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Lucie Loosová
orcid https://orcid.org/0000-0002-5790-5199
Masaryk University, Brno, Czech Republic
Faculty of Education
Department of Special and Inclusive Education
e-mail: 470030@mail.muni.cz

Jan Viktorin
orcid https://orcid.org/0000-0003-3298-6081
Silesian University, Opava, Czech Republic
Faculty of Public Policies
Institute of Pedagogical and Psychological Sciences
e-mail: jan.viktorin@fvp.slu.cz

Perceptual Motor Skills in Children and Pupils with Mild Intellectual Disabilities

Abstract

This literature review analyzes eight specialized papers which focus on issues of the perceptual motor skills of children and pupils with mild intellectual disabilities. Children and pupils with mild intellectual disabilities have deficits in perceptual motor skills. The deficits of adaptive and intellectual skills of these children and pupils may be greater (mainly because of their conceptual and abstract reasoning) than their relative deficits of perceptual motor skills. Stronger perceptual motor skills in children and pupils with mild intellectual disabilities may be the target of school intervention as a means of alleviating problems in adaptive functions.

Keywords: literature review, perceptual motor skills, mild intellectual disability, children, pupils

Introduction

Intellectual disability is characterized by substantial limitations in the areas of adaptive behavior and intellectual function, which are demonstrated in everyday social and practical skills. Intellectual function deficits include deficits in cognition, learning, logical thinking, problem-solving, adapting to new (emerging) situations, and other skills. The limitations in adaptive behavior contain three types of skills, i.e., conceptual (writing, counting, reading, speaking, telling time, etc.), social (responsibility, interpersonal skills, solving social problems, self-confidence, etc.) and practical (self-service, employment, the use of money, telephoning, etc.). In approximately 85% of all cases, the individuals are categorized as having mild intellectual disabilities. This category defines the need of support in social, practical, and conceptual skills and in certain life activities (Boat & Wu, 2015; Di Blasi et al., 2007; Pinborough-Zimmerman et al., 2007; Schalock et al., 2007; Vuijk et al., 2010).

The fine motor skills of people with intellectual disabilities is particularly important since this area relates to both adaptive and cognitive functions and is a prerequisite for many daily activities. Fine motor skills are an important prerequisite for adaptive behavior in children and are essential to the overall development and health of children. Fine motor skills contribute to the success of children in kindergarten and affect primary school performance in reading, spelling, writing, and math (Cameron et al., 2012; Memisevic & Sinanovic, 2012; Obrusnikova & Cavalier, 2017; Suggate et al., 2017).

The coordination of visual perception and fine motor movements represents perceptual motor skills. Perceptual motor skills are an excellent indicator of a child's overall level of functioning, as they are strongly related to school performance and intellectual functions. However, the exact nature of the relationship between intellectual functions and perceptual motor skills is not clear. Some studies have used measures of intellectual function to predict perceptual motor skills (Beery & Beery, 2010; Graf & Hinton, 1997; Kulp, 1999).

Eye–hand coordination is an important part of perceptual motor skills and there is some overlap between perceptual motor skills and eye–hand

coordination. Eye–hand coordination is a skill where motor and visual processes are effectively applied together to carry out daily activities such as handwriting, doing chores, and getting dressed. Handwriting has been extensively studied in relation to perceptual motor skills. Research has confirmed the strong association between handwriting and perceptual motor skills (Pfeiffer et al., 2015; Shin et al., 2015).

