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INTELLIGENCE QUOTIENT (IQ) AND RECEPTIVE-EXPRESSIVE LANGUAGE SKILLS IN 5–6-YEAR-OLD CHILDREN

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Abstract

Objective: This study examined the association between intelligence quotient (IQ) scores and receptive, expressive, semantic, and grammatical language performance in 5–6-year-old children.

Methods: This cross-sectional study prospectively enrolled and assessed 50 children from four cities in Türkiye. IQ was assessed using the Stanford–Binet Intelligence Scale, and language skills were evaluated using the Turkish Early Language Development Test (TEDİL). IQ was treated as a continuous variable, and associations between IQ and language outcomes were examined using Spearman rank correlations. Exploratory sex comparisons used the Mann–Whitney U test.

Results: The sample included 25 girls and 25 boys; 37 children were aged 5 years and 13 were aged 6 years. Mean IQ was 110.38±12.72. IQ scores were positively correlated with receptive language ($p=0.643$, $p<0.001$), expressive language ($p=0.764$, $p<0.001$), and total language ($p=0.766$, $p<0.001$). Positive correlations were also observed for all four language subdomains ($p=0.569$–0.726; all $p<0.001$).

Conclusion: Higher IQ scores were associated with stronger receptive, expressive, semantic, and grammatical language performance in this study.

Keywords: *Child language, Intelligence, Language Development, Semantics, Receptive–expressive language.*

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Introduction

Language development during the preschool period is a foundational component of communication, learning, and social participation. Contemporary terminology emphasizes that difficulties in language development should be interpreted within a broad developmental context rather than through a single discrepancy model between verbal and nonverbal ability.[1] Population-based research also indicates that children with language disorders may show heterogeneous cognitive profiles and that nonverbal ability can influence clinical presentation but should not be used alone to define language difficulty.[2]

Receptive and expressive language skills show developmental continuity and are related to later academic and functional outcomes. Longitudinal studies have shown that core language ability is relatively stable from early childhood into later childhood and adolescence,[3,4] and early productive vocabulary predicts later academic achievement.[5] These findings highlight the importance of evaluating language abilities during the preschool years, when individual differences in comprehension, vocabulary, grammar, and expressive formulation become clinically and educationally meaningful.

Recent preschool research further supports a close but non-unitary relation between language and domain-general cognition. In typically developing preschoolers, executive-function components, particularly verbal working memory and cognitive flexibility, explain unique variance in language skills even after age and nonverbal intelligence are considered. Studies of preschool children with developmental language disorder (DLD) likewise report associations between executive functioning, vocabulary, morphosyntax, and broader language performance, although individual profiles are heterogeneous.[6-13]

The relation is also shaped by the broader cognitive and environmental context. Preschool studies indicate that nonverbal cognitive performance can be associated with verbal-language outcomes, while maternal education and socioeconomic conditions contribute additional variation in receptive and expressive development.[14-16] Contemporary work therefore favors a multidimensional interpretation in which intelligence, executive control, language-processing efficiency, and environmental exposure may jointly influence observed language-test performance rather than a simple one-directional IQ-to-language pathway.[16-22]

The relationship between cognitive ability and language is complex and likely bidirectional. Genetic and developmental evidence suggests links between lexical and grammatical growth,[23] and early language skills show concurrent associations with executive functions and other domain-general cognitive processes.[24,25] From this perspective, IQ may be associated not only with overall language scores but also with specific subdomains such as semantics and grammar. However, Turkish data examining continuous IQ scores together with receptive and expressive language subdomains in 5–6-year-old children remain limited.

Within this framework, the present study contributes a dimensional, subdomain-level analysis in Turkish-speaking 5–6-year-old children. Rather than using IQ categories for inference, the revised analysis examines continuous overall IQ in relation to standardized receptive, expressive, and total language scores and to separate grammar and semantics scores. This approach is intended to characterize the strength and pattern of cognitive-language associations within the observed IQ range, not to establish diagnostic cutoffs or causal effects.

