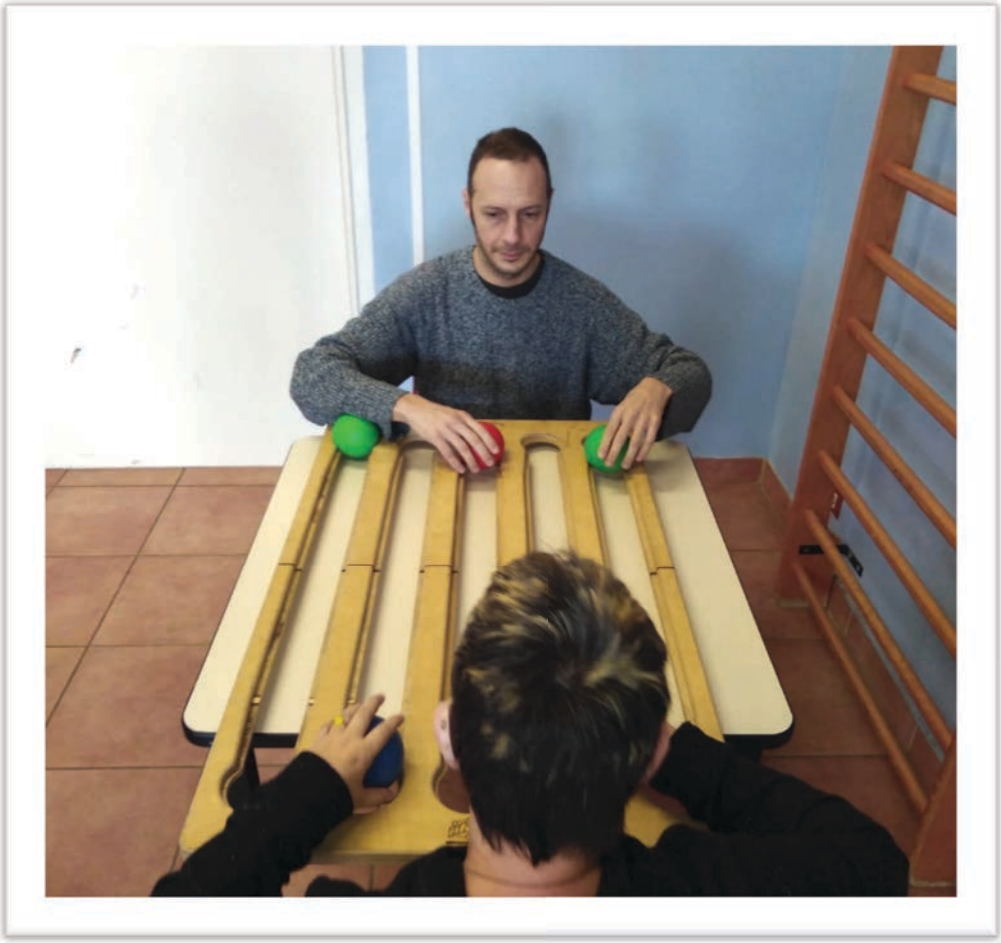
Lapo Botteri

Study of the effects of Juggling sessions with the juggleboard on subjects with intellectual disability



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Abstract. The aim of this study is to highlight a first monitoring session of the effects produced by working with the juggleboard, created by Craig Quat, applied to the development of specific technical abilities of Juggling, transposed on general motor abilities in working with disabled people. The study itself has been carried out on subjects with mid-to-high motor abilities and medium intellectual disabilities. The work has been valued with motor test given at the beginning and at the end of each working session. The results of the study highlight that the activity of Juggling with the juggleboard helps developing specific technic abilities and improves motor sequencing abilities and responsiveness to oculo-manual input of the participants.

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Introduction

It is more than fourteen years that I have been teaching Educational Ludic Circus (Youth Circus), but when I started the discipline did not have a proper name, it was generally called “Circus”. I worked with the most important group of Italian specialized operators, to develop and spread a new teaching method, new exercises and feedback strategies. However, the Association that always put itself as referent for this new and polyhedral world is “Giocolieri e Dintorni” (www.jugglingmagazine.it).
In April 2016, during a Social Circus conference in the convention “Altra Risorsa” given in Florence by AltroCirco (www.altrocirco.it), I had the pleasure to meet Craig Michael Quat, who presented his method for the first time to an Italian audience.
I soon got keen on his teaching proposals, especially on the use of one of his props (that can be defined as educational objects): the juggleboard. After two years of intensive work and experimentation of his approach, I decided to test and witness in an objective way the efficiency of this working method.
This work is an analysis of the application and the results of this method.

