	1.25	6.39	0.91	1.73		
Frostig VPT	44.11	6.83	50.00	7.42	49.69	10.81	52.43	9.24	2.28		

\* $p<0.05$

When Table 4 is examined, it is seen that figure-ground discrimination, one of the sub-dimensions of the Frostig Visual Perception Test, changes significantly by the duration of preschool education attendance ( $p=0.016$ ;  $\eta^2=0.11$ ). When the results of the post-hoc test that is given to see between which groups this significant difference exists, it is seen that children who receive education and are 7-11 months old, 12-16 months old, and 17 months old or older got significantly higher scores than children who receive education and are 0-6 months old in

Table 5. Results of Pearson Correlation Coefficients between the Working Memory Scale sub-factors and the Frostig Visual Perception Test sub-dimensions

Variables	1	2	3	4	5	6	7	8	9
1. FVPT	-								
2. EMC	.756**	-							
3. FGD	.721**	.292**	-						
4. FC	.663**	.379**	.263**	-					
5. PPS	.562**	.286**	.443**	.241*	-				
6. PSR	.566**	.317**	.459**	.275*	.320**	-			
7. WMS	.474**	.264**	.491**	.323**	.292**	.361**	-		
8. Verbal M	.430**	.211*	.467**	.326**	.281**	.313**	.925**	-	
9. Visual M	.315**	.236*	.287**	.150	.164	.272**	.624**	.281**	-

\* $p<.05$ ; \*\* $p<.01$

Table 5 shows the correlation coefficients between the Working Memory Scale and its sub-factors and the Frostig Visual Perception Test and its sub-dimensions. When the table is examined, it is seen that there is a medium-level positive significant relationship between the Frostig Visual Perception Test scores and the Working Memory Scale scores ( $r=.474$ ,  $p<.01$ ). Correlation coefficients are calculated as .430 between the Frostig Visual Perception Test and verbal memory and as .315 between the Frostig Visual Perception Test and visual memory, and these relationships are significant ( $p<0.01$ ). There is a significant low-level relationship between verbal memory, one of the Working Memory sub-factors, and eye-motor coordination and perception of position in space, two of the Frostig Visual Perception Test sub-dimensions, and there is a medium-level significant relationship between verbal memory and the figure-ground discrimination, form constancy, and perception of spatial relationships, other sub-dimensions of Frostig Visual Perception Test. There is a significant low-level relationship between visual memory, another Working Memory sub-factor, and eye-motor coordination, figure-ground discrimination, and perception of spatial relationships, three of the Frostig Visual Perception Test sub-dimensions.

## DISCUSSION and CONCLUSION

Many studies show that supporting working memory, which is a very important predictor of academic learning, in the early years is extremely important in terms of children's academic, cognitive and social skills (Altemeier et al., 2008; Berg, 2008; Blair and Razza, 2007; Blair et al., 2008; Walcott et al., 2010). Likewise, the determination of visual perception skills, which play an

important role in learning, especially in literacy learning, in the early years is among the issues that are emphasized (Sunar, 2019). From this point of view, in this study, the relationship between these two variables, which are extremely important in children's academic skills, is discussed based on the literature.

In the study, in the examination of the difference between the genders of the children and the working memory, the mean scores of the working memory scale of the girls were higher than the mean scores of the working memory scale of the boys, and this difference between the two genders was found to be significant. In the examination of the difference between the sub-components of working memory and gender, it was seen that the verbal memory component was also significant in favor of girls. In their study investigating the relationship between episodic memory and visual spatial working memory with age and gender, Pauls et al. (2013) found that the gender variable made a difference in favor of women in terms of phonological memory performance. This result supports the findings of the current study. On the other hand, Gathercole et al. (2004) found that the structure of verbal memory, visual memory and working memory did not make any difference in terms of gender in children aged 7-14.

In the study, a significant difference was found in favor of girls between the genders of the children and the total scores of visual perception. In the examination of this significant difference in favor of girls in terms of sub-factors, it is seen that this difference is in the sub-factors of eye motor coordination, shape ground separation and shape stability. Altun Ekiz and Özdere (2020) found a significant difference in favor of girls in terms of total score in the sub-dimensions of eye motor coordination, perception stability, and perception of space relations in their research to examine the visual perception development levels of children aged eight and nine. However, they did not find a significant difference in favor of girls in the sub-dimensions of shape ground separation and space location perception. Başkurt (2018) conducted a study on the examination of visual perception skills of children aged 60-72 months living in different places in terms of various variables. In this study, it was found that girls' standard scores of shape-ground separation were significantly higher than boys. In the study conducted by Dağ (2019), it was observed that boys had a lower average than girls in terms of general visual perception score, but this did not make a significant difference. In the analysis of the sub-factors, it was found that there was a significant difference in favor of the girls in the eye motor coordination sub-test. These results support the significant result in favor of girls in the current study in terms of the relationship between visual perception skills and gender.

