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EXAMINING LANGUAGE DEVELOPMENT AS A PREDICTOR OF GEOMETRY AND SPATIAL PERCEPTION SKILLS IN PRESCHOOL CHILDREN [1]

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ABSTRACT

Geometry and spatial skills are closely linked to mathematics, and preschool children's interactions with math help develop these abilities. Early language development is crucial for all aspects of children's growth. This study explores the relationship between language development and geometry and spatial skills in preschool children. Data from 120 preschool children were collected using the Turkish Early Language Development Test (TEDIL) and the Geometry and Spatial Perception Test (GSPT). The data were analyzed using normality tests, descriptive, and correlational analyses, with multiple linear regression to assess if language development predicts geometry and spatial skills. Results show significant positive relationships between children's receptive, expressive, and verbal language skills and their geometry and spatial skills. Regression analysis indicates that receptive and expressive language skills are key predictors of geometry and spatial abilities. These findings contribute to the literature, offering insights into the connections between language and spatial development in early childhood.

Keywords: Preschool children, language development, receptive language, expressive language, geometry and spatial skills.

Okul Öncesi Çocuklarda Geometri ve Uzaysal Algı Becerilerinin Yordayıcısı Olarak Dil Gelişiminin İncelenmesi

ÖZ

Geometri ve uzaysal beceriler matematikle önemli derecede ilişkilidir. Okul öncesi dönem çocuklarının matematikle olan etkileşimleri aynı zamanda geometri ve uzaysal becerilerinin de gelişmesine olanak tanımaktadır. Öte yandan erken yaşlardaki dil gelişimi çocukların tüm gelişim alanları için temel bir koşul olarak düşünülebilir. Bu bağlamda şimdiki çalışmanın amacı okul öncesi dönem çocuklarının dil gelişimleri ile geometri ve uzaysal becerileri arasındaki ilişkileri incelemektir. Çalışmada kurumsal okul öncesi eğitime devam eden 120 çocuktan Türkçe Erken Dil Gelişimi Testi (TEDİL) ve Geometri ve Uzaysal Algı Ölçeği (GUZAL) aracılığıyla veri toplanmıştır. Elde edilen veriler normallik sınaması, betimsel ve korelasyonel analizler temelinde incelenmiştir. Ayrıca okul öncesi dönem çocuklarının dil gelişimlerinin geometri ve uzaysal becerilerini anlamlı şekilde yordamasına ilişkin olarak çoklu doğrusal adımlı regresyon analizine tabi tutulmuştur. Çalışma sonuçları çocukların alıcı, ifade edici ve sözel dil becerileri ile geometri ve uzaysal becerileri arasında pozitif yönde ve anlamlı ilişkiler olduğunu göstermektedir. Gerçekleştirilen regresyon analizi sonuçları ise çocukların alıcı ve ifade edici dil becerilerinin, onların geometri ve uzaysal becerilerinin pozitif yönde ve anlamlı birer yordayıcısı olduğunu işaret etmektedir. Elde edilen sonuçlar literatür ve kuramsal temellerde tartışılmıştır. Ulaşılabilen kaynaklar çerçevesinde, okul öncesi dönem çocuklarının dil gelişimleri ile geometri ve uzaysal becerilerinin doğrudan incelendiği bu ilk çalışmanın alanyazına katkılar sağlayabileceği düşünülmektedir.

Anahtar Kelimeler: Okul öncesi çocuklar, dil gelişimi, alıcı dil, ifade edici dil, geometrik ve uzamsal beceriler.

[1] This article is derived from the second author's master's thesis, which was conducted under the supervision of the first author.

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INTRODICTION

In the preschool period, children experience significant advancements in language development, which are closely intertwined with their rapidly evolving cognitive, physical, and social skills (Menyuk & Brisk, 2005). Language acquisition begins in the womb and continues uninterrupted throughout early childhood, exerting a profound influence on children's overall well-being and their capacity to develop into competent individuals (Arıcı, 2016). A central factor driving young children to acquire new words is their desire to communicate with those around them. Adults play a crucial role in this process by engaging children in conversations about objects or situations that capture their attention, thereby fostering language growth (Brooks & Kempe, 2012). Language development constitutes a fundamental pillar of both cognitive and social maturation in early childhood. Receptive language refers to an individual's ability to comprehend and interpret spoken language, including its form, content, and usage (McIntyre et al., 2017). In contrast, expressive language encompasses the capacity to convey thoughts, needs, and feelings through words and sentences, requiring not only lexical memory but also appropriate contextual and grammatical application. Both receptive and expressive language are integral parts of effective communication and facilitate children's problem-solving and reasoning processes (Ribot et al., 2019).