Credits

My thanks go to the Centro Terapeutico Europeo (European Therapeutic Centre, ETC) of Torri (Rignano sull’Arno, Florence, Italy) for believing in the project and supporting me logistically and financially, assisting me with their human resources, both with the staff and with their users.
I also thank Craig Michael Quat who helped me in a very professional way and willingness to choose the best tests to use in the project; Antonio Celso Pereira Varela, for having shared his first european study on the juggleboard with me.
Manuela Vinci for the creation of the charts; Marco Mazzoni for the suggestions and the supervision and Silvia Cavalletto for the translations.
Claudia Brandani, Christian Poggiolesi and Valentina Sechi for the correction of the drafts.
I finally thank Massimo Piccione for the final review and the layout.

1. Educational Ludic Circus and Juggling

The notion of "Educational Ludic Circus" (ELC, Youth Circus) is constantly evolving. The main idea involves the use of circus disciplines, deconstructed and contextualized to an educational and motor sector/area. To give an etymological analysis of the expression, it is useful to split it up into its three semantic components, to give to each of them an exhaustive definition (*Chart 1*).

Chart 1. Definition of Educational Ludic Circus.

Educational	**Ludic**	**Circus**
Explains the learning dimension and the individual development. Linked to the term "ludic", it gives a holistic/integrate value to the activity.	Underlines the non-competitive value of the activity. It directly refers to spontaneous motor, intended to a pleasure moment of learning.	It is the context from which the didactic proposals are taken from. It can be defined as the motor component of this activity.

Since its beginning, ELC has proved to be a very effective resource as far as learning is concerned, especially in experience-based and non-competitive learning. ELC is adaptable, oblique and transversal; its strength lies in its amusing and engaging proposals.
ELC main goal is the global development of the individual, intending to increase and improve personal motion abilities, social skills and management of emotions.

1.1 Educational Ludic Circus disciplines

It is not easy to list all the various activities and exercises concerning ELC, since it owes its changing and multifaceted aspect to various artistic and sports disciplines, with the result of integrating them. However, if we want to give a general definition of its guidelines, we can select four basic disciplines. As reference points, there are:

- Acrobatics;
- Clowning;
- Balancing;
- Juggling.

This four main disciplines develop different motor abilities and are usually integrated and mixed to one another in a learning program, which can have adjustable last and goals.

1.2 Juggling

With the word "Juggling" we commonly mean "the ability to throw several objects up into the air, and then catch and throw them up repeatedly" or "the ability to do dexterity games with objects". This is the definition for a really wide discipline that includes numerous elements. It is a heterogeneous whole of diverse abilities, both for the types of objects involved and for the use we make of them.
However, a common element in the employment of the various objects is the complex ideo-motor scheme and the fine coordination required to accomplish all the Juggling movements.
Among the disciplines that shape ELC, I give preference to Juggling, inasmuch it is an activity that does not require particular preconditions and is not dangerous, but, on the other hand, has a strong impact as far as development of neural plasticity is concerned.

1.3 Juggling and Neuroscience

During the last fifteen years, studies on brain and neural system functions (Neuroscience) have exponentially increased, thanks to the new and more successful analysis tools, which allowed to deeper and unexpected researches. Juggling has been frequently used as an analysis tool for brain processing activities, having been recognized as complex oculo-manual activity, implying the involvement of multiple sensory information.
This evidence generated a series of certified scientific documents, that are now directing new educational studies about this "old-fashioned" discipline, expanding its goals and creating a much more efficient methodology.
Below, there are some of the most interesting researches carried out on this topic (available in full in the Bibliography) Draganski 2004; Boyke 2008; Schiavone 2015; Filho 2016. At this stage, I think it is important to include the results that came out from a study carried out by Boyke, Driemeyer, Gaser, *et alii*, entitled "Training-Induced Brain Structure Changes in the Elderly".
The study shows the change of cerebral white matter after a specific (Juggling) training, highlighting two aspects which resulted paramount for our group:

- *The study is carried out on the "waterfall" exercise* (basic Juggling exercise with three balls), performed by beginners. We actually do not have idea of what happens to the brain of an expert juggler, who, although having already acquired basic schemes, is always in a process of learning, trying to achieve faster and more complex combination. However, it is easy to assume that the higher is the brain planning required, the higher will be the development of cerebral hemispheres connection;
- *The percentage of success of the motor action is not directly linked to the development of cerebral white matter development.* According to that, it is possible to deduce that neural benefits derives not from the execution of the motor action and the feedbacks, but from the planning itself. This hypothesis will lead to focus the attention on the planning activity and on visualizing the movements, pushing aside the increasing abilities required for the various technical performances. On this assumption we base the development of concepts like Functional Juggling and Inclusive Juggling.

