Journal of Physical Education and Sport ® (JPES), Vol.19 (Supplement issue 5), Art. 288, pp. 1937-1942, 2019
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Assessment of the impact of an inclusive diving program, on subjects with cognitive disability: analysis of the enhancement of cognitive processes

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Published online: October 22, 2019
(Accepted for publication: October 15, 2019)
DOI:10.7752/jpes.2019.s5288

Abstract:
This research focuses on a diving project on individuals with cognitive disabilities through scuba diving experiences. The work establishes the collaboration of the Heracle research laboratory of the N. Cusano University with DDI, an international organization engaged in diving programs for disabled people. DDI offers the opportunity to experience moments of confrontation with other divers in experiences of strong emotional impact, as well as to acquire a valid patent at international level. The study focuses on the management of relationships, connections and communication between students and instructors with a strong inclusive value using simplified and international teaching. It is defined as "simplified" because it is an adaptation of the method used in diving for the able-bodied. It has been adapted to the specific needs of the disability to make it intuitive and easily replicable. It is a method recognized and shared internationally by diving specialists, in fact, this feature makes the system inclusive. The observation of the motivational dynamic to the hypothesized immersion is deepened, strictly correlated to the warm cognition; the analysis of emotional problems induced by the underwater experience, such as anxiety and panic, their management and the transformation of these feelings from problem to resource. Starting from the hypothesis concerning the neural networks involved in the processes, which from sensation lead to perception and cognition, this research aims to demonstrate how their intersection with movement and action can enhance cognitive processes such as attention and learning, correlating the development of new acquisitions, the strengthening of autonomy and the improvement of the quality of life. Three tests of the Nepsy II battery were administered experimentally to the original sample, concerning: the understanding process of emotions; the visual attention; the comprehension of the task (sub-tests parameterised in Morsanuto's article). An observation card was filled in by the instructors to monitor the effect of the activity on the participants. All the tests were administered individually at the beginning and at the conclusion of the diving course which lasted nine months with twice weekly frequency.
Key words: education, coherence, motivation, emotional skills, attention.

Introduction

As mentioned in the abstract, the research focuses on a diving project with cognitive disability through scuba diving experiences. The work establishes the collaboration of the Heracle research laboratory of the N. Cusano University with DDI, an international organization involved in diving programs for disabled people(Venza et al., 2006, Morsanuto, Marsico, 2019). DDI offers people with cognitive, physical and sensory disabilities the chance to receive underwater training (Maraviglia 2012). The main objectives of the course are:

- Strengthening autonomy;
- Developing users' motor, cognitive and attentional skills;
- Generating psychophysical well-being;
- Increasing self-control skills;
- Developing social skills;
- Encouraging the development of social events and the creation of networks in the area;
- Facilitating inclusive moments through aggregation.

The DDI educational-didactic method does not only deal with training disabled athletes but also with the instructors through technical courses conceived to transfer all the skills (theoretical and practical ones) to train and to assist divers with disabilities (Altavilla, et al., 2015, Sanseviero et al. 2019). DDI issues patents with international validity which allow the new diver to enter completely in the international diving community, allowing him to perform recreational dives, within the limits of the certification obtained, in the seas around the world.

The research therefore aims to investigate the effectiveness of the method by observing it and analysing it from a neuroscientific point of view.

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State of art

The focus starting point of this research was to observe how the performance could emerge from the internal evolutions of the sense-motor systems and from the influence that the environment plays in these systems. To better understand the relationship between movement, sensation and cognition it is fundamental to take into consideration three important aspects: emergency, the role of the environment and modularity (Meraviglia 2015). A self-organized dynamic system can be all deterministic even though its properties cannot be seen in another way than observing what happens over time (Tiziana et al., 2017; Cirillo et al. 2016). The property of a dynamic system is a function with mathematical features that may not be entirely evident. The emerging structures may change in a discontinuous way in parallel with the constant changes of the parameters of the system (Wonder 2015). The theory of dynamic systems helps to investigate this concept. Behaviours emerge through the properties of the structures involved (body, environment, CNS); this reciprocity can be decentralized and does not depend directly on the brain.