Perceptual motor skills are dependent on intact fine motor coordination, motor inhibition, visual perception, and constant attention. An assessment of perceptual motor skills is an essential part of a psychological/educational assessment of the child's individuality in school planning. Although it is related to intellectual functions, perceptual motor skill deficits may be present even when there are no intellectual deficits. Because of their independence from intellectual functions and their complex structure, perceptual motor skills have been extensively studied in clinical populations in an effort to locate brain dysfunction and more accurately describe and identify perceptual motor skill deficits (Demsky et al., 2000). Mattison, McIntyre, Brown, and Murray (1986) studied children with specific learning difficulties (intelligence quotients ranging from 85 to 115) who had deficits of perceptual motor skills and were defined by having difficulty integrating motor coordination and visual perception which was not caused by specific problems with the motor or visual system. Other studies have examined perceptual motor skill deficits in specific groups. Schultz et al. (1998) found that children with Tourette syndrome had perceptual motor skills one standard deviation below the levels of children with typical development. Sutton et al. (2011) found that children with attention deficit hyperactivity disorder and traumatic brain injury had scores of more than one standard deviation lower than children with typical development. A study by Ercan, Yilmaz, Taş, and Aral (2016) showed that a group of children with speech-sound problems had significant deficits in perceptual motor skills of more than one standard deviation below a control group of intact children. An extensive study by Geldof, van Wassenaer, de Kieviet, Kok, and Oosterlaan (2012) showed that children with low birth weight and children born preterm had mild to moderate deficits in perceptual motor skills compared to children with typical

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development. While studying perceptual motor skills in people with intellectual disabilities, Muñoz-Ruata, Caro-Martínez, Martínez Pérez, and Borja (2010) found significant deficits in perceptual motor skills, although their nature and extent in this population remained unclear.

Given the importance of the relationship between intellectual functions and adaptive behavior and perceptual motor skills, we have sought to better understand the extent and nature of perceptual motor skill deficits in children and pupils with mild intellectual disabilities in comparison to children and pupils with typical development.

Methodology

The literature review addresses the issue of perceptual motor skills in children and pupils with mild intellectual disabilities. We defined two basic thematic criteria for the selection of studies which are suitable for this analysis: perceptual motor skills and mild intellectual disability. We searched the titles in the Web of Science, ERIH+, and SCOPUS databases. The collection and study of the foreign literature on the subject was carried out at the beginning of 2020. We have tried to approach the chosen topic for the literature review in a comprehensive way. By analyzing and then synthesizing the findings, we investigated whether the deficits of perceptual motor skills in children and pupils with mild intellectual disabilities will show the same or different results as in children and pupils with typical development.

The criteria for including studies depended on the following specific guidelines and definitions. Firstly, for a study to be selected as one with children and pupils with mild intellectual disabilities, a definition of mild intellectual disability had to be included. Secondly, for a study to be selected for this review as one in which VMI (Visual Motor Integration) skills were assessed well, it had to include a standardized pencil-and-paper test commonly used for VMI assessment. Thirdly, for a study to be selected for this review as one containing a control group of typically developing children and pupils, a definition of typically developing had to be included.

Finally, the studies had to be written in English and published in peer-reviewed journals in the period 1989–2019.

A total of 57 different studies were included in the initial results. Subsequently, studies were excluded for the following reasons: children and pupils with mild mental disabilities who also had a comorbid diagnosis of cerebral palsy or autism spectrum disorder (n=18); research presented in the form of reviews, case studies, letters, or nonoriginal articles rather than peer-reviewed research (n=26); authors using tools other than VMI tests to measure fine motor skills or visual perception, e.g., visual form recognition, grooved pegboard, etc. (n=5).

After narrowing down the selection, we worked with the resulting eight empirical studies. Based on the established criteria for selecting the texts and according to the analysis, we synthesized the findings from the relevant studies into the literature review. In the systematic review, we tried to analyze the selected papers, to briefly present their characteristics, to determine their particularities, to evaluate their contribution to theory and practice, and to include the knowledge about the topic of perceptual motor skills in children and pupils with mild intellectual disabilities. Table 1 provides a general overview of the studies selected for this review.

