ASSESMENT OF VISUAL-MOTOR SKILLS IN PRESCHOOL CHILDREN

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Abstract: Visual-Motor Integration (VMI**)** represents a key component of neuropsychological development in preschool age, reflecting the interaction between visual perception and motor control. It is of fundamental importance for the formation of early academic skills and school readiness. The present study aims to analyze the developmental level of visual-motor coordination in children aged 4–5 years and to identify potential gender differences in performance.
The study involved 30 children (N = 30) aged 4–5 years, equally distributed by gender (15 girls and 15 boys), with no diagnosed intellectual, sensory, or neurological impairments. The Bender-Gestalt Test, which requires the copying of nine geometric figures, was employed to assess visual-motor integration. The analysis included a quantitative evaluation of the total number of errors and a qualitative differentiation across three indicators: angle execution, orientation, and relative spatial positioning.
The mean total error score was $M = 48.6$ ($SD = 9.4$), indicating the presence of moderate difficulties in visual-motor coordination. The highest values were observed in the "angle execution" indicator ($M = 18.5$; $SD = 4.0$), followed by "orientation" ($M = 16.0$; $SD = 3.5$) and "relative position" ($M = 14.1$; $SD = 3.0$). The data reveal moderate inter-individual variability (range: 32–65 errors). Regarding gender differences, boys demonstrated a higher mean error count ($M = 50.2$; $SD = 8.7$) compared to girls ($M = 47.0$; $SD = 9.9$), suggesting relatively better performance by the girls in this sample.
The findings confirm that visual-motor integration in preschool age is a process characterized by pronounced individual variability and varying degrees of maturity. The greatest difficulties were observed in the precise reproduction of angles, highlighting the significance of fine motor skills and spatial organization. The identified moderate gender differences align with literature data regarding the earlier maturation of certain psychomotor functions in girls. The results underscore the necessity for early diagnostics and support of visual-motor skills as a prerequisite for successful school adaptation.
Keywords: preschool children, visual-motor skills, development, school readiness.

1. INTRODUCTION

The development of visual-motor integration (VMI) during the preschool years represents a dynamic and multifaceted process that reflects the interrelationship between visual perception and motor control. Visual-motor integration is defined as a child's ability to perceive visual stimuli and transform them into accurate, coordinated, and goal-directed movements (Case-Smith & O'Brien, 2015). This capacity is fundamental for the acquisition of early academic skills and successful adaptation to the school environment.
Ages 3–4 Years: This period is characterized by the formation of fundamental manipulative skills. Children begin to hold a pencil more functionally, albeit with some instability; they can complete simple puzzles and their handwritten lines gradually gain greater consistency and intentionality (Gabbard, 2018).
Ages 4–5 Years: Rapid progress is observed in the ability to copy geometric shapes, manipulate small objects, and use scissors. These milestones reflect the intensifying integration between visual information and motor execution—a key component for mastering more complex academic and practical activities (Zhang, Lin & Li, 2025).
Ages 5–6 Years: There is a significant refinement of visual tracking, motor precision, and spatial planning, supporting tasks that require higher levels of coordination and organization (Athanasiou & Chadjopoulos, 2019).
The factors influencing VMI development can be categorized into three primary dimensions:

1. Fine Motor Skills: This stands out as a leading component, as the capacity for precise and coordinated movements directly facilitates the integration between the visual and motor systems.
2. Visual Perception: This is regarded as a significant predictor for the successful execution of integrative tasks, emphasizing the role of processing and interpreting visual information.
3. Socio-Cognitive Factors: These reveal the multidimensional nature of development. Language skills, attention, and cognitive flexibility influence task performance, suggesting that VMI should be viewed not merely as a "visual-motor" skill, but as an integral part of holistic cognitive development (Yuniarwati & Lin, 2025).

Empirical data indicate that well-developed visual-motor skills in early preschool age predict better executive function development and higher school readiness (Feder & Majnemer, 2007; MacDonald et al., 2016). Recent research (2025) involving typically developing children aged 4–6 found a significant positive correlation between

gross motor skills and VMI. A moderate correlation was also observed between fine motor tasks (e.g., bead stringing, drawing) and VMI scores, confirming that motor development underpins integrative processes (Yuniarwati & Lin, 2025).
Conversely, lower VMI scores are associated with poorer achievement in early academic skills, including reading and writing (Madamanchi et al., 2025). Furthermore, a systematic review (Sánchez-González et al., 2022) highlights the tight nexus between visual function and motor development, where deficits in one domain may adversely affect the other.
Comparative studies involving children with Autism Spectrum Disorder (ASD) have shown that these children score lower in both VMI and visual perception compared to typically developing peers, particularly at age 5 (Chou et al., 2025). These findings underscore the role of neurological characteristics in VMI development and the necessity for early assessment and targeted intervention.
The present study is dedicated to the empirical investigation of cognitive and psychomotor determinants in preschool age, focusing on visual-motor coordination, visual perception, and constructive praxis. In this sensitive period of ontogenetic development, the integration between sensory input and fine motor skills serves as a key indicator of neuropsychological maturity.
For objective diagnostic purposes, the Bender-Gestalt Test was employed—a globally recognized instrument that allows for the precise analysis of the ability to reproduce geometric figures and the perceptual organization of space.
Object of Study: The dynamics of mental processes mediating visual-motor coordination and visual-spatial organization in children.
Subject of Study: The current developmental level of these skills in children aged 4–5, operationalized through the qualitative and quantitative indicators of the Bender-Gestalt methodology.
Research Objectives:

