

"Let's Kick the Disease": Karate and Rehabilitation. A pilot Study.

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Abstract:

Problem statement: Specific movement patterns are often deeply limited in disability but naturally understood and acquired as specific basic skills in normal athletes. Delayed learning of motor gestures is one the main causes of execution difficulty that is observed in athletes with disability. **Approach:** A group of patients suffering from mild-moderate cognitive-intellectual-relational disability was recruited in order to be treated with karate exercises as a method of training, education, inclusive-integrated teaching and rehabilitation. The content of the exercises was organized, over seven months of observation, on working protocols concerning certain natural and specific positions of Karate based on equilibrium, use of lower limbs, agility, praxis and postural patterns. A specific stabilometric platform (SP) was used in the study (Balance System SD, Biodex Medical Systems Inc., Shirley - New York) to measure and improve balance, load displacement, ROM of specific movements and proprioception. The Illinois agility test and the Florida Apraxia Screening Test – (FAST) were used to increase speed and improving apraxic and attention components respectively. **Purpose:** In order to increase the physical performance of individuals, optimising coordination and motor patterns that are impaired in disability, project objectives and strategies were proposed. Inclusive teaching and specific rehabilitation were incorporated. The protocol allowed participants to practice positions with a dynamic method rather than a static one. The aim was to transfer postural mechanical load and motor activation to the left half of the body, to compensate excess of body permanence in the right area at the SP test in order to facilitate learning abilities that are usually lacking in this type of disability. **Results:** For each one of the eight subjects, after administration of the exercise protocol on specific positions of the discipline, a balance inclination from right quadrants towards left quadrants respect to initial average was observed. The results confirmed an improvement in all components of the exercises proposed, with consequent neuroplasticity phenomena, even where multiple intellectual deficits coexisted. **Conclusions:** The observed improvements were of motor and sensory-cognitive nature. Karate can be considered a means of maintaining specific skills and a rehabilitation tool in disability cases.

Key Words: rehabilitation; behavioral disabilities; intellective disabilities; karate training; neuroplasticity.

Introduction

Individuals with an intellectual disability have neurodevelopmental deficits characterized by limitations in intellectual functioning and adaptive behavior. These disabilities originate and manifest before the age of 18 and can be associated with a considerable number of related and co-occurring problems including mental health (e.g., depression, and anxiety), neurodevelopmental (e.g., autism spectrum disorders, and attention deficit hyperactivity disorder), as well as neurological (e.g., infantile cerebral palsy) and medical conditions (e.g., meningitis). Intellectual functioning is generally called intelligence and includes a wide range of mental activities such as the ability of logical reasoning and practical intelligence (problem-solving), ability in learning, verbal skills, and so on. It manifests and expresses itself through a numerous set of capabilities, behaviors, thoughts, and emotions. In other words, intellectual functioning is definable as the global ability that allows the individual to understand reality and interact with it. These disabilities express as lacking competence in social, conceptual, and practical skills. Social skills include interpersonal skills, social responsibility, self-esteem, gullibility, naivety, resolution of social problems, and the ability to follow the rules of the society and to obey the laws. Conceptual skills include the ability to understand time, finance, and language. Practical skills include the ability to use tools, carry out activities of daily living, and interact with other people. All these skills are learned throughout development and performed in response to common problems and simple/complex tasks as well as expectations from our community and society.

A project called "Sport through the Senses" was carried out at the rehabilitation unit of "San Carlo"

Hospital in Potenza (IT) in collaboration with the Italian Paralympic Committee. ^[1] The project included Karate among its disciplines. The rehabilitation program's title was "Let's kick the disease". The simplicity of the protocol allowed to collect numerous scientific observations with qualitative assessments of specific exercises, from which valid and general indications were identified and proposed to subjects affected by intellectual-relational disabilities, with regard to:

1. training methodology to adopt in athletes who are starting to practice in the international Paralympic scene;
2. teaching methodology to provide in order to facilitate learning processes.

Inclusive teaching and specific rehabilitation were incorporated. Specific movement patterns that are often deeply limited in disability but naturally understood and acquired as specific basic skills in normal athletes, were privileged. Delayed learning of motor gestures was detected as the cause of execution difficulty that is observed in athletes with disability; for this reason, all those strategies useful to improve and consolidate assigned task were put into practice.