This study therefore examined whether IQ scores were associated with receptive language, expressive language, total language, semantic, and grammatical scores in 5–6-year-old children with IQ scores of 90 or higher. The primary hypothesis was that higher IQ scores would be positively associated with higher language scores.

Methods

Study design and participants

This cross-sectional study prospectively enrolled in this study. The analytic sample included 50 children aged 5–6 years who were attending or not attending preschool education in Tokat, Ankara, Istanbul, and Çanakkale, Türkiye. The sample consisted of 25 boys (50.0%) and 25 girls (50.0%); 37 children (74.0%) were aged 5 years, and 13 children (26.0%) were aged 6 years. IQ was assessed before language testing. Children with IQ scores of 90 or higher were classified into average, high-average, superior, or very-superior IQ categories and were included in the language assessment. For the revised inferential analysis, these IQ categories were retained for descriptive reporting only, whereas the original IQ score was analyzed as a continuous variable.

Ethical considerations

This study approved by Turgut Ozal University Faculty of Medicine Clinical Research Ethics Committee (Reference No.: 99950669/137; Date: 28 May 2015). The study was approved by an institutional ethics committee before data collection. The committee's name and approval identifiers have been removed from this blinded manuscript and are provided in the title page and submission system. Parents or legal guardians received information about the study, and written informed consent was obtained before assessment.

Data collection instruments

Demographic form

The demographic form included chronological age, sex, parental education and occupation, number of siblings, birth order, primary caregiver, preschool attendance, living environment, parental age, parents' marital status, and child interests.

Stanford–Binet Intelligence Scale, Turkish Age-Level Form (Uğurel-Şemin, 1972)

Turkish age-level Stanford–Binet Intelligence Scale, adapted and standardized for use in Türkiye by Uğurel-Şemin in 1972.[26] This instrument was selected in the original 2015 study protocol for two main reasons. First, the Turkish age-level Stanford–Binet was in established use in Türkiye for the assessment of young children at the time of data collection; more recent reviews have documented the continued use of the 1972 revision in Turkish Guidance and Research Centers.[27] Second, the age-level structure of the instrument was compatible with the study's narrowly defined 5–6-year-old population and with the original eligibility procedure, in which children with IQ scores below 90 were excluded before language assessment. The overall IQ score obtained from the assessment was used as the continuous cognitive measure in the present analyses. Each child was assessed individually, and the assessment took approximately 30–70 minutes. For descriptive purposes, IQ scores were also classified as average (90–109), high average (110–119), superior (120–129), or very superior (≥130); only children with IQ scores of 90 or higher were included in the language assessment.[26] The overall IQ score was selected because the original study

aimed to examine general cognitive performance in relation to receptive–expressive language skills rather than domain-specific cognitive abilities. Psychometric information reported for the version used in Türkiye has indicated a test–retest reliability coefficient of 0.90 and subtest reliability coefficients ranging from 0.70 to 0.80. Reported validity evidence has included correlations greater than 0.70 between vocabulary-subtest scores and age.[26,27] The administration materials used in the original study were from a 1986 printing of this Turkish form; this printing date should not be confused with the 1986 Stanford–Binet Fourth Edition (SB-IV). The form used in this study was the Turkish age-level Stanford–Binet adapted and standardized by Uğurel-Şemin in 1972.[26] The administration materials used in the original study were a 1986 printing of this Turkish form. In the present analyses, the overall IQ score was used as the continuous cognitive measure; no factor-level scores were analyzed or interpreted. This instrument was used as part of the original 2015 study protocol to examine the association between overall cognitive performance and receptive–expressive language skills, rather than to establish contemporary population norms, prevalence estimates, or diagnostic cutoffs. All participants were assessed within the same narrow age range and using the same administration procedure. Because the form contains verbally mediated content, some shared construct variance with the language measures cannot be excluded; this issue is addressed explicitly in the Discussion.