The early childhood environment also plays a key role not only in language development but also in shaping children's attitudes toward mathematics. It is widely acknowledged that children's mathematical skills can flourish in environments where they are able to connect fundamental mathematical concepts with everyday experiences. Nurturing children's natural curiosity and understanding of mathematics helps them develop positive attitudes toward the subject (Hofer et al., 2013; Ministry of National Education [MoNE], 2024). Mathematical learning begins at home during early childhood and is further reinforced through supportive learning environments in preschool institutions, where it is viewed as an area rich with opportunities to enhance children's knowledge and skills (Björklund et al., 2020).

Early mathematical development is strongly related to geometry skills, which provide a foundation for understanding and reasoning about the physical environment. Research in education and psychology indicates that children learn geometry not passively but through active engagement in meaningful tasks (Clements et al., 2018; Hawes et al., 2015). In inquiry-based learning environments enriched with diverse examples, children explore geometric concepts, attributes, and transformations (Clements, 1998).

The preschool education program implemented in Turkey aims to support children's cognitive development and reasoning skills through mathematics-related learning outcomes (MoNE, 2013). Several of these outcomes are directly associated with geometry, suggesting that teachers who design learning environments aligned with these goals can effectively foster children's geometric understanding (Öğütcen, 2020; Öğütcen & Akman). In this context, teaching geometry to children across all age groups—particularly during the preschool years—is considered essential. Geometry learning in early childhood can be defined as children's ability to recognize and identify objects and phenomena in their surroundings based on geometric forms. During this period, geometry and spatial perception skills form the foundation for later mathematical learning as well as for understanding various related domains (Novita et al., 2018).

The Relationship Between Preschool Language Development and Mathematics, Geometry and Spatial Perception Skills

As societies advance in the information age, communication and language competencies have become increasingly critical. Even minor disruptions in language development can adversely affect individuals' quality of life, often leading to social withdrawal during childhood (Warren & Walker, 2005). While infants do not initially understand spoken words, their language abilities progress rapidly: early speech emerges around one year of age, vocabulary expands significantly by age two, and children typically gain a functional command of basic grammatical structures by age three. Although language development is often assumed to be largely established by age four, key components such as vocabulary, narrative ability, and

communicative competence continue to develop throughout the preschool period (Wagner & Hoff, 2013).

Language development—initiated in the family context—becomes more robust when supported by preschool educational settings (Ersan, 2015). Given that language is closely intertwined with various developmental domains (Brodin & Renblad, 2020; Ren & Höhle, 2022; Wang et al., 2014), preschool institutions play a critical role in enhancing this process. Studies consistently show that children who attend preschool outperform their peers in language-related competencies (Yıldırım & Koçak, 2016). Similarly, Ersan's (2020) longitudinal analysis of children in Turkey demonstrated significantly stronger language outcomes among those who participated in early childhood education programs.

Language functions as a central tool enabling children to build social relationships, regulate behavior, and construct meaning. Its development progresses in parallel with cognitive processes such as reasoning, categorization, and problem solving (Çakır, 2013; Ren & Höhle, 2022). Skills including recognizing similarities and differences among objects, identifying shapes, and classifying based on attributes are fundamental cognitive abilities that also relate to early mathematical thinking (Aktaş Arnas & Aslan, 2005). Young children engage with mathematics in everyday contexts, and such early interactions play an important role in their long-term mathematical dispositions and achievements (Ginsburg et al., 2008; Ferdinand et al., 2024; Wang et al., 2015).

Geometry, as one of the key content areas in mathematics (National Council of Teachers of Mathematics [NCTM], 2000), enables children to analyze shapes, explore geometric relationships, and strengthen spatial reasoning. While geometry is rooted in mathematics, it represents a distinct domain that requires specific forms of knowledge and learning experiences (Fidan & Türnüklü, 2010; NCTM, 2000). These skills develop most effectively when connected to children's prior knowledge and embedded in meaningful activities situated in daily life (Clements et al., 2018; Hintikka, 2009; Iuculano et al., 2018). In fact, children frequently engage with geometric concepts such as size, position, and shape during everyday activities, sometimes in surprisingly sophisticated ways (Ginsburg et al., 2008).