They are called "non-linear dynamic models" since the development is not always bottom up, but progressive and continuous; it could also be unstable, since a minimum modification is sufficient to produce an effect of great importance (Raiola, G., 2011). It is, in fact, a multi theory since different factors and multiple causes contribute to motor development. Self-organization plays an important role: the system uses its own faculties to replicate movements up to the realization of a structured and efficient pattern, which produces an effect or satisfaction. The modification always derives from a state of stability, which is stimulated so that the component parts become available for a new integration (ex. crawling vs. walking). Each element of the system is not independent from the others. The movements are organized in synergies, which are flexibly adapted to the accomplishment of the tasks (Gaetano, R., 2012).

The environment is an integral part of the dynamic systems which, in the specific case of diving, must take into account not only the physical space where diving is learned, but also the social and above all linguistic context, since the proposed codes are totally new to the user. The scuba diver has been didactically codified and confirmed with strongly interpersonal characteristics. The immersion methodology, normally known as a "couple system", in disability it must adapt to the cognitive level also realizing small immersion groups, maintaining however the rules of management or mutual control and comparison and if necessary, rescue (D'Isanto et al., 2019; Raiola, 2014). The group dimension is also extended to the organization of the event itself, to the journeys, to the travels, to the training (Gargiulo 2006). The last aspect is related to the modularity of the system. The sensitive aspect relates to the motor and the cognitive aspect. The different perceptive stimuli are coded and integrated into the perception, this unification precedes cognition and later, the motor program is generated. The dynamic systemic approach (Hurley, Noë 2003) provides a structure organized in horizontal modules and each of these modules is active and intended for a specific task. This theory could explain the development of residual capacities in the cognitive disability. Another correlation to take into consideration is the relationship between heart and brain. Heart is equipped with a complex nervous system which processes and produces information independent from those generated by the brain and by the autonomic nervous system (Armor, 1991; Raiola et al., 2018).

Heart synthesizes and releases neurotransmitters such as epinephrine and dopamine and therefore through the hormonal and nervous systems, heart influences the functioning of the brain (Folkour, 1960). The term "*coherence*" indicates a physiological state in which the cardiovascular, hormonal, nervous and immune systems work in balance and with effectiveness. *Coherence* is a condition very similar to what experienced by athletes when they are in the so-called "*zone"*, a particular state of attention and perception in which intention is the conductor of the system (Pisapia et al. 2018). In this condition, the mind is in the optimal condition to learn. According to Giller et al. (1999) brain waves are so influenced by the heart rhythm that they can change in relation to the inconsistent patterns of the heart.

Through the spinal cord, the thalamus and the amygdala brainstem, the heart sends information to the brain, in the form of heart rates, related to emotional states. When the heart rate is consistent the brain reacts with a better functioning of the cortical area creating states of "mental clarity". If the brain produces coherent rhythm patterns, it stimulates positive emotional states such as enthusiasm and confidence (Hamel, 2006), fundamental characteristics for motivation. It can be assumed that underwater training also develops in the subject with cognitive delay the ability to control and manage breathing closely correlated with cardiac coherence (Servan, 2000). The diver is in fact asked to profoundly modify the breathing method: he passes from the nasal to the one with the dispenser which looks like an obstruction of the airway. The mask supplied to the diver also modifies the breathing pattern.

The self-discipline of breathing, the absence of gravity and sounds during the immersion create a vacuum of stimuli and rational meanings (Gargiulo, 2006), favouring a condition of greater perception of those elements (internal and external) that normally do not interact with the subject.

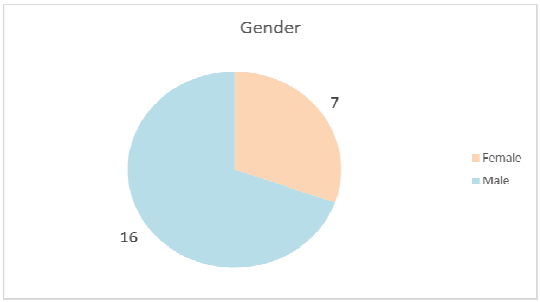
The state of relaxation and concentration that the immersion instils, in synergy with the sense of trust lavished by the group condition, tends to decrease the anxiety-producing state and satisfies the needs (Maslow, 1970) pertaining to safety and fun; this experience is the sum of a tolerable tension, a possible effort and a pleasure deriving from fatigue (Gargiulo, 2006).