Turkish Early Language Development Test

After IQ assessment, each child was individually evaluated using the Turkish Early Language Development Test (TEDİL), which took approximately 20–30 minutes. The test included 37 receptive-language items and 39 expressive-language items. Of the receptive items, 13 assessed grammar and 24 assessed semantics; of the expressive items, 17 assessed grammar and 22 assessed semantics. Receptive grammar, receptive semantics, expressive grammar, and expressive semantics correct-response scores were calculated. Receptive-language, expressive-language, and total-language standard scores were obtained according to TEDİL scoring procedures.[28]

TEDİL is the Turkish adaptation of the Test of Early Language Development–Third Edition (TELD-3). TEDİL demonstrated high internal consistency. For children aged 5 years, Cronbach's alpha coefficients were 0.93 and 0.91 for Receptive Language Forms A and B and 0.96 and 0.92 for Expressive Language Forms A and B, respectively; for children aged 6 years, the corresponding coefficients were 0.92, 0.93, 0.94, and 0.92. Test–retest reliability coefficients were 0.96 and 0.93 for Receptive Language Forms A and B and 0.89 and 0.83 for Expressive Language Forms A and B, respectively. Inter-rater reliability was also reported to be very high (r=0.99).[29]

Statistical analysis

Data were originally entered and managed in IBM SPSS Statistics, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as numbers and percentages for categorical variables and as means, standard deviations, medians, and ranges for continuous variables where available. Normality of the continuous IQ score and each language outcome was assessed using the Shapiro–Wilk test together with visual inspection of histograms and Q–Q plots. The distributional assumption was not satisfied for all language outcomes, and the grammar and semantic subdomain scores were bounded discrete correct-response counts. Therefore, Spearman rank correlation coefficients (ρ) were used consistently to examine its associations with receptive-language, expressive-language, total-language, receptive-grammar, receptive-semantics, expressive-grammar, and expressive-semantics scores. Exploratory comparisons by sex used the Mann–Whitney U test. All tests were two-sided, and statistical significance was set at $p<0.05$. To avoid the instability and information loss associated with inferential comparisons across markedly unequal IQ categories, particularly the original very-superior group (n=3), IQ was analyzed continuously in all primary association analyses. The IQ categories are retained only for descriptive characterization. Although this approach makes use of all available score information, N=50 still limits the precision and generalizability of the correlation estimates and the study should be regarded as exploratory pending replication in a larger sample.

Results

Participant characteristics and descriptive scores

Participant and measurement characteristics are summarized in Table 1. The mean IQ score was 110.38±12.72 (median, 108.50; range, 90–147). Twenty-seven children (54.0%) were classified in the average-IQ group, 11 (22.0%) in the high-average group, 9 (18.0%) in the superior group, and 3 (6.0%) in the very-superior group. Mean receptive-language, expressive-language, and total-language scores were 99.18±14.05, 100.32±15.65, and 99.66±15.94, respectively. The IQ categories are presented descriptively only; all primary association analyses used the continuous IQ score.

Table 1. Participant characteristics and descriptive measurement scores.

Variable	Value
Total sample	50
Sex, male/female, n (%)	25 (50.0) / 25 (50.0)
Age, 5/6 years, n (%)	37 (74.0) / 13 (26.0)
IQ score, mean±SD; median; range	110.38±12.72; 108.50; 90–147
Receptive-language score, mean±SD; median; range	99.18±14.05; 98.00; 70–124
Expressive-language score, mean±SD; median; range	100.32±15.65; 99.50; 78–129
Total-language score, mean±SD; median; range	99.66±15.94; 100.50; 72–130
IQ category, n (%)	Average: 27 (54.0); high average: 11 (22.0); superior: 9 (18.0); very superior: 3 (6.0)

Abbreviations: IQ, intelligence quotient; SD, standard deviation; TEDİL, Turkish Early Language Development Test.

Distributional assessment

Shapiro–Wilk testing did not reject normality for IQ (W=0.965, p=0.138), receptive language (W=0.967, p=0.180), total language (W=0.969, p=0.215), or receptive semantics (W=0.955, p=0.054). Normality was rejected for expressive language (W=0.939, p=0.012), receptive grammar (W=0.793, p<0.001), expressive grammar (W=0.889, p<0.001), and expressive semantics (W=0.934, p=0.008). In view of this mixed distributional pattern and the bounded

discrete nature of the subdomain scores, Spearman rank correlation was used for all revised IQ–language association analyses.