Historical perspectives also highlight the significance of geometry in early education. Foundational thinkers such as Froebel and Pestalozzi emphasized geometric forms and included both two- and three-dimensional elements in their educational materials, arguing that such experiences support young children's perceptual foundations for learning (Aktaş Arnas & Aslan, 2005). In contemporary settings, children encounter geometric forms across diverse environments, and these encounters contribute to the development of geometric and spatial perception skills (Markovits & Patkin, 2020). Research further indicates that the foundations of later mathematical and geometrical understanding are established during the preschool years (Clements et al., 2018; Ersan & İvrendi, 2016). For example, Pruden et al. (2011) found significant positive associations between children's everyday familiarity with spatial language and their geometric and spatial perception abilities.

A growing body of research shows significant relationships between language and mathematics competencies in early childhood. Language skills have been linked to mathematical reasoning (Taşkın, 2013), mathematical processing abilities (Koyuncu & Yabaş, 2017), and even the development of specific domains such as arithmetic and geometry (Hornburg et al., 2018; Purpura & Ganley, 2014). In general, preschool language development appears to be a critical determinant of children's mathematical engagement and performance. This relationship is evident in how children develop geometry and spatial skills alongside their language abilities. Children define spatial relationships, express directions, positions, and shapes while interacting with their environment; in this process, verbal language serves as a tool for understanding spatial awareness (Newcombe, 2010). For example, understanding and using spatial expressions such as "above," "below," and "next to" helps children analyze positions, routes, and shape relationships during block play or other geometry-related activities. Therefore, the development of receptive and expressive language skills can be considered a fundamental cognitive process that supports children's acquisition of geometry and spatial perception skills (Kesicioğlu & Alisinanoğlu, 2022; McIntyre et al., 2017; Vehkavuori et al., 2021).

Despite this emerging evidence, no known studies have directly examined the relationship between preschool children's language development and their geometry or spatial perception skills. Addressing this gap, the present study investigates whether the language development levels of children aged 60–72 months significantly predict their geometry and spatial perception abilities. Accordingly, the following research questions were explored:

a) Is there a significant relationship between the receptive, expressive, and total language skills of

children aged 60–72 months and their geometry and spatial perception skills?

b) Do receptive, expressive, and total language skills significantly predict children's geometry and spatial perception skills?

METHOD

Research Model

This study employed a quantitative research design to examine the relationships between five-year-old preschool children's receptive, expressive, and total language skills and their geometry and spatial perception skills. For this purpose, children's language skills and geometry–spatial perception skills were measured, the correlations between these variables were analysed, and the predictive role of language skills on geometry and spatial perception skills was evaluated.

Study Population and Sample

The study population consisted of preschool children attending independent kindergartens affiliated with the Ministry of National Education in the Alanya district during the 2023–2024 academic year. The sample included 120 five-year-old children enrolled in three independent kindergartens. Of the participating children, 57 were boys (52.5%) and 63 were girls (47.5%). Mothers' educational levels were predominantly university-level (65%), and fathers had a similar rate of university graduation (65%). While 61% of the mothers (n = 72) were employed, the employment rate for fathers was 97.5% (n = 117).

Data Collection Process

Ethical approval for the study was obtained from the Alanya Alaaddin Keykubat University Senate Ethics Committee (14.11.2023; No: E-32368283-605.01-153727). Following ethical approval, research permission was granted by the Ministry of National Education. Subsequently, parental consent was obtained, and the Turkish Early Language Development Test (TEDİL) and the Geometry and Spatial Perception Test (GUZAL-T) were administered to the participating children. Written permission to use both instruments was obtained from their developers/adapters.

Data Collection Tools

Demographic Information Form

Completed by parents to gather descriptive information about the children and their families. The form included items regarding the child's age, number of siblings, prior preschool attendance, and parents' educational levels.

Turkish Early Language Development Test (TEDIL)

The Test of Early Language Development–Third Edition (TELD-3), developed by Hresko et al. (1999), is an assessment tool designed to measure the language abilities of children aged 2;0 to 7;11. The test aims to (a) identify children with delays in early language development, (b) determine strengths and weaknesses in verbal skills, (c) guide intervention planning, (d) serve as a research instrument, and (e) complement other assessment techniques (Güven & Topbaş, 2014).

The Turkish adaptation of the test was conducted by Güven (2009), and the adapted version was named TEDİL. Following pilot applications, the items were revised, and the reliability and validity procedures were completed. TEDİL evaluates three components of language—semantics, morphology, and syntax—within receptive and expressive language domains.

TEDİL has no time limit, and administration typically takes 15–40 minutes depending on the child's developmental level. The test includes two parallel forms (A and B), each consisting of receptive and expressive subtests. Age-appropriate starting items are specified for each subtest, and responses are scored dichotomously (1 = correct, 0 = incorrect). Testing continues until the child provides three consecutive incorrect responses (Güven, 2009).

