Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva / Italian Journal of Health Education, Sports and Inclusive Didactics - ISSN 2532-3296 - Anno 4 n. 4 - ottobre - dicembre 2020 Suppl. - ISBN 9788860223920 - CC BY-NC-ND 3.0 IT - doi: https://doi.org/10.32043/gsd.v4i4%20sup.229

DYSGRAPHY AS DYSHARMONY OF BODY MOVEMENT. NEW SCENARIOS BETWEEN TRADITION AND TECHNOLOGY

DISGRAFIA COME DISARMONIA DEL MOVIMENTO DEL CORPO. NUOVI SCENARI TRA TRADIZIONE E TECNOLOGIA

Enza Sidoti[1]
Università degli Studi di Palermo
University of Palermo
enza.sidoti@unipa.it

Dorotea Rita Di Carlo[2]
Università degli Studi di Palermo
University of Palermo
dorotearita.dicarlo@unipa.it

Abstract

Various studies show how movement establishes relationships with the environment and how this relationship is decisive in the learning process of each individual. The body is the first means by which the individual experiences the environment, it is the first channel of communication between him and others and will continue to be the privileged intermediary in the relationship with others, between the inner and outer world (Federici, Valentini, Tonini Cardinali, 2008, p.85).
The present article stems from the need to describe an intervention proposal that provides for the integration of the Terzi method with exergames, with the aim of enhancing visual-spatial skills and promoting the improvement of writing skills in children with dysgraphia. In particular, the aim of the work was to test the value of didactic practices centred on a conscious and intentional use of the body and its motor potential in order to propose possible didactic paths that use movement in the learning process of writing.

Diversi studi dimostrano come grazie al movimento si instaurino rapporti con l'ambiente e come questa relazione sia determinante nel processo di apprendimento di ogni individuo. Il corpo è il primo mezzo con cui l'individuo sperimenta l'ambiente, è il primo canale di comunicazione fra lui e gli altri e continuerà ad essere l'intermediario privilegiato nella relazione con gli altri, tra il mondo interno e quello esterno a sé (Federici, Valentini, Tonini Cardinali, 2008, p.85).
Il presente articolo nasce dall'esigenza di descrivere una proposta di intervento che prevede l'integrazione del metodo Terzi con gli exergames, con lo scopo di potenziare le abilità visuo-spaziali e favorire il miglioramento delle abilità di scrittura nei bambini disgrafici. In particolare, obiettivo del lavoro è stato sperimentare la valenza di prassi didattiche incentrate su un uso consapevole e intenzionale del corpo e delle sue potenzialità motorie al fine di prospettare possibili percorsi didattici che utilizzino il movimento nei processi di apprendimento della scrittura.

Keywords

Body, movement, writing, cognition

Corpo, movimento, scrittura, cognizione

1 Autor of paragraphs 1,3,5,5.3
2 Autor of paragraphs 2,4,5.1,5.2,6

1. Writing: a complex activity

Writing is a complex skill that is acquired as a result of a long learning process and involves specific stages that encompass both cognitive skills and sophisticated graphomotor skills. Writing requires skills related to mnemonic, attentional and space-time coordination processes; it also involves the ability to organize in sequence a series of fine movements. For this reason, the writing process involves different neural networks, both cognitive and motor, which, by integrating with each other, allow and promote the development of such skills. Learning to write is not a simple and intuitive activity but is based on the skills of orthographic coding, letter and syllable memory and fine motor skills. Writing is therefore the point of arrival in a long cognitive path, which is based on the integration of cognitive skills with orthographic-graphic-motor skills.

Writing is a combination of eye-manual coordination, movement and language that is translated into graphic signs with meaning and is a motor act that requires skill, speed, fluidity and precision in the production of the written sign (Olivaux, 2014). A fundamental stage in the process of learning to write is the balanced integration between space, shape and movement of the hand, which in normal conditions and in the absence of difficulty in writing, allow the child to write in a straight line, orient himself on the page and control the force to be applied to draw harmonious and fluid lines (Manetti, 2018; Pratelli, 2019). The process of learning to write also involves the force of the hand, spatial definition and coordination (above-below; left-right). A healthy development of the writing process is the first, indispensable step towards the ability to write skilfully and appropriately. Memory, ready reflexes, processing and cognitive connections combined with motor activity, contribute to a healthy development of writing ability, which is essential to achieve better school performance. These aspects of a more instrumental nature, related to the ability to skilfully process a written text, are fundamental because they play a propaedeutic role with regard to the ability to laboriously produce a written text (Longcamp et al., 2011; Wamain et al., 2012; Gainotti, 2014; Sim et al., 2014; Sabatini, 2016). The quality of children's graphic ability is significant in their developmental path because it has repercussions on their school performances, written compositions and other important aspects related to the emotional and relational sphere.