At first, elementary and preparatory positions (from bi- to uni-podal) were chosen to optimize balance and stability in the execution of kicks, until the athletes acquired the technical-specific knowledge through practice. Adopting Karate stances may not seem particularly useful in modern competitions compare to rapid movement and execution techniques; however, when taking up the sport, they are of considerable effectiveness in disabled sportsmen. Adopting these stances helps maintain body balance in a not always solid or safe basis in disability cases. Training stances allowed to use lower limbs more and to acquire agility and postural patterns specific to the discipline.

In order to stimulate the cognitive system, a simple form of observation was proposed, which can be defined as ideo-motor training, based on:

- imitation learning or modeling, gesture visualization - focused on the processes of "modeling" between an observed model and an observer learner - and mental representation (imagery), which facilitates acquisition of movement and optimizes physical execution (Miller & Dollard, 1941, p. 267; Bandura & Kupers, 1964, p. 2);
- verbal communication for a better understanding of what must be performed;
- quality of performance understanding, in order to allow movement and actuation of specific tasks to comply with criteria of proper execution, as much as possible considering cognitive disability;
- involvement, in addition to lower limbs, of upper limb movement with implication of visual feedback and oculus-manual coordination, which were evaluated with apraxia specific tests (Rodrigo, 2014, p. 27).

Material & methods

Participants and research procedure

Twelve participants, heterogeneous for age and sex, were examined. They presented mild-moderate cognitive-intellectual-relational disability, homogeneous in terms of disability and characteristics, who were able to sustain adequate periods of attention (at least 25 min of continuous practice) and to perform the technical tasks assigned with sufficient correctness. The imperfect execution of a specific movement was not considered a penalizing exclusion criteria, while lack of understanding of the movement that had to be performed was considered so. Subjects with disability who take part in the Karate Paralympic competitions, have a Kata execution level (practice of correct forms and postures) that corresponds to the "yellow value", that indicates an average manifestation of disability with a + 0,2 additional score that must be added to the total valid points, according to FIJLKAM/WKF regulation.

During the seven months of experimentation, 4 participants with moderate intellectual-relational disabilities were excluded because they were unable to maintain sufficient compliance to prescribed exercises; the remaining eight people were particularly motivated whilst carrying out the exercises. In order to avoid creating further inequality conditions in non-participants, no control group was created to perform simplified exercises compared to the administered protocol.

Considering the subjects' disability category, the team decided to avoid exceeding in information inputs that could have created confusion, respecting the individuals' learning times. All participants gave informed consent to participation. This research was approved by the Independent Ethics Committee of the Tor Vergata University Hospital (Rome, Italy) and conducted according to the Declaration of Helsinki.

Instrumentation

A specific stabilometric platform (SP) was used in the study (Balance System SD, Biodex Medical Systems Inc., Shirley - New York) to measure and improve balance, load displacement, ROM of specific movements and proprioception (Fig. I) (Arnold & Schmitz, 1998, p. 323).



Fig. I: Balance system SD (Biodex Medical Systems Inc., Shirley - New York).

This tool allowed to assess neuromuscular control and to estimate the capacity of maintaining postural stability in mono-podal or bi-podal stances on a stable or unstable surface. Its function is based on fact that our feet act as a fulcrum, as the head moves with a certain frequency. This system, in addition to measuring medial-lateral displacement *along the frontal plane* (right-left) and anterior-posterior displacement *along the sagittal plane* (forwards-backwards), also checks and records if they correspond or not to the frequency of oscillations that characterizes the human body. The relevant measured parameters were: anterior-posterior stability index, medial-lateral stability index and overall stability index values.

Tests and Evaluations

Postural stability tests were carried out with the SP, for each of the eight participants in the program (Arnold & Schmitz, 1998, p. 323). To reduce learning effects, the test on the circular platform was carried out by making the athletes perform three equal tests with the specific goal of maintaining an upright position for 20s, with a 10s pause between each test. The mean value of these tests was calculated automatically by the instruments' system. Each patient was asked to obtain and maintain a comfortable position on the SP, with their feet and shoulders aligned throughout the test (Fig. II), before administration of the specific exercise protocol (T0) and at the end (T1).



Fig. II: Subject position on stabilometric platform (SP)

The meaning of the test was then illustrated and of the own body's centre of gravity was identified on video. The test consisted of making the centre of gravity coincide and keep as close as possible to the central point of the dial that appeared on screen; the individuals were encouraged to self-adjust their posture, following the display which offered the needed feedback to control their body position in every moment, in order to facilitate understanding and reproduction of specific movement patterns. In addition to recording the value of platform stability, foot position, height and age, the machine processed the data by providing a colour image with graphic correspondence of all centre of gravity movements that occurred around the central point up to the objective's achievement.