Reliability analyses demonstrated high internal consistency, with Cronbach's alpha coefficients ranging from .86 to .98 for both receptive and expressive subtests across forms A and B (mean α = .93 and .92, respectively). Validity evidence was established through content, criterion, and construct validity studies. Item difficulty and discrimination analyses supported content validity, while increasing scores across age groups and strong correlations between subtests (r = .90) provided construct validity evidence. A total verbal language score is obtained by averaging receptive and expressive language subtest scores (Güven, 2009).

Administration of the Turkish Early Language Development Test (TEDIL)

The Turkish Early Language Development Test was administered to 120 children included in the study between 20 November 2023 and 12 January 2024. The test was administered in the school counsellors' room on the floors where the classrooms were located. After a brief introduction and chat with the children, the administration of the test started. The tests of all children except one child were completed in a single session. One child clearly stated that he/she was bored and wanted to return to his/her class, and the test was completed in the second session after the child rested by taking a break. The application of the tests took an average of 30-40 minutes.

Geometry and Spatial Perception Test (GSPT)

The Geometry and Spatial Perception Test (GSPT), developed by İvrendi et al. (2018), is designed to assess the geometry skills of preschool children aged 5–6 years. The development process of the test was conducted during the 2016–2017 academic year with children attending kindergartens and independent preschools affiliated with 15 different primary schools. Two schools participated in the pre-pilot stage, one in the pilot stage, and twelve in the main implementation.

The pre-pilot phase involved administering a 42-item preliminary form to ten children by two preschool teachers. Based on expert feedback, the item pool was expanded to 54 items, after which the pilot study was conducted with 100 children by two researchers. Revisions were made to enhance item clarity following the pilot results.

The main implementation was then carried out with 500 preschool children who had not participated in the pilot study. Data collection was completed by four volunteer senior students in the preschool education department, each of whom received three days of training (1.5 hours per day) on the test items and administration procedures.

The KR-20 coefficient for the full scale was .84. Reliability coefficients for the subdimensions ranged from .45 to .73. The standard error of measurement was calculated as 1.96, indicating a potential measurement error of ±1.96 points. Item–total correlations ranged between .26 and .56. In test–retest evaluations, the instrument demonstrated high stability, with a correlation coefficient of .80 (İvrendi et al., 2018).

Administration of the Geometry and Spatial Perception Test (GSPT)

The GSPT was administered to the 120 participating children between 20 November 2023 and 12 January 2024. The assessments were conducted in the school counselor's room, located on the same floor as the classrooms. Care was taken to ensure that the environment was free from distractions. Each administration took approximately 15–20 minutes, and all children completed the test in a single session.

Data Analysis

Data analyses were conducted using SPSS 24. The analytical procedures included tests of normality, descriptive statistics, correlation analyses, and regression analyses. Skewness and kurtosis values between –2 and +2 were considered evidence of normal distribution (Tabachnick & Fidell, 2015). Pearson correlation coefficients were computed to examine the relationships among the variables.

To assess the suitability of the data for regression analysis, correlations among independent variables and Variance Inflation Factor (VIF) values were examined. A correlation below .70 and a VIF value lower than 10 were taken as indicators that multicollinearity was not a concern (Can, 2014; Pallant, 2017).

Finally, stepwise regression analysis was employed to determine whether preschool children's language development levels significantly predicted their geometry and spatial perception skills. The stepwise method is considered a detailed approach for identifying variables that meaningfully contribute to the model while excluding those that do not (Can, 2014).

RESULTS

Descriptive statistics for the dependent variable (GSPT scores) and independent variables (receptive language, expressive language, and total verbal language scores) are presented in Table 1.

Table 1. *Descriptive Statistics of Dependent and Independent Variables*

Variables	n	Min	Max	$\bar{x}$	ss	Kurt.	Skew.
Receptive Language	120	67	128	94.28	12.44	-.621	.175
Expressive Language	120	71	125	96.87	8.56	1.08	-.169
Verbal Language Total	120	65	132	94.71	11.46	.132	.225
GSPT	120	13	40	29.47	5.83	-.138	-.536

GSPT: Geometry and Spatial Perception Test, Kurt.: Kurtosis, Skew: Skewness

Analysis of Table 1 shows that receptive language scores ranged from 67 to 128, while expressive language scores ranged from 71 to 125. Total verbal language scores varied between 65 and 132. Children's geometry and spatial perception test scores ranged between 13 and 40. The skewness and kurtosis values for all variables fell between –.63 and 1.08, indicating that the distributions did not deviate substantially from normality. Accordingly, the use of parametric statistical analyses was considered appropriate.