Association between IQ scores and language scores

When IQ was analyzed as a continuous variable, higher IQ scores were positively correlated with receptive-language (Spearman ρ=0.643, p<0.001), expressive-language (ρ=0.764, p<0.001), and total-language scores (ρ=0.766, p<0.001) (Table 2). The strongest correlation among the primary language outcomes was observed for total language.

Association between IQ scores and language subdomains

Positive correlations were also observed between IQ scores and all four TEDİL language-subdomain scores: receptive grammar (Spearman ρ=0.569, p<0.001), receptive semantics (ρ=0.629, p<0.001), expressive grammar (ρ=0.726, p<0.001), and expressive semantics (ρ=0.722, p<0.001) (Table 2).

Exploratory comparisons by sex

Girls had numerically higher mean receptive-language (101.24 vs 97.12), expressive-language (101.56 vs 99.80), and total-language (101.60 vs 97.72) scores than boys; however, the differences were not statistically significant (p=0.317, p=0.448, and p=0.351, respectively).

Table 2. Spearman rank correlations between continuous IQ scores and TEDİL language outcomes.

Language outcome	n	Spearman ρ	p value
Receptive language	50	0.643	<0.001
Expressive language	50	0.764	<0.001
Total language	50	0.766	<0.001
Receptive grammar	50	0.569	<0.001
Receptive semantics	50	0.629	<0.001
Expressive grammar	50	0.726	<0.001
Expressive semantics	50	0.722	<0.001

Abbreviations: IQ, intelligence quotient; TEDİL, Turkish Early Language Development Test; ρ, Spearman rank correlation coefficient.
IQ was analyzed as a continuous variable. All tests were two-sided.

Discussion

In this sample of 5–6-year-old children with IQ scores of 90 or higher, continuous IQ scores were positively associated with receptive-language, expressive-language, total-language, and all semantic and grammatical subdomain scores. The strongest correlations were observed for total language (ρ=0.766) and expressive language (ρ=0.764), followed by expressive grammar (ρ=0.726), expressive semantics (ρ=0.722), receptive language (ρ=0.643), receptive semantics (ρ=0.629), and receptive grammar (ρ=0.569); all associations were statistically significant at p<0.001. Analyzing IQ continuously avoided the loss of information and instability associated with the markedly unequal IQ-category sizes in the original analysis.

The overall pattern is consistent with a growing preschool literature showing that language performance covaries with several cognitive processes rather than with a single isolated ability. In typically developing preschoolers, verbal working memory and cognitive flexibility have explained unique variance in language performance, and executive functioning has been related to vocabulary, syntax, and language learning.[6,11] In preschool DLD samples, nonverbal executive functioning has been associated with morphosyntax, while broader studies report difficulties or variability in working memory, inhibition, shifting, and processing speed.[7-10,12,13] The present finding that all seven TEDİL outcomes were positively related to continuous IQ is therefore compatible with a multidimensional cognitive-language linkage, although the present study did not directly measure these intermediary processes.

Working memory is one plausible mechanism because sentence comprehension and grammatical formulation require temporary maintenance and integration of lexical and syntactic information. Recent longitudinal neuroimaging in preschoolers linked syntactic processing with working-memory-related activation and showed that neural connectivity during language processing predicted later comprehension.[20] Executive attention, inhibition, and cognitive flexibility may also support selection among competing lexical representations and adaptation to changing task demands.[6-11,13,22] Processing speed provides another plausible pathway: meta-analytic and experimental evidence in DLD indicates slower processing across linguistic and nonlinguistic domains and links processing efficiency with lexical and grammatical performance.[17-19] These mechanisms should be regarded as explanatory hypotheses for the present correlations rather than variables tested in this dataset.