The system offered data regarding control of general direction, of various directions and execution time: if the required time was less, the performance was considered better with the same foot positions and SP level of difficulty.

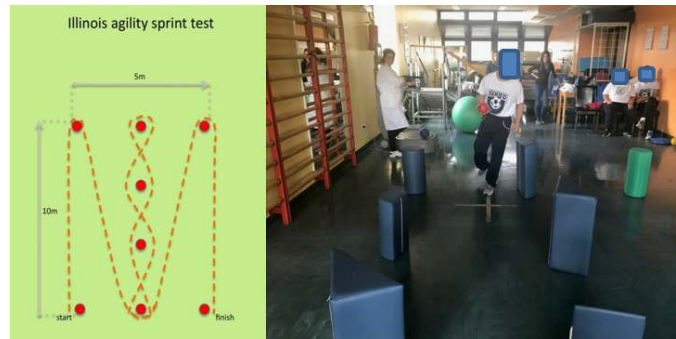


Fig. III: Illinois agility test.

The Illinois agility test (Fig. III) was used to increase speed. It examines the disabled athlete's ability to turn in different directions and angles: the aim is to complete a path (10 x 5 m) with different motor tasks in the shortest time possible, without knocking down the cones, in a dedicated space and after an organic-functional preparation.

The Florida Apraxia Screening Test – (FAST) was used as an easily applicable clinical tool. It was applied for a qualitative analysis of the disabled athlete's motor performance. The test was very useful in improving attention and the apraxic component. The evaluations concerned:

1. percentage of time spent (Fig. IV, Fig. V) in four quadrants (I-II- III-IV);
2. time per zone (A, B, C, D respectively);
3. lateral-medial index (effective score);
4. anterior-posterior index (effective score);
5. overall stability index (effective score);

The tests' analysis and evaluations allowed to work on: timing, proprioception, balance, motor acts, movement, muscle action, speed and agility, attention and apraxia components (De Renzi, Motti et al, 1980, p.6; De Renzi, Pieczuro et al, 1968, p. 43).

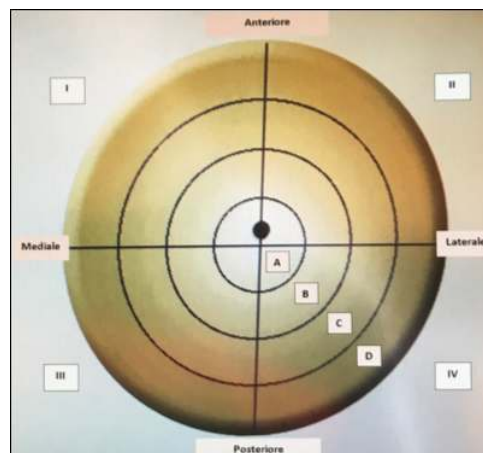


Fig. IV: The four quadrants of the test.

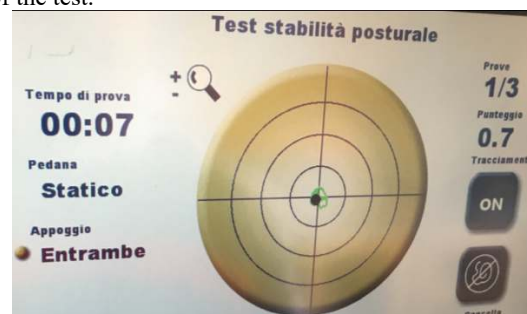


Fig. V: example of SP test.

Rehabilitation Protocol and Performance

The protocol allowed participants to practice positions with a dynamic method rather than a static one. The aim

was to transfer postural mechanical load and motor activation to the left half of the body, to compensate excess of body permanence in the right area at the SP test. In order to optimize balance and improve moving ability, the pilot study was focused on "natural positions" of Karate, which ensure such a stability that they allow to perform any movement in any trajectory or direction (Miller & Dollard, 1941, p. 267). The study was also focused on less stable "specific postural positions", which required a considerable balance practice.



Fig. VI: Hachiji-Dachi or Shinzen-Tai position.