Table 1. Overview of the analyzed studies on perceptual motor skills in children and pupils with mild intellectual disabilities

Author(s)	Title	Year, country	Research sample	Research aim
Gresham, F. M., MacMillan, D. L., Bocian, K. M.	Learning Disabilities, Low Achievement, and Mild Mental Retardation: More Alike Than Different?	1996, United States	152 pupils (67 pupils with specific learning difficulties, 40 pupils with low achievement, and 45 pupils with mild intellectual disabilities)	Comparing pupils with specific learning difficulties, low achievement, and mild intellectual disabilities in social skills, school achievement, cognitive functions, perceptual/motor functions, problem behaviors, school history, and involvement in school
Dykens, E. M.	Are Jigsaw Puzzle Skills "Spared" in Persons with Prader–Willi Syndrome?	2002, United States	21 children and pupils with Prader–Willi syndrome in the range of mild intellectual disability (9 boys and 12 girls) and 21 pupils with typical development (8 boys and 13 girls)	Examining previous clinical manifestations of children and pupils with Prader–Willi syndrome, including unusual word compilation and search

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Wuang, Y. P., Wang, C. C., Huang, M. H., Su, C. Y.	Profiles and Cognitive Predictors of Motor Functions Among Early School-Age Children with Mild Intellectual Disabilities	2008, Taiwan	233 pupils with mild intellectual disabilities (142 boys and 91 girls)	Describing the sensorimotor profile of children with mild intellectual disabilities and examining the relationship between motor, sensory, and cognitive functions
Duijiff, S., Klaassen, P., Beemer, F., de Veye, H. S., Vorstman, J., Sinnema, G.	Intelligence and Visual Motor Integration in 5-Year-Old Children With 22q11 Deletion Syndrome	2012, Netherlands	65 children with 22q11-deletion syndrome in the range of mild intellectual disability (43 girls and 22 boys)	Investigating the relationship between the visual–motor integration and intelligence of children with 22q11 Deletion syndrome
Howley, S. A., Prasad, S. E., Pender, N. P., Murphy, K. C.	Relationship Between Reaction Time, Fine Motor Control, and Visual–Spatial Perception on Vigilance and Visual–Motor Tasks in 22q11.2 Deletion Syndrome	2012, Ireland	31 children with 22q11.2 Deletion syndrome in the range of mild intellectual disability (15 boys and 16 girls) and 26 children with typical development (12 boys and 14 girls)	Examining the visual motor skills and reaction time of children with 22q11.2 Deletion syndrome
Vicari, S., Mantovan, M., Addona, F., Costanzo, F., Verucci, L., Menghini, D.	Neuropsychological Profile of Italian Children and Adolescents with 22q11.2 Deletion Syndrome With and Without Intellectual Disability	2012, Italy	34 children and adolescents with 22q112 Deletion syndrome (of which 12 children had mild intellectual disabilities) and 83 children and adolescents with typical development (43 girls and 40 boys)	Identifying specific neuropsychological features of children and adolescents with 22q11.2 Deletion syndrome
Memisevic, H., Sinanovic, O.	Executive Functions as Predictors of Visual–Motor Integration in Children with Intellectual Disability	2013, Bosnia and Herzegovina	90 children with intellectual disabilities (of which 42 children had mild intellectual disabilities and 48 children had moderate intellectual disabilities)	Evaluating the relationship between executive functions and perceptual motor functions in children with intellectual disabilities
Lo, S. T., Collin, P. J., Hokken-Koelega, A. C.	Visual–Motor Integration in Children with Prader–Willi Syndrome	2015, Netherlands	75 children with Prader–Willi syndrome in the range of mild intellectual disability (34 boys and 41 girls)	Evaluating connections between perceptual motor functions and gender, age, intelligence, and genetic subtype in children with Prader–Willi syndrome

Findings of the review

A research study by Gresham, MacMillan, and Bocian (1996) aimed to compare pupils with specific learning difficulties, mild intellectual disabilities, and lower overall achievement in social skills, school achievement, cognitive functions, perceptual motor functions, problem behaviors, school history, and involvement in school in the United States. A total of 152 pupils were enrolled, of which 67 pupils had specific learning difficulties, 40 showed low achievement, and 45 had mild intellectual disabilities. The level of cognitive function in these pupils was tested using the Weschler Intelligence Scale for Children (WISC-III) and the Raven Colored Progressive Matrices (RCPM). As for the perceptual motor functions, they were tested by means of the Bender–Gestalt Test. The study found that cognitive functions were higher in pupils with specific learning difficulties than in pupils with low achievement and mild intellectual disabilities. Pupils with low achievement showed more success in school – especially with reading – than pupils with mild intellectual disabilities and specific learning difficulties. Pupils with mild intellectual disabilities demonstrated poor performance in all school areas compared to the group of pupils with specific learning difficulties and the group of pupils with low achievement. No differences were found between these groups of pupils in problem behaviors and social skills.