Relationships Between Variables

Pearson Product-Moment Correlation Coefficients were calculated to examine the relationships between receptive language, expressive language, total verbal language scores, and geometry–spatial perception scores. The results are presented in Table 2.

Table 2. *Pearson Correlation Coefficients of Variables*

Variables	Receptive Language	Expressive Language	Verbal Language Total	GSPT
Receptive Language	1			
Expressive Language	.64**	1		
Verbal Language Total	.94**	.86**	1	
GSPT	.61**	.59**	.66**	1

***P<.01,* GSPT: Geometry and Spatial Perception Test

Analysis of Table 2 indicates that all variables are positively and significantly correlated. Receptive language scores showed significant positive correlations with expressive language, total verbal language, and geometry–spatial perception scores. Expressive language scores were similarly correlated with total verbal language and geometry–spatial perception scores. Total verbal language scores were also significantly associated with geometry–spatial perception performance.

As expected, receptive and expressive language scores—both independent variables—were highly correlated with total verbal language scores (r = .94 and r = .86, respectively). Correlations above .70 may indicate potential multicollinearity among predictors (Pallant, 2017). Therefore, Variance Inflation Factor (VIF) values were examined. The VIF value for total verbal language was 25, exceeding the commonly accepted threshold of 10, suggesting that this variable was not suitable for inclusion in the regression analysis.

The Predictive Power of Receptive and Expressive Language Scores on Geometry and Spatial Perception Skills

The second sub-problem examined whether preschool children's receptive and expressive language scores significantly predicted their geometry and spatial perception skills. Stepwise multiple regression results are presented in Table 3.

The analysis showed that the stepwise model was completed in two steps. In the first step, receptive language scores significantly predicted geometry and spatial perception scores and explained 37% of the variance [$R = .60$, $R^2 = .37$, $F(1,118) = 68.783$, $p < .001$]. When expressive language scores were added in the second step, the explained variance increased to 44% [$R = .66$, $R^2 = .44$, $F(2,118) = 45.609$, $p < .001$]. These findings indicate that both receptive and expressive language skills uniquely contribute to preschool children's geometry and spatial perception performance.

Table 3. *The Effect of Receptive and Expressive Language Scores on Geometric-Spatial Perception Scores of Preschool Children*

Model	Predictive Variables	B	Standard Error	β	t	p	R	R^2
1	Stable	2.282	3.306	-	.690	.491	.608	.370
	Receptive Lan.	.289	.035	.608	8.294	.000		
2	Stable	-10.60	4.610	-	-2.300	.053	.663	.440
	Receptive Lan.	.185	.043	.390	4.324	.000		
	Expressive Lan.	.234	.061	.343	3.808	.000		

Model 1: F (1-118) = 68.783, p<.001
Model 2: F (2-118) = 45.609, p<.001

DISCUSSION

The present study examined the relationship between preschool children's language development and their geometry and spatial skills. A review of the literature revealed a lack of research directly investigating this relationship, possibly due to the limited attention given to geometry in early childhood education (Sarama & Clements, 2009). Nevertheless, geometry and spatial skills are considered a subdomain of mathematics (Hawes & Ansari, 2020; Tam & Chan, 2022; Young et al., 2018), suggesting that studies on language development and mathematics skills can provide relevant insights.

Several studies support the link between language and mathematical abilities. For example, Kung et al. (2019) found a significant relationship between children's mathematical language skills and mathematics performance in both China and the USA. Similarly, Turan and De Smedt (2023) reported that children's language skills were significantly associated with geometry, while Purpura and Ganley (2014) found that language abilities correlated with almost all mathematics skills, including geometric skills. These findings indicate that language and geometry/spatial skills are interrelated developmental domains, with language facilitating the understanding and internalization of abstract mathematical concepts.

Language development is an integral part of cognitive development, supporting thinking, problem-solving, and reasoning (Kargı, 2012; Senemoğlu, 2023). Recent studies also emphasize that early childhood mathematical skills emerge through daily routines, social interactions, and play-based activities (Erdoğan & Baran, 2005; Hachey, 2013; Nicolopoulou, 2010). Children with advanced communication skills are more likely to engage effectively with mathematical concepts, while those with limited vocabulary require additional support. Everyday interactions, such as using terms like 'near' or 'far,' contribute to both mathematical and spatial understanding (Diaz, 2008; Sperry Smith, 2016).