Material & method

The evaluation of the influence of the underwater activity on the analysed sample was obtained through the administration of some NEPSY-II battery test reagents for the neuropsychological evaluation of the developmental age (Urgesi, Campanella, Fabbro, 2011). The participants were between 16 and 30 years old, cognitive disabled with no previous experience in underwater activity. The battery was experimentally administered by three battery reagents (Nepsy II). The domains estimated were related to language, attention, sensorimotor functions and social perception; in details: understanding of emotions are evaluated; visual attention; understanding of a task. An observation card was filled in by the instructors (Raiola, 2011ab, 2015). At the end of these tests, the examined sample was compared with one which did not participate in specific motor activities but did perform basic activities that were evaluated through a previous research. As mentioned, the battery used serves in the neuropsychological evaluation in the developmental age. The experimental choice of the instrument was required by the idea of using a simple and intuitive administration evaluation tool in estimating the effectiveness of activities (D'Elia, 2019; Martino et. al 2019). In fact, its flexibility makes it possible to conduce individual tests, groups test or the entire battery.

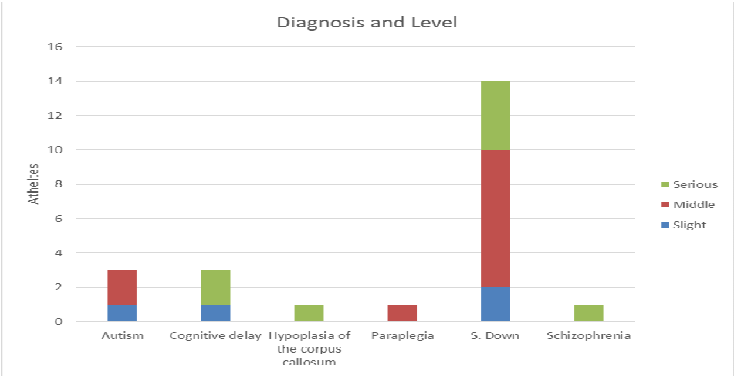
The tests can be combined in various ways depending on the evaluation requests. Some tests are specific for some age groups, while most tests, although administered to children of all age groups, include specific tests for each group. This allowed us to diversify the levels if there was a need. Furthermore, this type of battery makes it possible to avoid any frustrations due to the failure of a test, thus avoiding boredom and a drop-in concentration (Urgesi, Campanella, Fabbro, 2011). It has been previously proposed the possibility of using this tool, designed to analyse the skills of children (3/16 years), even on disabled adults with mental retardation with the aim of hypothesizing the theoretical age of these subjects in relation to the actual age associated to a certain severity of mental retardation by administering the same sub-tests used in the proposed study to an adult population with cognitive disability of statistically significant size (Morsanuto, Marsico, 2019). The score obtained, associated to a specific age range indicative of the abilities possessed by the subject and not to the chronological age, will be subsequently compared with the maximum score obtainable by the participant in that specific test and with the age limit that is supposed to be associated now. The result obtained will be compared with the values of the same tests administered to a similar reference sample, which does not perform motor activity (Morsanuto, Marsico, 2019).

Sample analysis



Graphic 1

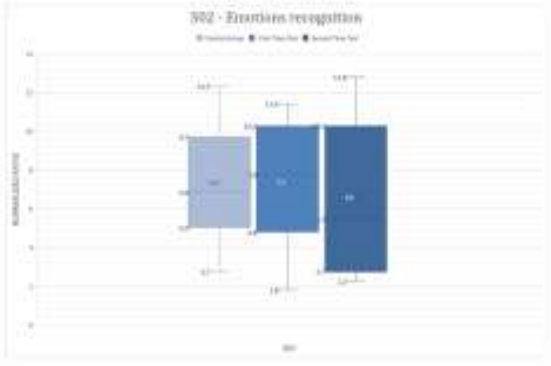
In the graph it is possible to observe the distribution of the sample between gender. The graph describes the distribution of the sample between diagnosis and by level of mental retardation.



