

# DEVELOPMENT OF EARLY GRAPHOMOTOR SKILLS IN CHILDREN WITH NEURODEVELOPMENTAL RISKS

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**SUMMARY** – Drawing as an early form of a child's graphomotor skill is used as an element in the assessment of visual-motor coordination. Development of artistic expression is a precursor of the later development of writing that requires a high degree of coordination and precision. Children with perinatal impairment of the central nervous system and prematurely born children belong to a group of children with neurodevelopmental risk. Some of the possible results of this type of difficulty can be mild forms of motor disabilities. A retrospective study was conducted by archive review of children under the age of 3 hospitalized at University Department of Rheumatology, Physical Medicine and Rehabilitation, Sestre milosrdnice University Hospital Center. The aim was to determine the incidence of graphomotor difficulties in children with perinatal impairments of the central nervous system and prematurely born children. The study included 50 children aged 12-36 months. The results showed 72% of the tested children to have drawings within the limits expected for their age, 13 children showed graphic abilities below the expectations for their age, while one child did not show functional use of pen. Literature indicates a common learning disability and difficulties with attention and fine motor skills in preschool and particularly in schoolchildren born with neurodevelopmental risk. This study therefore suggests that, despite good initial compensation in the early development of graphomotor skills, it is necessary to maintain follow-up procedures in order to prevent later difficulties in the development of graphomotor and writing skills.

*Key words: Motor skills; Handwriting; Language disorders; Developmental disabilities; Developmental psychomotor disorders; Obstetric labor, premature; Central nervous system – development*

## Introduction

The development of graphomotor skills, including the development of artistic drawing skills, is one of the elements taken under assessment when evaluating a child's developmental level. Human beings have had the need to leave a trace behind them ever since they came into being and drawing was one of the ways in which they could fulfill this instinct. Thus, draw-

ings have been around for as long as man has. The same thing happens with children: as soon as they can take a pen into their hands, which in most children happens after they are one year old, they start leaving traces all over their surroundings<sup>1</sup>. Children's drawings are used both as a diagnostic and therapeutic tool in clinical treatments. They are also applied as a form of projective technique in psycho-diagnostic evaluation and psychotherapeutic treatments in order to gain further insight into the client's personality structure and motivators. In early childhood, on the other hand, drawings do not possess a pronounced representational role<sup>2</sup>. Furthermore, visual-motor skills develop prior to the skill of visual observation<sup>3</sup>;

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therefore, drawings are used as an element in the evaluation of visual-motor coordination. At this stage of development, drawings point to the child's motor and cognitive maturation.

Perinatal cerebral impairment, frequently connected with premature labor, is the most common cause for the occurrence of neurological disorders in children<sup>4</sup>. One of the reasons for the occurrence of these disorders lies in the low birth weight of prematurely born children. Male premature infants have been determined as more sensitive in this aspect<sup>5</sup>. Mejaški-Bošnjak states that impairments of cerebral functions result from interactions between the existing cerebral damage and the compensational processes of cerebral development (maturation and plasticity)<sup>4</sup>. Damages to the motor functions of the central nervous system (CNS) cause disorders in the movement pattern. For example, damages to the upper motor neuron can cause paraparesis<sup>6</sup>, motor weakness in both lower extremities with higher or lower level of intensity. Perinatal impairments can be caused by traumatic, hypoxic, inflectional, pharmacological and hereditary factors<sup>7</sup>. Physiological problems of prematurely born children feature insufficient maturity of enzyme, metabolic, immune, respiratory, hematologic and renal mechanisms, which can, in turn, lead to impairments in motor and intellectual functions<sup>8</sup>. Consequently, children with perinatal damages to the CNS and prematurely born children belong to the group of neuro-risk children and should be given special attention and follow-up. Therefore, it is crucial to involve these children into early intervention programs since early intervention can trigger the processes connected to cerebral plasticity and thus compensate for the existing developmental difficulties<sup>9</sup>. Socioeconomic surroundings in which the child is growing up should also be taken into account at this point since they have been determined as one of the factors exercising an influence on the outcome of the prematurely born child's development<sup>10</sup>. About 10%-15% live births are part of the neuro-risk children group<sup>9</sup>; 80% of these children develop normally, while some 20% can experience temporary or permanent difficulties as early as in infancy<sup>11</sup>. In both cases, fine motor and especially graphomotor skills are affected among others. Some research has indicated a more frequent occurrence of speech difficulties in the neuro-risk children

group<sup>12</sup>. Despite their average or even above average intellectual functions, about 15% of the children with minimal cerebral dysfunction show difficulties with learning, ranging from mild to severe, connected to various combinations of impairments of perception, conceptualization, verbal skills, memory, attention control, impulses and motor function<sup>13</sup>. Furthermore, it has been proved that this particular population of children reached the benchmarks of normal socio-cognitive maturity in the early development stages later than other children<sup>14</sup>.