The American researcher Elisabeth M. Dykens (2002) conducted a study to investigate previous clinical manifestations of children and pupils with Prader–Willi syndrome, which included unusual word compilation and search. The research sample of this study consisted of 21 children and pupils with Prader–Willi syndrome who were in the range of mild intellectual disability (9 boys and 12 girls) and 21 pupils with typical development (8 boys and 13 girls). The research method was a one-hour test battery that individuals underwent under the supervision of trained research assistants. This set of tests included Kaufman's Brief Intelligence Test, standardized tests designed to test visual–spatial tasks, puzzles and strategies applied to them, and word searches. The results of the tests showed that the level of visual–spatial skills in children with Prader–Willi syndrome

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is significantly lower than that of children with typical development. Slight differences were also observed for word searches. On the other hand, children with Prader-Willi syndrome were significantly better at solving puzzles, placing an average of 28.10 pieces of jigsaw puzzles, while children with typical development placed only 10.71 pieces correctly. Likewise, 71% of the children with Prader–Willi syndrome had scores above the average for children with typical development, whereas only one child (6%) with typical development scored above the average of children with Prader–Willi syndrome. In children with Prader–Willi syndrome, the ability to assemble the puzzle was not predicted by intelligence quotient, age, obsessive-compulsive symptoms, degree of obesity, or gender, but by the genetic subtype of the disorder.

In their study, Wuang, Wang, Huang, and Su (2008) focused on describing the sensorimotor profile of pupils with mild intellectual disabilities in Taiwan. They tried to explore the correlation between cognitive and motor functions in these pupils. The research was conducted on 233 pupils with mild intellectual disabilities aged 7 to 8 years. The inclusion criteria included the absence of serious behavioral and emotional disorders. Children with associated autism spectrum disorder, specific learning difficulty, cerebral palsy, blindness, deafness, neurological disorders, muscular dystrophy, or epilepsy were also excluded to prevent data distortion. The study was carried out in 2002–2006 and the data were obtained using standardized tests aimed at assessing cognitive, motor, and sensory functions in pupils with mild intellectual disabilities. The study found that pupils with mild intellectual disabilities had significant problems with fine motor skills. Sensory integration functions were also slightly impaired in these pupils. Processing speed, perceptual organization, and verbal understanding predict perceptual motor skill scores. The main finding was that pupils with mild intellectual disabilities showed dysfunctions in sensorimotor skills, the early identification of which is necessary for better inclusion in the ordinary school environment.

Duijff et al. (2012) focused their study on investigating the relationship between visual–motor integration and intelligence capabilities in 5-year-olds with 22q11 Deletion syndrome (DiGeorge syndrome).

The Dutch study included 65 children with DiGeorge syndrome who were in the range of mild intellectual disability. As the research method, the Dutch version of the Wechsler Preschool and Primary Scale of Intelligence and the Beery–Buktenica Developmental Test of Visual–Motor Integration, Visual Perception, and Motor Coordination were chosen. The results of the study point to the fact that intelligence deficits in children with DiGeorge syndrome may be greater than their deficits in visual perception. Visual perception and visual motor integration have a greater impact on the results of some partial performance tests than on the level of motor coordination. The origin of the deletion, the presence of a cardiac anomaly, and gender were not found to predict the score of visual motor integration. Based on these results, the authors of the study concluded that stronger abilities in visual motor integration in these children may be the aim of school interventions as a means of alleviating problems in their adaptive functions.