Spatial thinking, a critical component of geometry, is essential for various cognitive and practical tasks

(Liben, 2007). Teacher and peer interactions play a crucial role in developing these skills. For example, feedback on positioning objects during play activities enhances children's spatial reasoning (Pritulsky et al., 2020). Additionally, children exposed to more spatial language—terms such as "inside," "above," and "around"—demonstrate better spatial thinking development (Newcombe, 2010). The Geometry and Spatial Perception Test used in this study also incorporates spatial language, including both 'show' and 'tell' instructions, confirming the link between language skills and geometry/spatial abilities.

The integration of geometry and spatial thinking in the Turkish preschool curriculum further supports these findings (Ministry of National Education, 2013, 2024). The curriculum emphasizes three core elements: recognizing spatial concepts (e.g., under, beside), using representational tools (e.g., simple maps), and reasoning about object positions. Children's ability to express spatial relations depends on their receptive and expressive language skills, highlighting the interdependence of linguistic and geometric competencies (Ferrara et al., 2011; Mizzi, 2017).

Storytelling and play-based interventions have also been shown to enhance geometry skills. Casey et al. (2008a, 2008b) demonstrated that combining storytelling with block games positively influenced children's spatial perception and geometric reasoning. These findings align with the current study, confirming the critical role of language and communication in geometry and spatial skill development.

The theoretical framework of Vygotsky's zone of proximal development (ZPD) further supports the study's results. Children develop higher cognitive skills through interactions with more knowledgeable individuals (Atay, 2009; Göl, 2021; Otto, 2021). Adult guidance during communication enables children to process and make sense of spatial and geometric concepts, reinforcing both language and cognitive development. Fox et al. (2024) also highlighted that longer, more descriptive parental spatial language positively relates to children's daily spatial activities and skill development.

In conclusion, this study demonstrates a strong positive relationship between preschool children's language abilities and their geometry and spatial skills. The findings are consistent with prior research and theoretical perspectives, emphasizing that language development not only mediates cognitive growth but also enhances the acquisition of geometry and spatial competencies. By providing concrete evidence on the interaction between these skills, this study contributes to the literature and offers insights for effective teaching strategies in early childhood education.

RECOMMENDATIONS

Based on the findings of this study, it is evident that preschool children's language skills are significantly related to their geometry and spatial perception skills. In light of this result, it is recommended that activities supporting both language and spatial skills be carefully designed and integrated into early childhood education. The primary goal of the geometry curriculum should focus on developing children's spatial reasoning (Schwarts, 2017). Meaningful learning can be promoted both at home and at school through the use of block toys, geometric materials, and other hands-on activities.

Parent seminars can be organized to raise awareness about the importance of language development and spatial skills in children's future learning. These seminars can also emphasize the role of spatial language in parent-child interactions and play-based activities.

Additionally, in-service training programs can be developed for preschool teachers to support both language and geometry/spatial skills. These trainings can be offered face-to-face or online, providing practical strategies and examples for classroom implementation.

LIMITATIONS

This study employed only quantitative measurement tools. Incorporating qualitative data collection methods, such as observations or interviews, could provide deeper insights and further strengthen the understanding of the relationships between preschool children's receptive language skills, expressive language skills, and geometry and spatial perception skills. Moreover, the study was limited to 5-year-old children attending institutional preschool programs, which restricts the generalizability of the findings to

other age groups or to children who do not participate in formal preschool education. Future research including a wider age range and non-institutionalized children could provide a more comprehensive perspective on these developmental relationships.

Ethical Statements

We declare that no ethical violations were found in this study and that all stages of the study were conducted in accordance with research and publication ethics principles. Ethical approval was obtained from the Alanya Alaaddin Keykubat University Social and Humanities Research Ethics Committee with decision number E-32368283-605.01-153727 dated November 14, 2023. No financial support was provided by any institution, organization, or funding agency during the conduct and publication of the research. Both authors declare that there is no conflict of interest with any person, institution, or organization in the planning, conduct, data analysis, and preparation of the article. Furthermore, there is no financial or personal connection that could influence the results or interpretations of the study. All content in this study was created by the authors. However, artificial intelligence programs (DeepL and ChatGPT) were used to ensure scientific language, meaning, and fluency in English.