2. Dysgraphia

Dysgraphia is a specific learning disorder characterized by a motorial deficit that causes a rigidity of the limbs during the act of writing (Smits-Engelsman et al., 2001). Authors such as Smits-Engelsman associated the cause of dysgraphia with a possible lack of coordination of the general motor-control system (Smits-Engelsman et al., 2001). Recent studies conducted with functional magnetic resonance imaging have shown that the learning of graphomotor sequences involves many interacting networks of different neuronal regions, which subsequently contribute to the formation of different mental images of graphomotor trajectories (Del Grosso Destreri N. et al., 2000; Delazer M. et al., 2002; Swett Ba et al., 2010). The cause of dysgraphia, therefore, is related to a poor regulation of fine motor skills and space-time perception that prevent the accomplishment of short and precise motor activity within delineated spaces (Rosenblum et al., 2010; Bara & Gentaz, 2011; Meulenbroek & Van Galen, 1988). Dysgraphia is made up of two subtypes, one of which is visual-spatial-perceptual and the other of postural-motorial character. The first encompasses all aspects related to selective and sustained visual attention, right/left orientation of the writing, the size and distance between the letters in the page layout; the second includes all aspects related to motor memory and motor control of the written sign on the page. The subtypes of dysgraphia are related to different etiological factors that can still be co-present in the same person, albeit with profiles of marked heterogeneity.

The Guidelines for Learning Disorders (SINPIA), in complete harmony with previous research, describe dysgraphia as a difficulty related to linguistic and visual-spatial factors, the

cause of which is related to the presence of difficulties in motor performance. For the dysgraphic child, who in Simeti's vision (1986) is also dyspraxic, it is difficult to put simple movements in an orderly sequence and for this reason the handwriting of dysgraphic writers is difficult to understand. In most cases they have irregular handwriting and a rigid grip that leads to fatigue and further worsens the quality of their handwriting; there is also the interference of the non-writing hand when it is disengaged from the task of keeping the sheet stable (Blason L. et al. 2008).

These children may also present a crossed or undefined laterality and a certain disposition to confuse right and left (Pratelli M. 1995; Smits-Engelsman BC. et al. 2001; Rosenblum S. et al. 2010).

Dysgraphia, in addition to having a neurobiological origin, is characterized by developmental stages and integration of biological and environmental factors, which actively interact in the onset of the disorder (Specific Evolutionary Learning Disorders - Recommendations for Clinical Practice defined by the Consensus Conference method, Consensus Conference, 2007, p.5).

The dysgraphic child, however, thanks to proprioceptive and motor training aimed at general coordination of movement (Farath et al., 2016) is able to improve motor control and therefore the written sign on the page (Chiappedi et al., 2016). This evidence is also confirmed in Italy. Here, programs have been proposed based on the correlation between learning disorders and praxis-motor difficulties. These have offered exercise/practice experiences to achieve significant improvements in reading/writing (Lodi et al., 2014).

3. Exercise, writing and cognitive functions

From early childhood growth processes are greatly conditioned by the interrelation between body and mind. In interacting with the world, the child puts his biological nature into action and builds the tools to interpret and organize the reality around him (Bruner, Shewood, 1997). It is through the movement of his body that the child learns to relate to the environment and his fellow human beings (Minetti, 2009; Fasting, 2009): the moving body is the first means by which the individual experiences the environment, it is the first channel of communication between him and others (Federici, Valentini, Tonini Cardinali, 2008, p.85). Running, jumping, moving freely allow the child to experience the limits and possibilities of his own physicality. Some studies have shown that physical exercise positively influences many cognitive processes, such as speed (Dustman et al., 1994), performance control (Kramer et al., 1999) and visual-spatial abilities (Shay, Roth, 1992). Through movement it is possible to perform every kind of action, both imaginary and concrete. Doing, intended as movement of one's body to explore and get to know the surrounding world, generates knowledge and enhances motor skills, essential requirements to harmonise the physical, cognitive and social development of the child. The balance between them, provides the basis for the development of future processes such as symbolization, identification and socialization, learning to read, calculate and write.