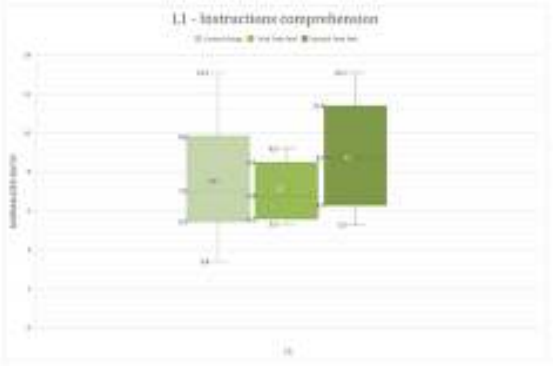
Graphic 2

Results

Data analysis has been represented through Box-and-Whisker diagrams, also called boxplots (Turkey, 1977). They help to visually represent four fundamental characteristics of a statistical distribution of sample data: the measure of central tendency through the median, the degree of dispersion or variability of the data with respect to the median, the form of the distribution of the data (in particular the symmetry), the presence of atypical elements (outliers). A boxplot has a line inside the box (square, rectangle), which represents the median. The box is delimited by two lines, the lower line, indicated with Q1 quartile or upper quartile. The distance between the third and the first quartile is called interquartile distance (interquartile range IQR), it is a measure of the dispersion of the distribution. The IQR increases as the dispersion (variance) of the data increases and also provides information on the distribution pattern (above all on the symmetry) if the upper line and the lower line of the box have different distances from the central measurement (line inside the box), the distribution of values is asymmetric. The lines that stretch from the edges of the box and end with two other perpendicular lines, the whiskers, define the intervals in which the values less than Q1 (in the lower part) and those greater than Q3 are placed (in the upper part). The lines that stretch from the edges of the box and end with two other perpendicular lines, the whiskers, define the intervals in which the values less than Q1 (in the lower part) and those greater than Q3 are placed (in the upper part). Values outside these limits are called outliers and in the graphic representation of the boxplot these values are reported individually as they constitute an important anomaly with respect to the other distribution data.

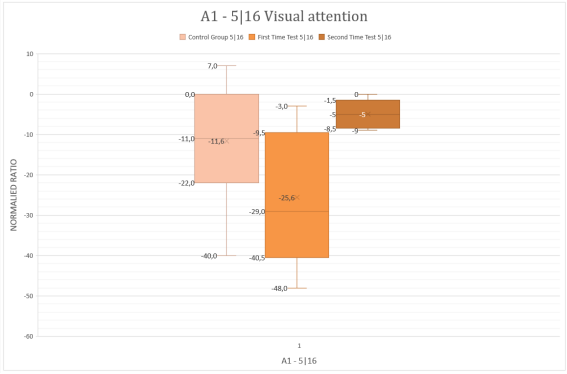


Boxplot 1



Boxplot 2

In details, the S02-Emotional recognition test takes place through the administration of 35 questions related to visual stimuli. The box plot shows that the distribution of the values of the second administration increases, even if we have an increasement in the maximum value (the fourth quartile increases), the first decreases, even if the median has dropped. Despite this, however, the maximum values detected by the whisker in the fourth quartile have increased as well as the minimum values. As for the boxplot concerning the understanding of the task there is a clear shift of the distribution towards the third and fourth quartiles, also increasing the median.