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GENİŞ ÖZET

Okul öncesi dönem, çocukların bilişsel, sosyal, duygusal ve dil gelişimlerinin hızla ilerlediği, aynı zamanda bu alanlar arası karşılıklı etkileşimin belirginleştiği kritik bir gelişim evresidir. Bu dönemde dil ediniminin doğumdan önce başlayıp erken çocukluk boyunca devam ettiği; çocukların iletişim kurma kapasitesini, sosyal uyumunu, akıl yürütme becerilerini ve çevresini anlamlandırma süreçlerini önemli ölçüde etkilediği bilinmektedir. Çocukların sözcük öğrenme motivasyonları çoğunlukla sosyal etkileşim ihtiyacına dayanmakta, özellikle yetişkinlerin çocukların dikkatini çeken nesneler ve olaylar üzerinden kurduğu etkileşimler dil gelişiminin temel belirleyicileri arasında yer almaktadır. Dil gelişiminin iki temel bileşeni olan alıcı dil ve ifade edici dil, çocukların hem başkalarının iletilerini anlamalarını hem de duygu, düşünce ve ihtiyaçlarını etkili biçimde ifade etmelerini sağlayarak, bilişsel süreçlerin desteklenmesinde güçlü bir rol üstlenmektedir.

Erken çocukluk döneminde gelişimi hız kazanan bir başka alan da matematiksel düşünmedir. Çocuklar matematiksel kavramları günlük yaşantılarıyla ilişkilendirdikleri somut deneyimler yoluyla öğrenmekte; bu süreç yeni bilgilerin yapılandırılması, problem çözme, sınıflandırma, karşılaştırma ve mantıksal çıkarım yapma gibi becerilerle bütünleşmektedir. Aile içinde başlayan matematiksel farkındalık, okul öncesi eğitim kurumlarında daha sistematik ve yapılandırılmış öğrenme fırsatlarıyla zenginleşmektedir. Bu bağlamda geometri, çocukların nesnelerin özelliklerini tanıma, sınıflama, şekiller arası ilişkileri kavrama ve çevrelerini uzamsal olarak anlamlandırmalarını sağlayan temel bir alt öğrenme alanı olarak öne çıkmaktadır. Çocuklar geometrik kavramları çoğunlukla manipülatif materyaller, blok oyunları, yapı-inşa etkinlikleri ve sınıf içi mekânı keşfetmeye yönelik etkinlikler aracılığıyla edinirler; bu tür deneyimler onların uzaysal düşünme ve uzaysal algı becerilerinin gelişimine doğrudan katkı sağlar.

Türkiye'de yürütülmekte olan okul öncesi eğitim programı, çocukların geometri ve uzaysal kavramlara ilişkin becerilerini desteklemeyi amaçlayan çeşitli kazanımlar içermekte; bu kazanımlar arasında nesnelerin şekil özelliklerini ayırt etme, konum–yön ilişkilerini ifade etme, nesneler arasındaki uzaysal bağlantıları tanımlama ve uzamsal terimleri doğru kullanma gibi hedefler yer almaktadır. Uzaysal algı becerilerinin erken çocukluk döneminde hızla geliştiği ve bu becerilerin ilerleyen yıllarda matematik, fen ve teknoloji alanlarındaki akademik başarıyla ilişkili olduğu çok sayıda araştırmada ortaya konmuştur. Uzaysal becerilerin özellikle STEM alanlarında kritik bir öneme sahip olduğu, çocukların üç boyutlu düşünme, zihinsel döndürme ve mekânsal ilişkileri yorumlama kapasitesini güçlendirdiği bilinmektedir.

Dil gelişimi ile matematiksel ve beceriler arasındaki ilişkiyi inceleyen çalışmalar, dilsel süreçlerin kavramsal düşünme için temel oluşturduğunu ortaya koymaktadır. Dil, çocukların çevresindeki dünyayı kategorilere ayırmalarını, benzerlik ve farklılıkları ayırt etmelerini, ilişkileri açıklamalarını ve problem çözme stratejilerini sözelleştirmelerini kolaylaştırmaktadır. Uzaysal terimlerin öğrenilmesi ve kullanılması, hem sözel ifade becerilerini hem de çocukların çevrelerindeki konum ve yön ilişkilerini doğru yorumlama yeteneğini geliştirmektedir. Örneğin "üstünde", "yanında", "içinde", "arkasında" gibi günlük yaşamda sık kullanılan terimlerin anlaşılması, uzaysal algının önemli bir göstergesidir. Çocukların oyun sırasında arkadaşlarına rotaları tarif etmeleri, nesnelerin konumunu sözel olarak açıklamaları veya yapı-inşa etkinliklerinde kullandıkları stratejileri ifade etmeleri, dil ile geometrik ve uzaysal düşünme arasındaki karşılıklı etkileşimin belirgin örnekleridir.