Writing is a motor activity which, if based on the movement of the body, supports the child in the construction of fundamental concepts for learning such as the notion of space and time (Barbeau, 1990, pp. 20-22). The movement of the body helps to strengthen some of the cognitive aspects that are deficient in dysgraphic children and the surrounding environment is for their body what the paper is for the hand: the environment, in this sense, becomes a graphic space and is configured to concretize and spatially represent temporal elements such as sequentiality, rhythm and length of time necessary to discriminate individual letters, not to confuse them, to understand their correct order and to avoid inversions, omissions or substitutions. In this perspective, it is through specific motor exercises that the child performs movements, in response to stimuli from the external environment, fundamental to develop proprioceptive experiences that promote knowledge of the world and learning (Terzi, 1995).

4. The Terzi method and exergames

The Terzi Method highlights the essential role of the relationship between the body in motion and the surrounding environment, emphasizing the results that this relationship brings to the cognitive and metacognitive processes that influence the learning of reading, writing and calculation at school. The Terzi method places the individual, who acts in the environment through the body creating cognitive representations, at the centre of the learning process. The exercises proposed by the Terzi Method highlight the concept of embodied cognition, that is, cognition rooted in the body, so as to highlight that cognitive development evolves from perception of the body, in parallel with the development of its motor functions and control.

The external world is therefore a factor that influences the learning process. However, the child's concept of the external environment is gradually changing as it is enriched with new content and new transformations that make it richer, more sophisticated and full of stimuli. The motor experiences proposed through the exergames encourage an interaction between the player and the game that is not limited to the use of manual controls such as the keyboard, but allows movement involving the entire body (Staiano, Calvert, 2011; Sgrò, 2014; Vernadakis et al., 2015; Sgrò, Bar- resi, Lipoma, 2016). From a cognitive point of view, these videogames improve school performance because they allow the transfer of skills acquired through motor play into educational activities. The most stimulated cognitive aspects are for example spatial awareness, attention, general co-ordination, understanding cause and effect (Fery, Ponserre, 2001), and eye-manual coordination (Drew, Waters, 1986). Moreover, the games encourage more precise responses to visual stimuli by creating increasingly refined cognitive maps (Höysniemi, 2006). Exergames are a valuable tool for the improvement of performance skills in elementary school children (Best, 2010; Da- vis et al., 2011; Best, 2012).

The coordination of the body in its immediate environment, alongside the stimuli offered with exergames, make it possible to achieve fine motor skills that are more fluid, harmonious and coordinated in time and space. Accustoming the child to skilfully orient his or her body in relation to objects and in a specific well-defined space, allows him or her to develop good visual-spatial orientation skills, which are then necessary to refine his or her graphomotor ability on a page.

5. The research

The objective of the research was to assess whether training focused on the enhancement of visual-spatial skills, incorporating motor exercises both in the traditional sense and through the use of technological tools, could bring significant improvements to the quality of writing of the children in the sample. Specifically, the aim was to investigate whether the effectiveness of the training adopted was directly proportional to the age of the children and whether, therefore, it was the youngest children who benefited most from the effectiveness of the programmes developed. A third aspect that we wanted to investigate concerned the motivational sphere and, specifically, how much motivation had benefited the emotional state of the child and therefore the process of improving the written language.

5.1. Target population

The research was carried out at seven educational institutions in the municipality of Palermo. There were 20 children involved in the experiment who attended the second, third, fourth and fifth year of primary school. The age of the children ranged between 7 and 10 years. The total sample was made up of 10 boys and 10 girls, with an official diagnosis of dysgraphia, 15 of whom exhibited other specific learning disorders. The different ages of the children was the criterion for the choice of the sample. Out of the 20 children, 10 represented the control group and 10 the experimental group. The experimental group, unlike the control group, carried out the activities designed for the research.