Artistic expression can help the child free himself of psychic tensions and develop his abilities of observation, introduction, self awareness, perseverance, work discipline, the sense of cultural entertainment and esthetic experiences<sup>15</sup>. A child's artistic expression depends on the level of his graphomotor development. Difficulties in visual-motor coordination and visual-spatial perception can be present, which can, despite a normal level of intelligence, result in poorer quality of drawings than expected from a child of a particular age group<sup>1</sup>. The development of drawing skill is a precursor of the later development of writing skill requiring a higher level of coordination and precision<sup>16</sup>.

Children do not take artistic language from their surroundings; it is an inborn way of communication and figuration. They use drawings as a means of exploration, problem solving, giving a visual form to ideas and the observed<sup>17</sup>. The development of a child's drawing regarding its form and content is connected with the development of his motor skills, perception for making and understanding notions, emotions and some other psychic, physical and social functions in his development<sup>13</sup>. According to mental and chronologic maturity and realization of drawings, the authors discern several phases of children's artistic expression. The period between the ages 1-3 is most commonly referred to as the phase of mottle, which can be subdivided into two phases: phase of accidental traces and mottle without control, and phase of controlled mottle and name-given mottle<sup>18,19</sup>.

The phase of accidental traces and mottle without control takes place during the child's first year and is characterized by the child's exploration of his surroundings *via* sensorimotor experiences. The child dips the fingers into ink or mushy food and leaves accidental traces while playing with his colored fingers.

By observing the elder family members at manipulating the drawing tools on paper, the child tries to imitate the perceived activities and draws the tools himself thus leaving traces on paper<sup>18,19</sup>.

The phase of controlled mottle and name-given mottle takes place after the child turns 2 and lasts throughout the preschool age. The child begins to explore the traces and learns in an individual way to respond to his surroundings in an appropriate way. Drawings feature repeated curved and circular lines. Unlike the first phase, color begins to have an important role in this phase. Somewhere around the age of 3 the child begins to imitate the circular shape and develops the name-giving for the drawn objects<sup>18,19</sup>.

## Methods

A retrospective study was conducted by archive review for the period from April to September 2010 and 50 cases of children aged 12-36 months hospitalized at University Department of Rheumatology, Physical Medicine and Rehabilitation, Sestre milosrdnice University Hospital Center, were studied. Children hospitalized at the Department underwent team assessment, at the point of which the developmental educational-rehabilitation assessment was also conducted by applying the München functional developmental diagnostic tools<sup>20</sup>, as well as the Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI)<sup>21</sup>. Descriptive statistics was employed to show results in numbers and percentages.

## Results

The study included 56% of boys and 44% of girls aged 1-3 years (Table 1). A total of 50 children were

*Table 1. Distribution of study subjects according to age groups*

Age	Frequency	Percentage (%)
1 (12-23 months)	24	48.0
2 (24-35 months)	22	44.0
3 (36 months)	4	8.0
Total	50	100.0

examined, mostly aged 12-23 months (48%); 8% of the tested children were aged 36 months, while the 24-35 month age group was represented by 44% of the children. In the sample, 56% of the examined children had some level of perinatal cerebral impairment determined by the brain ultrasound findings; 6% of the children had normal findings, while 3% had no brain ultrasound findings; 26% of the examined children were either prematurely born or had over transferred birth term, which is also one of the risk factors (Table 2). All the children were hospitalized due to mild motor difficulties (paraparesis and paraparesis discreta); 72% of the children had drawings within the expected limits for a particular age group, while one child showed the lack of functional pen ability (Fig. 1).

## Discussion

Sixteen out of 24 examined children aged 12-23 months were in the phase of accidental traces and mottle without control, while seven children demonstrated a higher level of interest for exploration of the drawing tool itself and the paper (putting the tool into their mouth, crumpling the paper, etc.), at the same time showing very little interest for the pen function.