Bu çalışma, okul öncesi dönemde alıcı ve ifade edici dil becerilerinin geometri ve uzaysal algı üzerindeki yordama gücünü incelemeyi amaçlamaktadır. Alanyazında dil gelişimi ile uzaysal beceriler arasındaki ilişkinin çeşitli yönlerinin ele alındığı görülmekle birlikte; dil becerilerinin çocukların geometrik ve uzaysal algı düzeylerini ayrı ayrı ne ölçüde yordadığına ilişkin bulgular sınırlıdır. Bu nedenle araştırma, 60–72 ay arası çocukların alıcı dil, ifade edici dil ve toplam dil becerilerinin geometrik ve uzaysal algı düzeyleri ile olan ilişkisini incelemekte ve bu dil alanlarının geometrik ve uzaysal algıyı ne ölçüde açıkladığını değerlendirmektedir. Araştırma nicel araştırma modeliyle yürütülmüş; Alanya'da üç bağımsız anaokuluna devam eden toplam 120 çocuk örneklem olarak seçilmiştir. Veri toplama sürecinde Türkçe Erken Dil Gelişim Testi (TEDİL) ve Geometri ve Uzaysal Algı Testi (GSPT) uygulanmış; elde edilen veriler SPSS 24 yazılımında analiz edilmiştir.

Betimsel analizler tüm değişkenlerin normal dağılım gösterdiğini ortaya koymuştur. Korelasyon analizleri, alıcı dil, ifade edici dil ve toplam dil puanlarının uzaysal algı ile pozitif ve anlamlı ilişkiler içinde olduğunu göstermiştir. Alıcı ve ifade edici dil puanlarının toplam dil puanıyla çok yüksek düzeyde ilişkili olması (çoklu doğrusal bağlantı riski) nedeniyle toplam dil değişkeni regresyon analizine dahil edilmemiştir. Aşamalı

regresyon analizinde çocukların alıcı dil becerisinin, onların geometrik ve uzaysal algı düzeylerinin %37'sini açıkladığı; ifade edici dil değişkeninin modele eklenmesiyle bu oranın %44'e yükseldiği görülmüştür. Bu bulgu, her iki dil alanının da geometrik ve uzaysal algıyı anlamlı düzeyde yordadığını göstermekte ve dil becerilerindeki gelişimin uzaysal ilişkileri anlama, geometrik kavramları yorumlama ve şekiller arası bağlantıları kurma süreçlerini desteklediğini ortaya koymaktadır.

Araştırmanın sonuçları alanyazındaki bulgularla uyumludur. Araştırmalar, uzaysal dil kullanımının geometri performansını artırdığını ve blok oyunları ile üç boyutlu etkinliklerin çocukların uzaysal düşünme becerilerini desteklediğini göstermektedir. Ayrıca yetişkin rehberliğinin, hem dil hem de bilişsel süreçler üzerinde önemli bir etkisi olduğu çeşitli kuramsal yaklaşımlar tarafından vurgulanmaktadır. Vygotsky'nin yakınsak gelişim alanı kavramı, çocuğun gelişiminin yetişkin tarafından sağlanan uygun dilsel ve bilişsel destekle ilerlediğini öne sürer. Bu durum, hem dil edinimi hem de uzaysal düşünme açısından büyük önem taşımaktadır.

Sonuç olarak bu çalışma, okul öncesi dönemde dil becerilerinin uzaysal algı üzerinde güçlü ve anlamlı bir etkiye sahip olduğunu göstermektedir. Dil gelişiminin desteklenmesi, yalnızca iletişim becerisinin değil, aynı zamanda erken matematiksel düşünmenin temellerinin güçlendirilmesi açısından kritik öneme sahiptir. Araştırmanın bulguları doğrultusunda öğretmenler ve program geliştiricilere, uzaysal dil kullanımını teşvik eden etkinliklerin artırılması, dil ve geometriyi bütünleştiren öğrenme ortamlarının tasarlanması, ailelerin uzaysal dil konusunda bilinçlendirilmesi ve öğretmen eğitim programlarına bu içeriklerin eklenmesi önerilmektedir. Örneklemin sadece belirli bir bölgedeki kurumsal eğitim alan çocuklarla sınırlı olması ve yalnızca nicel veri toplama araçlarının kullanılması ise araştırmanın sınırlılıkları arasındadır. Gelecek çalışmalarda daha geniş örneklemler, nitel veri toplama yöntemleri ve farklı yaş gruplarının incelenmesi önerilmektedir. Son olarak ulaşılabilen kaynaklar çerçevesinde, okul öncesi dönem çocuklarının dil gelişimleri ile geometri ve uzaysal becerilerinin doğrudan incelendiği bu ilk çalışmanın alanyazına katkılar sağlayabileceği düşünülmektedir.