5.2 Description of the activities carried out

The research took place in the school year 2018-2019, lasted 9 months and was carried out during two ninety- minute meetings per week In the first meeting both groups were given the Right-Left Awareness Test (Piaget-Head, 1980), to observe processes of lateralization, through movement in the immediate environment and the TRC (Test of Relational Concepts, Edmonston and Thane, 1988), to assess the knowledge of general concepts in relation to space-time. In the first meeting the children from both groups were asked to perform three types of writing exercise: free composition of a text, dictation and copying from the blackboard. These three tests evaluated whether any of the visual-motor, visual-spatial and visual-spatial-mnemonic aspects was deficient and at what level of seriousness. At the end of each phase (see Table 1) the three writing activities were presented again to monitor the effectiveness of the training offered.

The training described below was proposed only to the experimental group and provided the following phases:

First phase	First stage: some playful motor activities were carried out in a room that involved the free use of the body in order to develop coordination of the limbs;	Second stage: recreational motor activities that involved the use of technological tools to develop coordination of the limbs were carried out;
Second phase	First stage: There is the integration of motor games, experimented in the previous phase, with technological tools to develop proprioceptive and visual skills;	Second stage: Includes activities through the use of technological tools to enhance motor memory, visual attention and selective attention;
Third phase	First stage: was focused on the enhancement of fine motor skills through manual activities and with materials that were different from each other in shape, size and consistency;	Second stage: was focused on the enhancement of fine motor skills through technological tools;
Fourth phase	First stage: was dedicated to the enhancement of attention and speed in the carrying out of an activity, through materials tested in previous phases.	Second stage: was dedicated to the enhancement of attention and speed in the execution of an activity, through technological tools.

Table 1Training

At the end of the phases listed above, both groups were again subjected to initial tests to note the improvements achieved by individual children and, overall, by the two groups.

5.3 Results obtained

The results obtained in the final tests showed a significant improvement for the children who had taken part in the experimental trial, while the children belonging to the control group obtained almost the same results that they had achieved in the first administration of the tests.

In particular, it was found that children aged 7 and 8 years obtained even more satisfactory results than children aged 9 and 10 years.

Right-Left Awareness Test Results (Piaget-Head, 1980):

CONTROL GROUP

child	age	Pre-test	Post-test
1	7	7	11
2	7	8	12
3	7	11	16
4	8	12	16
5	8	9	13
6	8	6	9
7	9	8	11
8	9	3	4
9	10	10	12
10	10	5	7

EXPERIMENTAL GROUP

child	age	Pre-test	Post- test
1	7	6	6
2	7	10	9
3	8	8	7
4	8	12	13
5	8	10	10
6	9	9	10
7	9	7	9
8	9	4	6
9	10	13	12
10	10	11	11

Table 2 Results

The three writing activities done at the end of each phase acted as historical evidence of the effectiveness of the activities undertaken.

Motivation was the third aspect that provided the framework for the proposed activities and it was noted how motor activities involving the whole body are in themselves stimulating and enjoyable for children. In fact, they all participated with great enthusiasm. Combining motor activities with the exergames further added to levels of motivation. Indeed it was a pleasant surprise for the children to have been able to play video games in the classroom context.

The role of motivation was fundamental because it facilitated, albeit unconsciously, the learning processes and therefore helped the strengthening of graphomotor skills and the underlying cognitive processes.

Conclusions

This research is intended to address the difficulty dysgraphic children face in the writing process, with the aim of improving their relationship between space and time, two essential variables whose relationship also determines the speed with which a task is performed.

The basic idea that has marked the entire path of investigation was to highlight the close correlation that exists between movement of the entire body in its immediate environment and movement of the fingers, since it is the ability to move in one's surrounding space that makes one competent in the most minute of actions, characteristic of writing.

In consequence of the results obtained, it can be assumed that encouraging motor activity as a method to work on the difficulties of children with disability is a strategy that helps improve the written sign in writing, coordination on the sheet, focus on keeping to a straight line and memory to remember the words to write.

The results obtained suggest that a teaching approach focused on the body is an engaging and particularly stimulating and productive pedagogical method to stimulate learning.

It is also possible to think that if the 9 and 10 year- old children had been trained for a longer time, they would have obtained higher scores. However, in a future experiment, we intend to investigate the influence that the duration of a course has on learning processes.

