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NEUROPSYCHOLOGY EVALUATION AND APPLICATION TO STUDENTS WITH WRITTEN EXPRESSION DISORDER

Vasiliki Papanikolaou[1]

Abstract: *This study aims to contribute to the understanding of mirror writing by employing modern neuropsychological techniques, specifically optics challenging dynamics (P100), and by providing pedagogical approaches for problem-solving. The focus is on investigating the disorders of written expression in typically developing children who are introduced to the process of learning to write. Additionally, the paper examines the developmental differences in visual and kinetic skills among preschool and first-grade children. The research hypotheses revolve around the reduction in mirror writing occurrence during handwriting practice, the progressive development of visuospatial orientation and visuomotor skills, the impact of hand preference on handwriting tendencies, and the potential association between dyslexic handwriting and prolonged P100 latency in neuropsychological examinations. The study involves a sample of 100 participants, including kindergarten children and first-grade students. It utilizes both standardized tests and neuropsychological assessments, specifically visual evoked potentials (VEPs), to gather data. By addressing these research objectives, the article aims to contribute to the advancement of visuomotor skills, particularly in terms of visuospatial discrimination, controlled visual attention, and the healthy functioning of the visual pathway, while highlighting the differences in neuronal maturation and interhemispheric communication that underlie mirror writing.*

Keywords: *disorders of written expression; visual and kinetic skills; handwriting practice; visuospatial orientation, visuomotor skills; neuropsychological assessments.*

INTRODUCTION

1.1. Historical Evolution of Mirror Writing

Throughout history, writing has emerged as the primary means of communication, although it is not inherent in human nature but rather a cultural achievement requiring persistent teaching and practice (Fischer, 2003; Smith, 2012; Goff & Buchanan, 1956). Writing is a symbolic behaviour that reflects an individual's psychosomatic state and the environmental influences they encounter. Among various writing disorders, mirror writing has attracted significant attention, both historically and in modern neuropsychological investigations. Understanding and addressing mirror writing has implications for neuropsychology and pedagogy (Jones & Snyder, 1961; Lurie, 2011; Powell, 2009; Sampson, 1985; Schmandt-Besserat, 2010; Hebert et al., 2018; Blythe, 2011; So, 1964; Al-Shboul & Huwari, 2015; Fischer & Tazouti, 2012; Postgate, Wang & Wilkinson, 1995; Ullman, 1980; Parker, 2013; Fischer & Koch, 2016).

[1] **Vasiliki Papanikolaou** – PhD student at the Department of Pedagogy, Faculty of Education at St. Cyril and Methodius University of Veliko Tarnovo, Bulgaria; Master's degree in Unified Special Education and Training from the Pedagogical Department University of Nicosia (UNIC).

1.2. The Appearance of Mirror Writing in Our Century

Mirror writing is the production of letters or numbers in the opposite direction of normal writing. It involves writing words, phrases or sentences from right to left, with all letters inverted but in the correct order. Mirror writing can be observed in various populations, including mentally retarded individuals, Leonardo da Vinci, Lewis Carroll, young children learning to write, normal left-handers, individuals forced to use their nonpreferred hand, and people with mental retardation or specific neurological conditions (Fischer & Tazouti 2012). It can also be an unconscious or intentional action in adults acquired through practice. Mirror writing can be demonstrated as a trick using specific tactics or as a result of neuropsychological factors. The persistence of mirror writing indicates the need for further study of its behaviour (Portex et al., 2018; McIntosh et al., 2018).

1.3. The Mechanism of Mirror Writing

The mechanism of mirror writing is complex and has been subject to various hypotheses. One hypothesis suggests that there is a connection between eye movements and hand dominance, where right-handed individuals predominantly use their right eye as the dominant focal eye, and left-handed individuals use their left eye (Kushnir et al., 2013). The focus of the eye determines the dominant hand, and certain eye movements are more natural and frequent than others (Ireland, 1893). Another explanation posits that mirror writing occurs when the image or imprint in the brain tissue responsible for letter production is reversed due to brain damage or paralysis. Mirror writing can also result from the underdeveloped state of specific helices in the right hemisphere, which are typically active in the corresponding helices in the left hemisphere. Furthermore, mirror writing can be a consequence of asymmetric brain activation, causing the eyes to deviate and leading to the production of mirror movements by the non-dominant hand. The neural relationships involved in mirror writing have been a topic of interest among researchers, with some suggesting that cross-training between the two hands plays a role. The mnemonic fingerprints stored in the left hemisphere are believed to contain information on the mechanical activity required for muscle activation in the right hand. If the same information is applied to the corresponding muscles of the left hand, mirror writing occurs. Another perspective emphasizes the ease and accuracy of inductive muscle movements compared to adductive movements. Injury or damage to specific cerebral hemispheres can influence the direction of movement and result in mirror writing. Additionally, it has been proposed that each cerebral hemisphere is responsible for mechanical movements made to or from the hemisphere it controls, and damage to the left hemisphere can lead to the prevalence of right hemisphere mechanisms, causing mirror writing (Dehaene et al., 2005; Portex et al., 2018; So, 1964).

Furthermore, it is important to note that this study is the first of a series of three articles that will be published as part of this research endeavour. The subsequent articles will delve into additional aspects of mirror writing, expanding on its neurophysiological underpinnings and exploring interventions to mitigate its occurrence. By disseminating the findings through multiple articles, we aim to provide a comprehensive understanding of mirror writing and to contribute to the existing body of knowledge in this field.

METHODOLOGY

The study involves a sample of 100 participants, including kindergarten children and first-grade students. It utilizes both standardized tests and neurophysiological assessments, specifically visual evoked potentials (VEPs), to gather data. The research hypotheses revolve around the reduction in mirror writing occurrence during handwriting practice, the progressive development of visuospatial orientation and visuomotor skills, the impact of hand preference on handwriting tendencies, and the potential association between dyslexic handwriting and prolonged P100 latency in neurophysiological examinations.

DISCUSSION

By addressing the research objectives mentioned above, this study aims to contribute to the advancement of visuomotor skills, particularly in terms of visuospatial discrimination, controlled visual at-

tention, and the healthy functioning of the visual pathway, while highlighting the differences in neuronal maturation and interhemispheric communication that underlie mirror writing. The historical evolution of mirror writing reflects the gradual development of a complex and automatic skill, beginning with copying and progressing to spontaneous writing and written communication. The appearance of mirror writing in our century raises questions about the factors influencing the directionality of writing and the evolution of writing systems across different cultures. The mechanism of mirror writing is complex and involves various factors such as eye movements, hand dominance, brain damage or underdevelopment, and asymmetric brain activation. Understanding mirror writing can provide insights into the broader development of writing systems and enhance our understanding of the complex nature of writing and of its relationship with cognitive processes and cultural influences.

CONCLUSION

In conclusion, this study contributes to the understanding of mirror writing by employing modern neurophysiological techniques and by providing pedagogical approaches for problem-solving. The investigation of mirror writing in typically developing children learning to write and the examination of visual and kinetic skills among preschool and first-grade children shed light on the developmental differences and underlying mechanisms of mirror writing. The findings of this study have implications for neuropsychology and pedagogy, emphasizing the importance of addressing mirror writing in the context of visuomotor skills, visuospatial discrimination, and the healthy functioning of the visual pathway. By gaining a deeper understanding of mirror writing, we can enhance communication skills and facilitate effective written expression.

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