In the study, it was determined that there was no significant difference between the average scores obtained from visual memory, verbal memory and total working memory according to the duration

of children's attendance at preschool education. As children get older, they begin to notice correct and effective learning methods, which enables them to use working memory more effectively (Karakelle and Ertuğrul, 2012). In their study, Passolunghia et al. (2015) evaluated the intelligence, phonological skills, verbal short-term memory, visual-spatial short-term memory, working memory, counting, and number skills of 100 children at the beginning and end of the academic year. The findings suggest that there is a positive relationship between number skills, phonological skills, verbal and non-verbal intelligence skills and working memory at the beginning and end of the academic year.

However, these results in the literature do not coincide with the results of the current research. As it is known, as a result of the pandemic process, which was effective all over the world between 2019-2021, education was continued intermittently in Turkey. As a natural result of this, the children participating in the research had little opportunity to benefit from the preschool education process continuously and effectively. Like many children in the world, children who participated in the research carried out the education process with significant absence. While this absence is sometimes caused by national health policies due to the pandemic, they are often caused by the health concerns of the parents due to the process. Accordingly, it is seen that many children who were enrolled in schools for 17 months or more at the time of the research have benefited from this period for a maximum of 6-7 months. This shows that the average pre-school education period of the children participating in the study is 6 months and slightly above. Therefore, it is thought that there is no significant difference between the duration of children's attendance at preschool education and their average scores obtained from visual memory, verbal memory and total working memory.

In the study, it was observed that children with a longer time to attend preschool education had a high score of the shape ground discrimination sub-dimension, which is one of the sub-dimensions of Frostig visual perception skill. Uyanık (2015) found in his study titled "Examination of the visual perception development levels of children in the 48-60 and 61-72 month groups attending preschool education institution: Istanbul case" that the total scores of visual perception and all sub-dimension scores of children in the 48-60 month group differed significantly according to the school attendance year, and that the scores of those who attended kindergarten for two years were significantly higher than those who continued for one year. In his study, Başkurt (2018) found that the standard scores of figure-ground distinction of 60-72 month-old children differed significantly according to the age of starting preschool education. According to the results found, it was seen that the shape-ground distinction standard scores of the children who started preschool education

at the age of 36 months and earlier were significantly higher than those of the children who started preschool education at the age of 48 months.

According to the results of the research, a moderate and significant relationship was found between the Working Memory Scale and the Frostig Visual Perception Test. Working memory theories of recent years suggest that working memory and visual perception are closely linked and that these two variables actually share certain brain mechanisms (Druzgal and D'Esposito, 2001; Linden, 2007; Todd and Marois, 2004; Vogel and Machizawa, 2004). In their study, Narjmani et al. (2020) evaluated the effectiveness of visual perception training in the development of working memory of children with attention deficit hyperactivity disorder (ADHD). In this experimental study, they concluded that visual perception training is effective in improving the working memory of children with ADHD, and therefore visual perception training can be used in addition to other training methods to improve the working memory of children with ADHD. In their study, Zhang et al. (2020) compared the visual working memory and visual perception development of children with autism spectrum disorder (ASD) and typical development. In the study conducted by controlling the experimental-control group and IQ-age variable, it was observed that there was a significant relationship between visual working memory and visual perception in children with ASD and the general population. They also found that children with ASD performed lower in cognitive tasks focusing on working memory and visual perception. In reading learning, it is emphasized that the child should have sufficient visual perception skills to correctly distinguish the letters and words written on the paper. Children with poor ability to perceive space and location also have difficulty in remembering objects and written symbols correctly and have many difficulties in reading, writing and calculating, which are defined as academic skills (Sağol, 1998). Ayvaz Sivri (2016) examined the relationship between visual perception and reading skills of primary school freshmen in terms of various variables and found a significant difference between these two variables. Accordingly, children with high visual perception seem to have a high reading comprehension and reading speed. Gathercole et al. (2004) found a positive significant relationship between these two variables in their study in which they investigated the relationship between visual spatial working memory and reading comprehension skills. Bourke et al. (2014), as a result of their research with five-year-old children to determine the relationship between visual spatial working memory and writing skills, found that children with good writing skills also had good visual spatial working memory performances. Gade et al. (2017) examined the effect of an educational intervention developed on visual spatial working memory in the preschool period. In their research, they emphasized that working memory is important not only in acquiring academic abilities but also in determining learning difficulties. In addition, they expressed the opinion that memory education is the most

appropriate way to overcome the obstacles in academic achievement. Rezzagil (2018) found a significant correlation between working memory and school readiness. In their study, Rojas Barahona et al. (2015) showed that children with low scores on the Working Memory Scale made more frequent mistakes in working memory tasks such as remembering and writing.