1.4 Functional Juggling and Inclusive Juggling

With "Functional Juggling" we mean the use of the Juggling activity to develop individual motor skills.
It differs from traditional Juggling because it is focused on learning process instead of on the potential results. Functional Juggling can be applied in a wide range of modalities, such as structures or mechanical systems (like the props) that enlarge its availability, in contrast with traditional methods.
The definition "Inclusive Juggling" implies the adaptation or the adjustment of Juggling, with the purpose of improving its accessibility to any type of user.

1.5 Juggling and "life skills"

An impressive aspect of Juggling is its response it shows in the life skills (psychosocial and emotional life skills). This characteristic deeply caught my attention, and it is what support my will of researching new educational techniques and spreading this discipline.
There is no doubt every motor activity, ELC in particular, helps developing social and motor abilities in every training subject. Nevertheless, this study has also the aim to ascertain the specific effects the Juggling has on this topic, mostly, as far as I am concerned, on two specific life skills: Self-awareness and Stress Management.

1.5.1 Self-awareness

Juggling quickly brings every training subject to an awareness of individual limits. The activity is therefore linked to the acceptance of individual limits and to a consequent increase of self-confidence.
A common aspect for the beginners is to divide the exercise into “easy ones”, “difficult ones” and “impossible ones”, while an expert juggler quantifies the complexity of an exercise in time (“How much will it take for me to achieve this new trick, if I train twice a week?”).
Oculo-manual abilities, reactivity and coordination are extremely useful skills in everyday life; rising the awareness of individual touch-sensitiveness with the surrounding environment inevitably increase self-confidence. This is a crucial concept concerning disability, especially in cases where subjects are unable to use everyday objects, like pens, forks or glasses.

1.5.2 Stress Management

Learning new and exponentially complex oculo-manual coordination exercises necessarily brings the body to a stage of stress. Stress walks along with a juggler daily training; being able to prevent and control it is essential in the growth-path of this activity.
Every time we front a new learning pathway, satisfaction and frustration feeling are involved. An adjusted and focused pedagogy helps in the managements of those feelings. Pedagogy alone is not enough, though. The learner has to put her/himself out there, learning in a conscious and careful way how to manage working session and cool-down moments, analyzing and highlighting positive mistakes, while avoiding the unconstructive ones.
The turning point in stress management is the juggler will to achieve her/his goals and the sensation of pleasure deriving from training. Mixing up all those elements will give as a result a profitable and gratifying training sessions. Conversely, a badly set session with a wrong connection with the body, will lead to stress and anxiety.
Juggling exercises related to stress management are:

- Breathing exercises;
- Muscle tension awareness exercises;
- Meditation/visualization of the movements;
- Movements analysis;
- Preparatory exercises with facilitative objects or partners.

Practicing in awareness, consciousness and good teachers generate gratified jugglers. Stress management acquired in Juggling trainings is fully-fledged a life skill, so it is transferable to the various abilities linked to everyday life.

2. Craig Quat and his method

Craig Michael Quat is a juggler and a ELC teacher who has been recognized as the most innovative circus educationalist on international levels of the last years. Craig Quat was born and grew up in New Jersey and he first approached circus at the age of nine.
His peculiar personality and the various experiences he went through during his first years in circus defined his social attitude and emphasized his need of a circus pedagogy, especially as far as Juggling was concerned, which, from his point of view, should have been much more structured and effective than the already existing methods.



For further studies, Craig Quat interview in Italian translation is available on www.jugglingmagazine.it/circo-sociale/studi-e-ricerche/craig-quat/.
After years of studying and experimentation on new methods and new props, Quat received a few important recognitions:

- in 2016 Quat received the INAP (International Naturally Autistic People) AWARD for the excellence in Technology;
- in 2018 he became the art consultant of the Cirque du Soleil for the interactive pavilion of Juggling in Montreal Circus Museum (Canada).

2.1 Quat's method

During his career, Quat developed a teaching method based on the neuroplastic value of Juggling (Functional Juggling) and on a deeply accessible Pedagogy (Inclusive Juggling), stressing aspects in the development of the discipline of Juggling methodology, which had been undervalued until that moment.
They are:

- Non-linear and non-verbal facilitating techniques;
- Motivational and emotional regulation in time;
- Proximal development zone (see Lev Semënovič Vygotskij) and stimulation of the flux state;
- Learning base process based on recorded results;
- Facilitating methods for the sensorial integration (*Sensorial Integration Facilitation Technique*, SIFT);
- Social and cognitive implications in Juggling;
- Benefit and therapeutic applications of Functional Juggling.