In conclusion, it is possible to encapsulate the meaning of the research presented as the need to integrate physical exercise and writing. These two skills, apparently distinct, can be equated using a comparison that on the one hand sees motor activity as a series of individual movements that are joined together in an ordered sequence to form a gesture and, on the other hand, writing as nothing more than the succession of individual letters that together form the word to be written. Since writing is a sequential and therefore a motor activity, it is impossible to detach it from a motor training and practice that progresses from movement of the entire body in its immediate environment and then arrives at movement of the fingers.

References

Bara F., Gentaz E. (2011). *Haptics in teaching handwriting: The role of perceptual and visuo motor skills*. Human Mov Sci, 30.

Barbeau M. (1990). *Processus interactifs mnesiques et comportementaux apres coma posttraumatique chez l'infant*.

Best J. R. (2010). *Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise*. Developmental Review, 30(4).

Best J. R. (2012). *Exergaming immediately enhances children's executive function*. Developmental psychology, 48(5).

Blason L., Borean M., Bravar L., Zoia S. (2004). *Il corsivo dalla A alla Z, la teoria*. Gardolo: Edizioni Erickson.

Blason, L., Borean, M., Bravar, L., & Zoia, S. (2008). *Il corsivo dalla A alla Z.* In Chiappedi M., DE Bernardi E., Togni R., Baschenis IC., Nonini L., Balottin U. et al. (2016).

Bruner, J., Sherwood, V. (1997). Pensiero, linguaggio ed interazione nell'infanzia. In V. Ugazio, *La costruzione della conoscenza. L'approccio europeo alla cognizione del sociale*. Milano: Franco Angeli.

Davis C. L., Tomporowski P. D., McDowell J. E., Austin B. P., Miller P. H., Yanasak N. E., Naglieri J. A. (2011). *Exercise improves executive function and achievement and alters brain activation in overweight children: a randomized, controlled trial*. Health Psychology, 30(1), 91-98.

Del Grosso Destreri N, Farina E, Alberoni M, Pomati S, Nichelli P, Mariani C. (2000) *Selective uppercase dysgraphia with loss of visual imagery of letter forms: a window on the organization of graphomotor patterns*. Brain Lang. 71.