At the same time, cognitive-language associations are not uniform across populations or measures. Saar et al. found that nonverbal cognitive level was meaningfully related to verbal performance in preschool children with DLD, whereas recent work has examined nonverbal IQ, working memory, implicit statistical learning, and automatization speed as potentially distinct cognitive predictors of language outcomes.[16,21] The present sample differs from many of these studies because children were not selected for DLD and all had IQ scores of 90 or higher. This restricted cognitive range, together with the verbally mediated content of the age-level Stanford–Binet form, may partly explain why strong associations were observed for expressive and total language and reinforces the need to avoid interpreting the correlations as a pure effect of nonverbal intelligence.

Environmental context also remains important when interpreting individual differences. Large longitudinal data show that maternal education and socioeconomic disadvantage contribute to variation in preschool receptive and expressive language, and a Turkish study of children aged 3–6 years similarly identified maternal education and socioeconomic status as relevant correlates of language development.[14,15] Thus, the present IQ-language correlations may coexist with family and educational influences that were not modeled in this small original thesis sample.

Finally, the direction of association should remain open. Recent preschool evidence suggests that earlier language skills, particularly grammatical development, may themselves predict later working memory and cognitive flexibility, supporting reciprocal rather than strictly one-way developmental relations between language and cognition.[22] This is consistent with the cross-sectional nature of the present findings and argues against causal language such as IQ ‘determining’ language performance.

The findings are consistent with developmental literature emphasizing that language and cognition are closely related but not interchangeable domains. The CATALISE consensus and population-based evidence have moved the field away from defining language disorder solely through a discrepancy between language and nonverbal ability, while recognizing that cognitive ability can influence the clinical presentation of language difficulties.[1,2] The present results therefore should not be interpreted as evidence that language ability can be reduced to IQ. Rather, within a sample restricted to average and above-average IQ scores, higher IQ scores were associated with higher language-test performance.

The association with receptive language is developmentally plausible because comprehension draws on attention to verbal input, semantic mapping, working memory, and response selection. The positive association between IQ and receptive semantics may reflect variation in word knowledge, semantic relations, and verbal concept formation. Longitudinal evidence indicates that core language skills show measurable stability across childhood,[3,4] and early lexical ability is associated with later academic outcomes.[5] Nevertheless, the cross-sectional design does not establish a developmental direction between cognitive and language performance.

Expressive language and expressive grammar also showed strong positive correlations with IQ scores. Expressive performance requires access to vocabulary, grammatical formulation, word selection, and organization of spoken output. This pattern is compatible with evidence that lexical and grammatical development are linked,[23] and that language skills are associated with executive functions during the preschool and early school years.[24,25] Because the age-level Stanford–Binet form used in this study contains verbally mediated content, some degree of shared construct variance between the overall IQ score and the TEDİL language outcomes cannot be excluded. Accordingly, the observed correlations should not be interpreted as reflecting purely nonverbal cognitive ability or as evidence of a causal effect of IQ on language performance.

The 1972 Turkish normative framework of the age-level Stanford–Binet form should be considered when interpreting the findings. These historical norms may limit the contemporary interpretation of absolute IQ scores and the IQ ≥90 eligibility threshold. However, the present study was not designed to generate contemporary normative estimates, prevalence estimates, or diagnostic classifications; its primary inferential target was the within-sample rank association between cognitive and language performance among children assessed during the same period, within a narrow age range, and using the same procedure. Thus, the historical normative framework is most directly relevant to contemporary score interpretation and external generalizability, although an influence on sample selection through the eligibility threshold cannot be excluded. Replication with a contemporary cognitive instrument is warranted. Sex was not significantly associated with the primary language scores.

Clinical implications

The findings support considering cognitive profile as one contextual component of preschool language assessment while maintaining direct, multidimensional evaluation of receptive language, expressive formulation, semantics, and grammar. Lower language-test performance may warrant more detailed assessment of grammatical and semantic skills together with educational history, family context, hearing and developmental status, and other relevant cognitive characteristics. IQ scores should not be used in isolation to confirm or exclude a language difficulty, and the results of the present restricted sample should not be generalized to children with IQ scores below 90.