Howley, Prasad, Pender, and Murphy (2012) conducted a study that examined the level of perceptual motor functions and their response time using a series of standardized tests in 31 children diagnosed with 22q11.2 Deletion syndrome in the range of mild intellectual disability in Ireland. The results of these children were compared with the results of 26 intact children. Children with lower intelligence quotients were also involved in the study. During the research, the skills of individuals to understand the assignment and the subsequent reaction time of their perceptual motor functions was first tested. In the next part of the research, individuals completed the Wide Range Assessment of Visual Motor Abilities (WRAVMA), which included drawing, assigning, and a table with holes, in which individuals inserted pegs according to the assignment. Again, the reaction time of the perceptual motor functions was also investigated. From the results of the study we can conclude that the deficits of perceptual motor functions in children with 22q11.2 Deletion syndrome are primarily attributed to deficits in their psychomotor performance and their speed was influenced mainly by whether it was necessary to complete the task on time or not. So, we can say that if a child with 22q11.2 Deletion syndrome has unlimited time to complete a task,

the level of perceptual motor functions may be better than if there are time constraints.

Vicari et al. (2012) conducted a study to identify specific neuropsychological features of children and adolescents diagnosed with 22q112 Deletion syndrome regarding the possible variability due to intellectual disability. The research sample of this study was 34 Italian children and adolescents with 22q11.2 Deletion syndrome (12 girls and 22 boys) – 12 of whom had mild intellectual disabilities – as well as a group of 83 intact children and adolescents (43 girls and 40 boys). The research evaluated various areas, such as intelligence and specific skills in various neuropsychological subdomains (language, perceptual motor functions, and memory). The Stanford–Binet Intelligence Scale and the Wechsler Intelligence Scale for Children were used for intelligence testing. The area of perceptual motor functions was tested using the Visual Motor Integration, which consists of a sequence of 27 geometric shapes (from the simplest to the most complex), which were subsequently interpreted on paper. Furthermore, two subtests of the Visual Perception Test (VPT) were used to examine perceptual motor functions: VPT2 (combining identical patterns) and VPT4 (identifying the same patterns on a confusing background). The results of the research showed significant differences between children with DiGeorge syndrome and typically developing children, especially in the results of the VPT2 subtest. In the VPT4 subtest, children with DiGeorge syndrome had problems comparing patterns on a confusing background. Children with DiGeorge syndrome also had a lower score in the Visual Motor Integration Test than intact children. Children with DiGeorge syndrome showed a significant deficit in the area of perceptual motor functions, which persisted especially in children with DiGeorge syndrome without associated intellectual disability.

A study by Memisevic and Sinanovic (2013) aimed to evaluate the relationship between executive functions and perceptual motor functions in children with intellectual disabilities and the extent to which executive functions can predict the level of perceptual motor functions in these children. The research sample consisted of 90 children with intellectual disabilities from Bosnia and Herzegovina. Of these, 42 were in the range of

mild intellectual disability and 48 were in the range of moderate intellectual disability. The research method was the Behavioral Rating Inventory Executive Function (BRIEF), which focuses on monitoring, planning, emotional control, shifting, initiating, inhibition, working memory, and organization of material. Perceptual motor functions were measured using the Acadia Test of Visual–Motor Integration (VMI). The study revealed that only two subcategories of executive functions – monitoring and working memory – are an important prerequisite for the development of perceptual motor functions. The authors expected a stronger relationship between perceptual motor functions and planning. This result is attributed to the concept of planning being captured by monitoring scales and working memory. However, it is necessary to realize that all executive functions were positively related to perceptual motor functions. The authors also assumed that by practicing memory training, some children who have no difficulties in fine motor skills and visual perception can improve their performance in perceptual motor functions, thereby achieving more in school.

A Dutch study conducted by Lo, Collin, and Hokken-Koelega (2015), aimed to assess the level of visual motor integration in children with Prader–Willi syndrome, as well as to assess the factors that could influence it. The research sample of this study consisted of 75 children with Prader–Willi syndrome in the range of mild intellectual disability. The second phase of the research involved 54 children with Prader–Willi syndrome, 52 of whom completed the research. The level of visual motor integration was tested using the Beery–Buktenica Developmental Test of Visual–Motor Integration (Beery-VMI), in which the children were asked to interpret 30 geometric shapes (from the simplest to the most difficult) without a time limit. Visual perception, which was tested using the VMI supplementary visual perception test, was also among the areas tested. In addition, hand motor coordination was tested using the VMI supplementary motor coordination test. The children with Prader–Willi syndrome achieved very low scores in VMI tests in the study. Their level of visual perception and hand motor coordination was evaluated as below average. The complete test results of children with Prader–Willi syndrome in all tests are very poor compared to children with typical development.