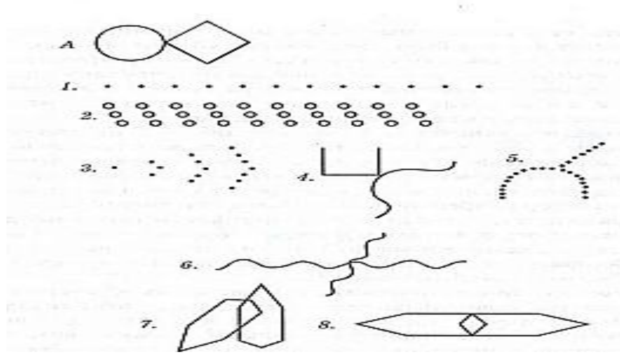
- To conduct a theoretical and empirical analysis of the genesis of visual-motor coordination and visual perception in the preschool stage.
- To differentiate and provide a detailed description of error types recorded via the Bender-Gestalt Test.
- To perform a comparative analysis to establish statistically significant differences in performance based on gender.
- To synthesize conclusions regarding the maturity of the examined mental functions and their implications for future school readiness.

The empirical verification involved 30 children ($N=30$) aged 4 to 5 years from a preschool institution. The sample was balanced by gender, including an equal number of girls ($n=15$) and boys ($n=15$). Inclusion criteria required the absence of documented intellectual deficits, sensory impairments, or neurological disorders, ensuring high group homogeneity and enhancing the validity and reliability of the results.

2. MATERIALS AND METHODS

The study utilized the Bender-Gestalt Test (Лови, Белопольский, 2008), a projective-perceptive method designed to assess visual-motor coordination, visual perception, and spatial organization. The instrument evaluates the maturity of the central nervous system and identifies potential indicators of emotional tension or developmental delays relative to age-specific norms.
The subject is presented with nine standardized geometric figures (see Figure 1), which they are required to reproduce by copying them onto a blank sheet of paper.

Figure 1. Stimulus material for the Bender-Gestalt Test.



Source: (Лови, Белопольский, 2008).

Performance assessment is conducted based on three primary parameters:

1. accuracy in angle reproduction (with the exception of Figure 2);
2. orientation of individual elements;
3. relative spatial positioning of elements within each figure.

The study is carried out individually, in a quiet and familiar environment for the child, in order to minimize the influence of external stressors. Instructions are formulated briefly and clearly, for example: "Look at these pictures and draw them as accurately as possible."

The analysis of the results is mixed-method (qualitative and quantitative), encompassing both a descriptive interpretation of the errors committed and a quantitative assessment of the indicators, in accordance with established interpretative criteria.

3. RESULTS

Table 1. presents the total number of errors made by the preschool children.

Table 1. Total number of errors for the children in the sample.

Indicator	Minimum	Maximum	Mean (M)	Standard Deviation (SD)
Total number of errors (sum)	32	65	48.6	9.4

Source: Author's own survey data (2026)

Mean Error Rate (M = 48.6)

The high mean error rate indicates that the participants, as a group, experience difficulties in shape perception and the integration of visual stimuli. This is consistent with the primary objective of the Bender-Gestalt Test, which assesses visual-motor coordination and the ability to reproduce visual patterns.

Distribution of Scores (SD = 9.4)

A standard deviation of 9.4 suggests moderate variability among participants. Assuming a normal distribution of scores, it can be expected that most individuals committed between approximately 39 and 58 errors ($M \pm SD$). This highlights that while the group overall demonstrates relatively similar levels of difficulty, there is a moderate dispersion in performance.

Score Range (32 – 65)

The range of scores indicates significant individual differences. Some participants demonstrated stronger performance with a minimum error count of 32, while others experienced severe difficulties, reaching up to 65 errors. This suggests variability in visual-motor abilities, cognitive skills, and/or the efficiency of visual stimuli integration, all of which the test is designed to measure.

Table 2. presents the mean values and standard deviations for the specific error types: angulation, orientation, and relative position.

Table 2. Error types in the Bender-Gestalt Test.

Error Type	Minimum	Maximum	Mean (M)	Standard Deviation (SD)
Execution of Angles	10	26	18.5	4.0
Orientation	9	22	16.0	3.5
Relative Position	7	20	14.1	3.0

Source: Author's own survey data (2026)

The results from the Bender-Gestalt Test delineate a relatively clear differentiation between the various error types regarding their frequency and variability. The analysis of means and standard deviations allows for inferences concerning the relative difficulty of specific perceptual-motor indicators and the degree of homogeneity within the studied sample.