Delazer M, Lochy a, Jenner C, Domahs F, Benke T. (2002) *When writing 0 (zero) is easier than writing O (o): a neuropsychological case study of agraphia. Neuropsychologia*. 40(12).
Disturbi evolutivi specifici di apprendimento - Raccomandazioni per la pratica clinica definite con il metodo della Consensus Conference, Consensus Conference, 2007.
Drew B., Waters J. (1986). *Video games: utilization of a novel strategy to improve perceptual motor skills and cognitive functioning in the non-institutionalized elderly*. Cognitive Rehabilitation, 4.
Dustman, R.E., Emmerson, R., & Shearer, D. (1994). *Physical activity, age, and cognitive-neuropsychological function. Journal of Aging and Physical Activity*, 2.
Farhat, Hsairi I., Baati H., Smits-Engelsman BC., Masmoudi K., Mchirgui R., et al. (2016). *The effect of a motor skills training program in the improvement of practiced and nonpracticed tasks performance in children with developmental coordination disorder (DCD)*. Human Mov Sci, 46.
Farhat, R. (2016). *Genetic determinants of drug resistance in Mycobacterium tuberculosis and their diagnostic value*. Am. J. Respir. Crit. Care Med.
Fasting K. (2009). *Born to move? Perspectives from the social sciences*. Oslo: ECSS Congress.
Federici A., Valentini M., Tonini Cardinali C. (2008). Il corpo educante. Roma: Aracne, 85
Fery Y., Ponserre S. (2001). *Enhancing the control of force in putting by video game training. Ergonomics*, 44.
Gainotti G. (2014). *È utile che i bambini continuino a scrivere a mano?* Crusca per voi, II, 49.
Höysniemi J. (2006). *Design and evaluation of physically interactive games. Dissertations in Interactive Technology*, Tampereen yliopisto Oy, 5.
Kramer A.F., Erickson K.I. (2007) *Capitalizing on cortical plasticity: influence of physical activity on cognition and brain function*, «Trends Cognitive Science».
Lodi D., Barbieri, M., Buiani, M., Seghi, G. (2014). *Corporeità e difficoltà d'apprendimento. Motricità e successo educativ*o. Brescia: La Scuola.
Longcamp M., Hlushchuk Y., Hari R. (2011). *What differs in visual recognition of handwriting vs. printed letters? An fMRI study*. Lancaster: Human Brain Mapping, 32(8), 1250-9.
Manetti E. (2018). *Osservazioni grafologiche sulle scritture dei bambini di terza, quarta, quinta classe delle scuole primarie*. In C. Angelini, E. Manetti (eds.), Imparare a scrivere a mano. Roma: Epsylon.
Meulenbrock R.G.J., Van Galen G.P. (1988). *The acquisition of skilled handwriting: discontinuous trend in kinematic variables*. In Colley A.M. & Beech J.R. (editors). Cognition and action in skilled behavior. Amsterdam: Elsevier Science Publishers.
Minetti A.E. (2009). *Human adaptability to move: internal and external resources*. Oslo: ECSS Congress.
Olivaux R. (2014). *Pedagogia della scrittura e grafoterapia*. Roma: Epsylon. Ed. or. (2005). Pédagogie de l'écriture et graphothérapie. Paris: L'Harmattan.
OMS (2000). *Life skills education for children and adolescents in schools,* year 2000 U.S. Department of Health and Human Services (2008). Phisycal Activity Guide-lines Advisory Committee Report*,* Washington DC.
Pratelli M. (1995). *Disgrafia e recupero delle difficoltà grafo-motorie*. Gardolo: Erickson.
Pratelli M. (2019). *Disgrafia e recupero delle difficoltà grafo-motorie*. Trento: Erickson.
Rosenblum S, Aloni T, Josman N. (2010) *Relationships between handwriting performance and organizational abilities among children with and without dysgraphia: a preliminary study*. Res Dev Disabil. 31(2).
Sabatini F. (2016). *Lezione di italiano*. Milano: Mondadori
Sgrò F. (2014). *Edu-Exergames. Tecnologie per l'educazione motoria*. Milano: Franco Angeli.
Sgrò F., Barresi M., Lipoma M. (2016). *Analisi degli effetti di un protocollo di attività motoria mediato dagli exergames sui livelli di competenza delle abilità fondamentali in bambini della scuola*. Formazione & Insegnamento, 14(1).
Shay, K. A., & Roth, D. L. (1992). *Association between aerobic fitness and visuospatial perfor-*

mance in healthy older adults. Psychology and Aging, 7.
Sim E.J., Helbig H.B., Graf M., Kiefer M. (2014). *When Action Observation Facilitates Visual Perception: Activation in Visuo-Motor Areas Contributes to Object Recognition.* Oxford: Cerebral Cortex, 2.
Simeti, F. (1986). *Neuropsicologia dell'apprendimento*. Parma: Oppici.
Smits-Engelsman B.C.M., Niemeijer A.S., Van Galen G.P. (2001). *Fine motor deficiencies in children diagnosed DCD based on poor grapho-motor ability*. Human Mov Sci, 20.
Smits-Engelsman BC, Niemeijer aS, van Galen GP. (2001) *Fine motor deficiencies in children diagnosed as DCD based on poor grapho-motor ability*. Human movement science. 20.
Staiano A. E., Calvert S. L. (2011). *Exergames for physical education courses: Physical, social, and cognitive benefits. Child development perspectives*, 5(2).
Swett Ba, Contreras-Vidal JL, Birn R, Braun A. (2010) *Neural substrates of graphomotor sequence learning: a combined FMRI and kinematic study*. J Neuroph,103(6).
Terzi I., (1995). *Il Metodo Spazio-Temporale, Basi teoriche e guida agli esercizi*. Ed. Ghedini.
Vernadakis N., Papastergiou M., Zetou E., Antoniou P. (2015). *The impact of an exergamebased intervention on children's fundamental motor skills*. Computers & Education, 83.
Wamain Y., Tallet J., Zanone P.G., Longcamp M. (2012). *Brain responses to handwritten and printed letters differentially depend on the activation state of the primary motor cortex.* NeuroImage. Bethesda: Maryland, 63(3).
Wille A.M., Ambrosini C. (2008). *Manuale di terapia psicomotoria dell'età evolutiva*. Cuzzolin Editore.