The administration of specific exercises consisted of at least 15 min sessions of six preparatory levels of postural patterns, from "natural to specific" with increasing difficulty, starting from bi-podal positions (Shinzen-Tai) to mono-podal ones (Ashi-Dachi), and in which maximum achievement was represented by maintaining position for 10 s, thus requiring very advanced segmental coordination. The most stable position was in bi-podal support, precisely in Hachiji-Dachi or Shinzen-Tai (Fig. VI), which consisted in the natural body position, standing upright with upper limbs relaxed along the trunk and clenched fists. The feet with tip of the toes spread apart (on a transverse axis) formed a space equal to shoulder width; the centre of gravity projection fell within the stance polygon and body weight was evenly distributed on lower limbs. In this position, the subject performed all the arm techniques before learning dynamics of various movements to produce a superior level of coordination.

The second level of exercise was represented by the "lowercase L" postural position named Renoji-Dachi (Fig. VII) where heels were almost aligned on the sagittal axis. The difficulty increased even more in third level exercises, particularly in the "T" position called Teiji-Dachi (Fig. VIII) in which the backward foot was perpendicular to the forward one.



Fig. VII: Renoji-Dachi position.



Fig. VIII: Teiji-Dachi position.

Balance precariousness in bi-podal support increased in the specific execution the Neko-Ashi-Dachi posture (Fig. IX), where the trunk was positioned backwards and body weight was 90% on rear limb and only 10% on the forefoot segment of the anteriorly positioned foot, thus limiting the base area.

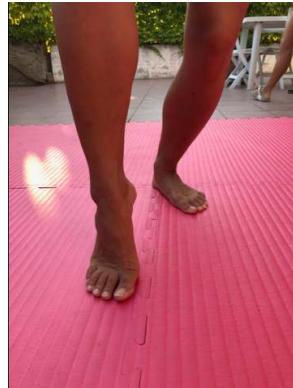


Fig. 9: Neko-Ashi-Dachi position

Fifth and sixth levels were characterized by the Ashi-Dachi posture (Fig. X, Fig. XI), a generic term that indicates mono-podal stance positions (right Migi or left Hidari). From the position shown in Fig. X (indicating the lower limb loading on the sagittal plane with thigh and knee flexion and consequent complete closing of angles), frontal kick can be performed (Mae-geri); the foot can take on 3 different "anatomical forms" depending on its use: neutral, in plantarflexion and in dorsiflexion. It is possible to perform different types of kicks switching from position in Fig. X to position in Fig. XI, with a 180° external rotation of the weight bearing foot on sagittal axis respect to the execution trajectory.



Fig. 10: Ashi-Dachi position

^[1] This postural change allows to free the coxo-femoral joint in such a way that the specific motor action ends with knee extension, reaching the target with instep or sole of the foot, depending if it's a circular kick (*Mawashi-geri*) or an inverted circular kick (*Ura Mashi geri*).

Learning often takes place by imitation, as well as by procedural/sequential techniques and experience, even in intellectual-relational disability (Hickok, 2015, p. 476). Therefore, the protocol was provided for simple Kata-like performances, in which simulation and execution of gestures, movements and postures specific to the discipline were carried out.

The subjects who performed the test had to carry out 20 significant karate specific actions in which a lower limb was used to perform complex motor patterns (for example, the execution of a circular kick). The subjects also carried out 10 not significant actions (for example daily actions, even of involuntary nature) using only upper limbs and through a simple motor scheme (for example, touching the face). The success of these actions determined a final score on the FAST test. The previously mentioned karate specific actions were considered specific to ideo-motor apraxia evaluation. The comparison was made between:

1. information present in short- and long-term memory (what they learned about positions);
2. programming and choice of motor act (what/ how they perform it);
3. feedback information.

The FAST test and Karate have similar evaluation and executive elements. The specific gestures, in

which a lower limb was used, allowed to evaluate:

1. 1. errors in gesture content;
2. 2. spatial errors;
3. 3. timing errors;
4. 4. other errors.

The content errors (related to the mild intellectual-relational disability) included:

1. 1. error persistence;
2. 2. correct actions but not corresponding to those required;
3. 3. not well executed and not required actions.

Timing errors included:

1. 1. sequence errors;
2. 2. gesture removal errors;
3. 3. additional gesture errors.

Spatial errors include:

1. 1. errors of movement amplitude;
2. 2. internal configuration errors (between lower limbs);
3. 3. external configuration errors (contact between lower limb and ground).

Other errors:

1. 1. non-recognizable responses;
2. 2. approximate responses;
3. 3. incomplete answers.

Detecting these errors allowed to work on attention and motor action, improving basic levels.

Results

Results showed slight improvements in test scores since the subjects increased the number of karate specific actions from 1 to 5 compare to initial values. A slight decrease was observed in the number of errors. Speed and agility improved in the range from 0 to 10 s too.