The highest mean value ($M = 18.5$; $SD = 4.0$) was observed in the "Execution of Angles" indicator, suggesting that this type of error occurs most frequently among the participants. The higher standard deviation compared to other indicators indicates greater inter-individual variability. Furthermore, the range (10–26) confirms a significant

dispersion of results, which may be interpreted as uneven development or functioning of fine motor skills and visual-spatial organization within the group. This indicator is traditionally associated with difficulties in the coordination between visual perception and motor reproduction, as well as potential deficits in detail control.
Regarding "Orientation" ($M = 16.0$; $SD = 3.5$; range 9–22), a moderately high error frequency was observed, albeit with lower variability compared to "Execution of Angles." This can be interpreted as a more uniform distribution of difficulties related to spatial positioning and the directional organization of figures. Although less pronounced, these errors remain a significant component of the overall visual-motor functioning profile.
The lowest mean value was recorded for the "Relative Position" indicator ($M = 14.1$; $SD = 3.0$; range 7–20). The lower mean and the smallest standard deviation among the three indicators suggest relatively better performance in this aspect of the task and greater homogeneity within the group. This may imply that participants are more successful at preserving the spatial relationships between individual elements of the stimulus material compared to the precise reproduction of angles and orientation.
Table 3. presents the means and standard deviations of the Bender-Gestalt Test scores for the girls and boys in the sample.

Table 3. Total number of errors in girls and boys.

Sex	Mean (M)	Standard Deviation (SD)
Boys	50.2	8.7
Girls	47.0	9.9

Source: Author's own survey data (2026)

An analysis of the Bender-Gestalt test results regarding error types across genders reveals moderate sex differences in the mean error rates. Descriptive statistics indicate that boys demonstrate a higher mean score (M = 50.2; SD = 8.7) compared to girls (M = 47.0; SD = 9.9).
The 3.2-point difference in favor of girls (i.e., a lower error count) may be interpreted as an indication of relatively superior visual-motor coordination and perceptual organization within this sample. In the context of the Bender-Gestalt test, a higher total error score is traditionally associated with lower levels of integration between visual perception and motor execution, as well as potential difficulties in neuropsychological development or regulatory functions.
The standard deviations show similar, albeit slightly higher, variability among girls (SD = 9.9) than boys (SD = 8.7). This suggests a broader range of individual differences among the female participants, despite their lower mean score. Conversely, the smaller dispersion observed in the male group may be interpreted as greater homogeneity regarding the manifested error patterns.

4. DISCUSSIONS

Analysis of central tendency (arithmetic mean), measures of dispersion (standard deviation), and the range of variation of the recorded errors reveals that the studied group demonstrates moderate difficulties in tasks requiring visual-motor coordination. Simultaneously, the statistical indicators evidence significant inter-individual variability, suggesting heterogeneity in the level of visual-motor integration development among participants. The presence of relatively high standard deviation values supports the conclusion of an uneven distribution of performance within the sample and highlights the necessity for a differentiated analytical approach when interpreting the results.
Structural analysis of the error types outlines a specific profile of difficulties. The most pronounced deficits are related to the accuracy of reproducing the angular elements of the stimulus figures, which may be regarded as an indicator of underdeveloped fine constructive precision and difficulties in controlling graphomotor movements. Following in frequency are errors related to spatial orientation, suggesting certain fluctuations in the processing and transformation of spatial relationships. In contrast, the preservation of the relative position of individual figural components appears to be more intact, indicating a relatively stable global spatial organization.
The resulting profile can be interpreted as an indicator of specific features in the functioning of visual-motor integration, where tasks requiring a high degree of detailed structural accuracy and precise control of line and angle pose a greater challenge than tasks involving general spatial arrangement and overall configuration. This dissociation between local (detailed) and global (configurative) processing is consistent with theoretical models that view visual-motor integration as a multicomponent process involving the coordinated interaction of perceptual, spatial, and motor mechanisms.
Regarding gender differences, the data outline a tendency toward a higher mean number of errors in boys compared to girls during the performance of the Bender-Gestalt Test. While this difference manifests at the level of group means, it should be interpreted in light of the established intra-group variability. A greater dispersion is observed

within the female group, suggesting a broader range of individual achievement—from low to high scores. This circumstance underscores the importance of individual analysis alongside group comparisons and limits the possibility of unambiguous generalizations based solely on gender.

5. CONCLUSIONS

In summary, the empirical data obtained strongly support the conclusion that moderate yet qualitatively differentiated difficulties in visual-motor integration persist within the studied sample. The analysis reveals that these challenges are not generalized but are specifically concentrated on fine constructive precision and the accurate angular organization of graphic elements. The results indicate that while the general perception of forms may remain intact, the transition from visual imagery to manual reproduction is disrupted during tasks requiring a high degree of spatial planning. Frequent rotation errors, difficulties with closure, and angular distortions signal immaturity in the coordination between visual tracking and fine motor skills. This suggests that participants experience cognitive overload when required to simultaneously process geometric proportions and control the pressure and direction of the writing instrument. In conclusion, the identified specificities in the sample's visual-motor profile underscore the importance of early diagnosis and prevention. Promptly addressing these developmental "bottlenecks" would prevent further academic difficulties—particularly in writing and mathematics—and would support the overall adaptability of individuals in activities requiring high visual-constructive competence.

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