Another finding of the present study is that the relationship between visual perception skills and verbal memory is more significant than the relationship between visual perception skills and visual memory. Decker (2011) found a significant correlation between early literacy and visual short-term memory. This result is significant in terms of visual perception skills required for early literacy. In the study investigating the relationship between children's working memory and early literacy skills, Sağlam (2020) found that as the working memory capacity increased, early literacy skills also increased. He stated that there is a high level of positive relationship between phonological awareness skills and early literacy skills, especially in the verbal memory component of working memory. In a similar study, Zaretsky (2020) found that despite low vocabulary and phonological awareness skills, there was no difference between the verbal working memory capacities and early literacy skills of children who experienced typical language problems and learned languages. However, it was concluded that children with language problems had lower verbal memory performance. Many studies emphasize the strong relationship between verbal memory and literacy skills (Akoğlu, 2011; Alloway et al., 2005; Blair and Razza, 2007; Decker, 2011; Doğan, 2011; Rezzagil, 2018; Sağlam, 2020; Savage et al., 2007; Swanson, 2007). Likewise, there are studies emphasizing the importance of visual perception development in the development of literacy skills (Akı et al., 2008; Aral, 2010; Ayvaz Sivri, 2016; Harmankaya Maraşlı, 2010; Koç, 2002; Mangır and Çağatay, 1987). These results support the significant difference between visual perception and verbal memory relationship in this study. Based on this, the finding of the current study can be explained by the fact that the relationship between visual perception skill and verbal memory is stronger than the relationship between visual perception skill and visual memory; and the relationship between visual perception and verbal memory capacity is more effective in early literacy skills.

In this study conducted in light of the literature, it has been found that the visual perception skills of girls and boys with high working memory capacity are also high, and the working memory and visual perception skills of girls are higher than boys, and as the duration of kindergarten attendance increases, figure-ground discrimination, one of the visual perception skills, also increases. There is a medium-level significant relationship between the working memory capacity and visual perception skills, and this significant relationship is also valid for the two subcomponents of working memory, namely verbal and visual memory. However, the relationship between verbal



memory and visual perception skills is found to be slightly higher than the relationship between visual memory and visual perception skills.

Evaluations made in the early childhood period will make significant contributions to the development of suggestions for children to use their cognitive skills more effectively and prepare effective intervention programs. It is thought that evaluations of working memory capacity and visual perception skills in early childhood are essential in detecting perception and learning problems and taking necessary precautions before these problems arise. Several researchers agree that children with perception and learning disorders will develop serious learning difficulties and related learning disorders due to not being noticed at a young age and not taking the necessary early measures. This study, which is a vital determinant in the early identification of such difficulties in literacy and mathematics skills mainly caused by perception and learning disorders and draws attention to the positive relationship between working memory capacity and visual perception skills, puts forward a meaningful result. With the information to be obtained regarding the visual perception skills and working memory capacities of children, the development of appropriate diagnosis, therapy and education programs from an early age within a multidisciplinary approach will be encouraged. With the data obtained, educators will be able to prepare group or individual education programs according to the development, needs and interests of children.

In this context, it is expected that this study will create a foresight to reveal the problems that may occur in children in the early childhood years and make the necessary early interventions, contribute to the literature, and guide further studies in this field.

In this respect, the following may be recommended:

- ✓ Knowledge level, attitudes, and behaviors of parents related to visual perception skills and working memory capacity should be improved, and it should be ensured that they are informed about it,
- ✓ Preschool teachers should have sufficient knowledge and awareness about the concepts and processes related to working memory capacity and visual perception skills.
- ✓ Educational interventions to support working memory and visual perception skills should be prepared, and their efficiency should be investigated.
- ✓ It can be suggested to emphasize the importance of working memory, which is very limited, especially in the literature in Turkey, by investigating its relationship with several other skills.

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