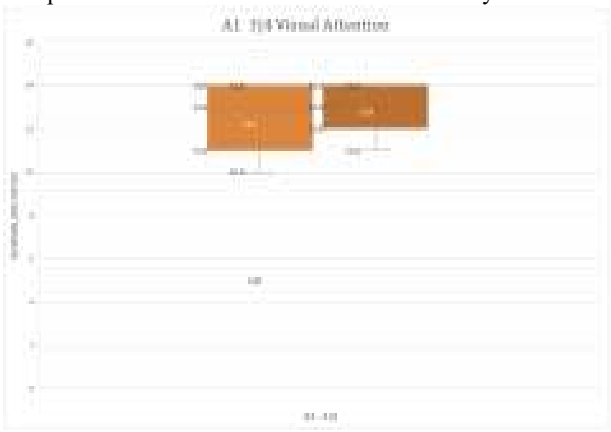


Boxplot 3

The analysis of this boxplot shows how the distribution of values has concentrated upwards in the second administration. It should be noted that the values of the first administration and of the reference sample are strongly negative. Although improvements have been demonstrated, the strongly negative values have shown the difficulty of test for which it was necessary to administer the reactive mode relative

to a lower age group. The results are demonstrated in the next box plot. The distribution of the sample in the following boxplot is concentrated in the fourth quartile where the values are higher.

The control sample showed no significant changes. The first analysis of the data showed that, in relation to the control sample, the reference one that participated in the diving activity, obtained superior results in terms of cognitive, attentional and emotion management skills, supporting the theory of causal connection between the development of neural networks and motor activity.



Boxplot 4

Conclusion

The analysis of the results obtained shows a general improvement in the cognitive abilities of the participants in the research project but with significant differences between the different tests. In details, tendentially higher scores are observed in the second administration compared to the first and compared to the control group in two sub-tests of the Nepsy-II battery: L1-Understanding of instructions and A1-Visual Attention (5-16 years). It is necessary to consider the comparison between the variability of the scores obtained in the two administrations; in fact in the L1 sub-test the IQR (interquartile difference) is higher in the second administration (1st IQR = 2.9; 2nd IQR = 6, 1; control group IQR = 4.4) highlighting a greater dispersion of the results around the median even though it presents almost equivalent values to the above and below it. The results obtained are altogether higher than those of the control group and have a greater but less homogeneous dispersion. Instead, the A1 (5-16) test presents a minor variability in the second administration with respect to the first and compared to the control group and greater homogeneity of the data above and below the median (1st IQR = -31; 2nd IQR = 7, IQR control group = 22). Differently, as far as the A1-Visual Attention sub-test is concerned, values comparable to those of the control group are observed but with less variability of the results compared to the median value (control group IQR = 3; experimental group IQR = 2). A certain stability is observed in the results obtained at the sub-test S02-Recognition Emotions between the two administrations, but values tend to be higher than those of the control group. Furthermore, a greater variability of the results is evident compared to the median in the second administration and in the control group but the higher and lower scores with respect to the reference score are less homogeneous in the last administration compared to the other conditions (1st IQR = 5, 5; 2nd IQR = 7.6; IQR control group = 4.7).

The analysis of the data obtained requires that some relevant notes be considered in order to contextualize the results obtained. It should be emphasized that the proposed study took into consideration a relatively heterogeneous sample of subjects both for diagnosis and for the severity of mental retardation with a prevalence of boys affected by Down Syndrome with medium cognitive delay. This last group is clearly more numerous than the others and, consequently, the improvements already mentioned are significant mainly considering the real and theoretical average age of this sub-sample which tends to mask the results of the other subgroups. The number is in fact the main limitation of the proposed study and does not allow us to draw statistically significant conclusions. Nevertheless, it is necessary to consider that, given the type of the sample and the type of activity carried out, the results obtained represent a panel of relevant data in the panorama of research concerning training aimed at implementing cognition and in particular within projects who consider diving as an intervention modality to improve neuro-psycho-motor function in subjects with cognitive disabilities. In conclusion, given the improvements obtained from the experimental sample with a small sample size, we aim to expand this study by involving a greater number of subjects, possibly going to constitute a more heterogeneous sample for pathologies and severity of delay in order to make more significant impact of underwater training on global cognitive skills. In this sense it could be useful to insert further neuropsychological tests to have at disposal a more complete evaluation of the battery.

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