Accordingly, cognitive scores should be interpreted alongside direct language measures and, where clinically relevant, executive-function, processing-speed, educational, and family-context information rather than as substitutes for language assessment.

Limitations

Several limitations should be considered. First, the sample was small (n=50), which limits the precision and generalizability of the correlation estimates despite the use of continuous IQ scores. Second, only children with IQ scores of 90 or higher were included, limiting generalizability to children with lower cognitive scores and restricting the observed IQ range. Third, the cross-sectional design precludes causal or developmental inference. Fourth, the archived record booklet identifies the instrument as the Turkish age-level Stanford–Binet form standardized by Uğurel-Şemin in 1972; detailed recruitment flow and additional diagnostic exclusion criteria were not fully documented. Fifth, potential confounders—including age, parental education, socioeconomic status, preschool attendance, birth order, and home language environment—were not controlled in multivariable models.

The sample-size limitation is particularly relevant to precision. Because the revised analysis uses a continuous predictor, the original n=3 very-superior category no longer contributes a separate inferential estimate or post hoc comparison; the very-superior IQ group was small (n=3), which is not unexpected given that scores in this range occur at the upper extreme of the population IQ distribution. Consequently, even statistically significant correlations may have uncertain magnitude in the source population, smaller associations may be missed, and subgroup or multivariable modeling would be unstable. Comparable mechanistic preschool studies have likewise used relatively modest samples, but such precedents do not remove the precision limitation of the present cohort.[9,11,12,20] The results should therefore be interpreted as preliminary effect estimates requiring replication rather than as definitive population parameters.

The data were prospectively collected in 2015 as part of a master's thesis and were re-evaluated for the present manuscript using a continuous-IQ analytic approach. Accordingly, the dataset may not fully reflect contemporary preschool populations, and changes in educational exposure, socioeconomic conditions, and language environment may limit external generalizability. In addition, the Turkish age-level Stanford–Binet form used in the original protocol was standardized by Uğurel-Şemin in 1972 and therefore reflects a historical normative framework. This requires caution when interpreting absolute IQ values against contemporary population expectations and when considering the IQ ≥90 eligibility threshold. Nevertheless, the primary objective was not to estimate contemporary normative values, prevalence, or diagnostic cutoffs, but to examine within-sample associations between continuous IQ and language measures among children assessed during the same period. The findings should therefore be interpreted as preliminary within-sample associations and replicated in a larger contemporary sample using a current cognitive assessment.

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Conclusion

Among 5–6-year-old children with IQ scores of 90 or higher, higher continuous IQ scores were positively associated with higher receptive-language, expressive-language, total-language, semantic, and grammatical scores. Cognitive profile may therefore provide useful context when interpreting preschool language assessments, but it should not replace direct language evaluation. The findings are preliminary and require confirmation in larger studies with a broader cognitive range, clearly documented assessment procedures, and multivariable adjustment for family and educational factors.

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Not applicable.

Conflict of Interest
The authors declare no conflicts of interest.

Compliance of Ethical Statement
This study approved by Turgut Ozal University Faculty of Medicine Clinical Research Ethics Committee (Reference No.: 99950669/137; Date: 28 May 2015). The study received institutional ethics approval before data collection. Identifying details of the ethics committee and approval identifiers have been removed from this blinded manuscript and are provided in the title page and submission system. Written informed consent was obtained from the parents or legal guardians of all participating children.

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Author Contributions
N.A.K.: Conceptualization; Design; Data collection and Processing; Analysis and interpretation; Literature review; Drafting; Critical revision; K.S.U.: Design; Analysis and Interpretation; Literature review; Drafting; Critical revision; Both authors approved the final version of the manuscript.

Data Availability Statement
The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to ethical and institutional permissions.

Thesis Disclosure
This manuscript was prepared from a master's thesis. Identifying information has been omitted from the blinded manuscript and is provided in the title page and submission system.

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