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Conclusion

The studies of children and pupils with mild intellectual disabilities who were administered tests of Visual–Motor Integration found differences between children and pupils with mild intellectual disabilities and children and pupils with typical development. The results of some studies corresponded to the expected 2–3 standard deviation deficits in adaptive and intellectual functions that children and pupils with mild intellectual disabilities experience in comparison to children and pupils with typical development. Data on the relationship between adaptive behavior and visual–motor integration suggests that visual–motor coordination training helps adaptive behavior, which leads to better day-to-day functioning of children and pupils with mild intellectual disabilities.

Pupils with mild intellectual disabilities, according to a study by Gresham, MacMillan, and Bocian (1996), achieved lower results in the area of cognitive functions compared to pupils with specific learning difficulties. Similar results wre reported in the study by Wuang, Wang, Huang, and Su (2008), which suggests that pupils with mild intellectual disabilities showed significant difficulties with fine motor control and dysfunction in sensorimotor skills.

Two studies focused on the relationships of other functional areas with perceptual motor functions in pupils with intellectual disabilities. One of them examined the relationship between executive and perceptual motor functions, and found that only two of the executive functions – monitoring and working memory – have a direct relationship with the development of perceptual motor functions in these pupils. It should be noted, however, that all executive functions have a positive impact on perceptual motor functions (Duijff et al., 2012). The second study looked at the relationship between the intelligence of pupils with DiGeorge syndrome and the level of their perceptual motor functions. The results of the study show that intelligence deficits in these pupils may be greater than perceptual motor function deficits (Memisevic & Sinanovic, 2013).

In one study, the level of visual motor integration was examined in pupils with Prader–Willi syndrome. These pupils achieved very low scores

in tests focused on visual–motor integration. Their level of visual perception and motor coordination was also assessed as below average (Lo et al., 2015). However, another study has shown that in strategic activities, such as composing puzzles, these pupils are able to be much more successful than pupils with typical development (Dykens, 2002).

Other studies have focused on pupils with DiGeorge syndrome, with the results of one showing significant deficits in the perceptual motor functions of these pupils (Vicari et al., 2012). The results of the second study, which also looked at the perceptual motor functions in pupils with DiGeorge syndrome, suggest that deficits in the area of these functions can be primarily attributed to deficits in the psychomotor development of these pupils. The level of perceptual motor functions in pupils with DiGeorge syndrome can also be influenced by whether pupils have unlimited time to complete the task (Howley et al., 2012).

If we were to define the connections between the results of individual studies, we should certainly mention that in all cases there were deficits in the development of perceptual motor functions in pupils with mild intellectual disabilities. It is also important to mention the relationship between the development of cognitive and executive functions, the stimulation of which can improve the development of perceptual motor functions in pupils with mild intellectual disabilities. We can also deduce from these studies that one of the main reasons for deficits in these areas is a deficit in the field of psychomotor development.

The findings of this literature review are very important, especially in relation to the development of individual areas in pupils with mild intellectual disabilities and the relationship between them. It is important to focus on the comprehensive development of all functions, i.e., psychomotor, cognitive, executive, and perceptual motor, in the education of pupils with mild intellectual disabilities. The individual functions influence each other, and if the development of one of the areas is neglected, deficits can also occur in another area. The literature review therefore points out the importance of the complexity of educating pupils with mild intellectual disabilities, which could be the basis for creating framework educational programs for their education. It can also

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serve professionals to better understand the characteristics of pupils with mild intellectual disabilities and the importance of the development of psychomotor development and cognitive functions, which is crucial to their overall development and which directly affects the possibilities of their education.

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