*Table 2. Birth term and brain ultrasound findings*

Birth	Frequency	Percentage (%)	Brain ultrasound	Frequency	Percentage (%)
On term	35	70.0	Clear	3	6.0
	13	26.0	Deviation	28	56.0
Premature or over transferred	48	96.0	Total	31	62.0
Total			No data available	19	38.0
No data available	2	4.0			
Total	50	100.0	Total	50	100.0

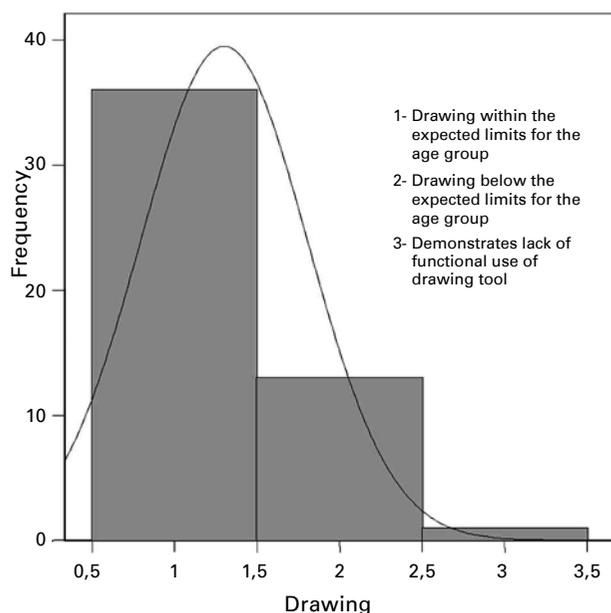


Fig. 1. Results of artistic expression development in children with neurodevelopmental risk.

One child showed no interest for the drawing tool at all and kept throwing it onto the floor. The lack of interest for drawing at this particular age can also be related to the lack of experience since the activity might not have been previously offered to the child. It is interesting enough that five out of 22 examined children aged 24–35 months had not reached the phase of controlled mottle, while most of the children, 17 of them, had reached this phase of artistic expression. Three of the four children aged 36 months had entered the phase of controlled mottle and were giving names to the drawn objects, which featured a circular shape within the drawing or modeled according to a preview. The results indicated that 72% of the examined children with mild motor impairments in the early infant age demonstrated a typical development of early graphomotor skills, i.e. their own artistic expression. Taking into account the fact that in this particular age group drawings serve as a means of motor game and visual-motor coordination exercise, it is important to emphasize that there are no strict rules and expectations connected to the very artistic, graphic expression. Despite this fact, 27% of the examined children demonstrated a lower level of artistic expression than expected for their particular age group, a fact pointing to the necessity of further follow-up and encourage-

ment. According to the data collected from the literature pointing to a significant number of children with mild motor difficulties who later on develop mild or severe symptoms of learning difficulties during their preschool and school age, including the graphomotor development difficulties, it is important to identify the significant role of follow-up procedures for those children and their graphomotor development in the light of their later successful integration into the educational system. Prompt detection of difficulties in the graphomotor development and application of suitable therapeutic proceedings can prevent later development of greater difficulties in writing.

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#### Sažetak

### RAZVOJ RANIH GRAFOMOTORIČKIH SPOSOBNOSTI U DJECE S NEURORAZVOJNIM RIZIKOM

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Crtež kao rani oblik grafomotoričkih sposobnosti djeteta u ranom djetinjstvu koristi se kao procjena vizuo-motorne koordinacije. Razvoj crteža preteča je kasnijem razvoju pisanja koje zahtijeva visok stupanj koordinacije i preciznosti. Djeca s perinatalnim oštećenjem središnjega živčanog sustava i prijevremenim porodom pripadaju skupini neurorizične djece. Jedan od mogućih ishoda ovoga tipa oštećenja su i blaže motoričke teškoće. Provedeno je retrospektivno istraživanje pregledom arhive za djecu do 3 godine koja su hospitalizirana na Klinici za reumatologiju, fizikalnu medicinu i rehabilitaciju Kliničke bolnice „Sestre milosrdnice“ radi utvrđivanja vremena pojavnosti teškoća u grafomotoričkim sposobnostima kod djece s neurorazvojnim rizikom. Istraživanjem je obuhvaćeno 50 djece u dobi od 12 do 36 mjeseci. Kod ispitane djece u 72% slučajeva crtež je bio u granicama očekivanja za dob, kod 13 djece grafičke sposobnosti su bile ispod očekivanih za dob, dok jedno dijete nije pokazivalo funkcionalnu upotrebu olovke. Literatura ukazuje na učestale teškoće učenja, pozornosti i fine motorike u predškolskoj i osobito u školskoj dobi kod djece rođene s neurorazvojnim rizikom. Ovo istraživanje stoga ukazuje na to da je unatoč dobroj početnoj kompenzaciji u ranom razvoju grafomotoričkih sposobnosti nužno praćenje ove populacije djece kako bi se na vrijeme spriječile moguće kasnije teškoće u razvoju grafomotorike i pisanja.

*Ključne riječi: Motoričke vještine; Rukopis; Jezični poremećaji; Razvojna invalidnost; Razvojni psihomotorički poremećaji; Trudovi, prerani; Središnji živčani sustav – razvoj*