100% of participants were right-handed; initial evaluation (Fig. V) on SP showed an average of 54% of time spent on the lower right quadrant, 23% on the upper right quadrant, 14% on the lower left quadrant and 9% on the upper left quadrant. The data indicated that 77% of subjects had an increased weight unload on the right half of the body and only 23% on left one. Although it was not the primary objective to modify timing on base area (obtained by the SP) it seemed interesting to highlight what was observed in seven months of work with participants.

For each one of the eight subjects, after administration of the exercise protocol on specific positions of the discipline, a balance inclination from right quadrants towards left quadrants respect to initial average was observed. The evaluation took place on the SP within 10 minutes from the end of exercise protocol performance.

	BASELINE ASSESSMENT PRE-TRAINING				BASELINE ASSESSMENT POST-TRAINING			
	<i>Actual score</i>				<i>Actual score</i>			
General stability index	1.5				1.0			
Anterior/posterior index	1.1				0.8			
Medial/lateral index	1				0.5			
% time in zone	A 100	B 0	B 0	D 0	A 100	B 0	C 0	D 0
% time in quadrant	I 9	II 23	III 14	IV 54	I 9	II 21	III 42	IV 28

Table I: average of the results obtained from the stability tests.

Table I shows changes compare to baseline data:

1. 1. movement to the left in subjects with predominant right base;
2. 2. there was no change in the I quadrant;
3. 3. significant improvement in general stability indexes.

Performing positions was an appropriate form of contact with the ground and a first approach to the discipline. Moreover, it was possible to verify how simple exercises were able to change permanence modalities in various areas of plantar unloading, due to the proprioception and balance training carried out at same time.

Discussion

The results showed improvements concerning qualities of both motor and sensory-cognitive nature. Including simple specific exercises in experimental studies for intellectual-relational disability or in a hospital rehabilitation context should encourage research studies on neuroplasticity phenomena.

It is important to consider that a certain percentage of bradykinesia coexists with the apraxic component. This allowed to affirm that, thanks to education of basic positions (measured in relation to intellectual-relational disability), it was possible to improve timing and agility at the same time, facilitating coordination skills. The study revealed that doing Karate or its-related exercises represents not only the practice of a sport oriented to the Paralympic competition, but above all of a discipline that facilitates the rehabilitation process of different abilities, potentially projected towards neuromotor and neuroplastic improvements. Moreover, it would be interesting to further study elements that characterize limited capacities of such patients.

Further evaluations are underway to determine whether improvement is maintained through practice or if it undergoes a drop-out effect with exercise abandonment.

Conclusions

The observed improvements were of motor and sensory-cognitive nature. Karate can be considered a means of maintaining specific skills and a rehabilitation tool in disability cases. A control group between T0 (before protocol) and T1 (after protocol) was not provided, because of poor compliance of the sample and in order to avoid creating further disadvantages. A control group could have eventually confirmed improvement variations obtained both from a motor and sensory-cognitive point of view. Statistical analysis (parametric and non-parametric) was not used in this study, which could have given greater significance to the identified values.

Karate is therefore configured both as means to maintain specific skills and as a rehabilitation tool in disability cases, beyond the concept of winning in sports.

Conflicts of interest - The author(s) declared no potential conflicts of interest.

References:

- Arnold, B. L., Schmitz, R. J. (1998). Examination of balance measures produced by the biodex stability system. *Jour of athl train.* **33**(4), 323–327;
- Bandura, A., Kupers, C. J. (1964). Transmission of patterns of self-reinforcement through modeling. *Jour of Abn and Soc Psyc.* **69**(1), 1–9;
- De Renzi, E., Motti, F., Nichelli, P. (1980). Imitating gestures. A quantitative approach to ideomotor apraxia. *Arch Neurol.* **37**(2), 6–10;
- De Renzi, E., Pieczuro, A., Vignolo, L. A. (1968). Ideational apraxia: a quantitative study. *Neuropsych.* **6**(3), 41–52;
- Hickok, G. (2015). The motor system's contribution to perception and understanding actions: clarifying mirror neuron myths and misunderstandings. *Lang and Cogn.* **7**(3), 476–484.
- Miller, N. E., Dollard, J. (1941). Social Learning and Imitation. *Ann of Amer Acad of Polit and Soc Sc.* **220**(1), 267–268;
- Rodrigo, P. (2014). See and touch. Optics, haptics and visuals at Merleau-Ponty. *Metis Presses*, Geneve, pp 27–41;