All this points were mixed up to create a new, balanced teaching method, which can be adopted in various learning experiences. This new method is remarkably effective and offers a new structure, which makes Juggling available to everybody.

2.2 Quat Props

The term "Quat Props" identifies all the objects invented or readapted by Craig Quat, in order to facilitate all the movements concerning Juggling.
As said before, the creation of an ideo-motor sequence aimed to realize a Juggling movement can often give problems to able-bodied and result inaccessible to people with disabilities.
This objects' function is to slow down, deconstruct and partially accomplish the aforesaid movements, giving the nervous system time to analyses, record and eventually replicate the specific movements.
There are different props with diversified functions, all self-made and privately replicable.
The most efficient prop, which also sums up all the functional aspects of all the other multiple props, is the juggleboard.

2.3 The juggleboard

The juggleboard is a rectangular wooden table, designed to allow the rolling of the Juggling balls.
It is divided in five rows, each of ninety centimeters of length and eight centimeters of width.
The rows narrows at the extremity of the table, emphasizing the friction effect and, consequently, decelerating the balls.
Each row begins and ends with a "pocket", that is a hole where the balls stop.
The balls can be moved by the juggler's strength or by the gravity, depending on the conditions for use of the table.

The largest part of the exercises that can be made with the juggleboard have been catalogued and written in specific alphanumerical transcription, known with the name of Prop Swap Notation.

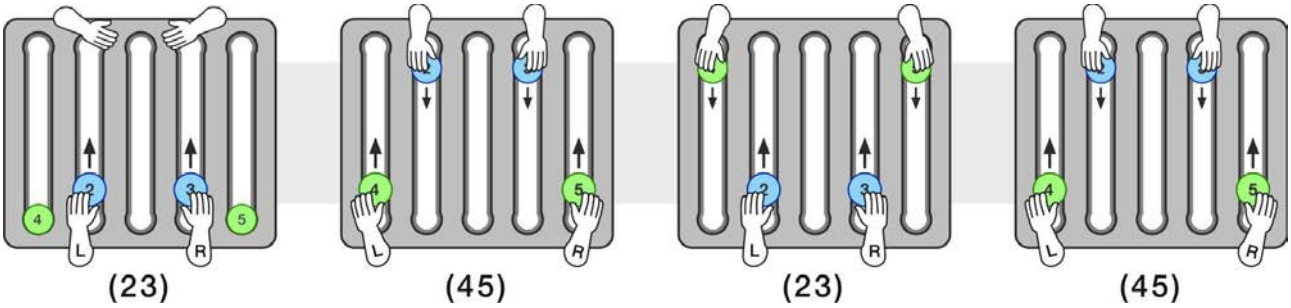


The schemes resulting from the juggleboard application are divided in two main groups: "closed schemes", in which the balls never change their row, and "opened schemes" in which the balls are moved from one row to another.
The board can be used horizontally or vertically. There are various exercises that can be applied in both the modalities. However, I will only describe the basic ones.
The juggleboard can be handmade, as all the other props. However, using an industrial professional table, increase the level of performance of the work that can be proposed.
The reported analysis has been made using the juggleboard produced by Playjuggling Italia (Play srl), the only producer recognized by Craig Quat method.

2.4 Use of the juggleboard

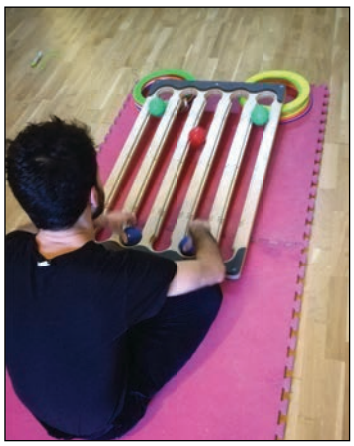
2.4.1 Vertical modality

With this term we mean the use of the juggleboard fronting its shorten side. This mode can be practiced alone or in couple. The vertical mode has a numerical notation; each scheme responds to a series of numbers which indicate the rows in which the balls are moving.
The various schemes can be summed up with transitional rolling, creating scheme sequences.
The *Primary composition* is the sequence of basic closed schemes, that includes all the movements that stimulate the space-time elements.



Vertical modality couple exercises
When two people front the shorten extremities of the juggleboard, the roles are often established: the facilitator (who conducts the session) and the participant (who follows the session).
The facilitator's role is to regulate the speed of the exercises, according to the abilities of the participant; the aim is to leave her/him to an individual work.
In the couple modality, both the closed and the open modalities can be applied.

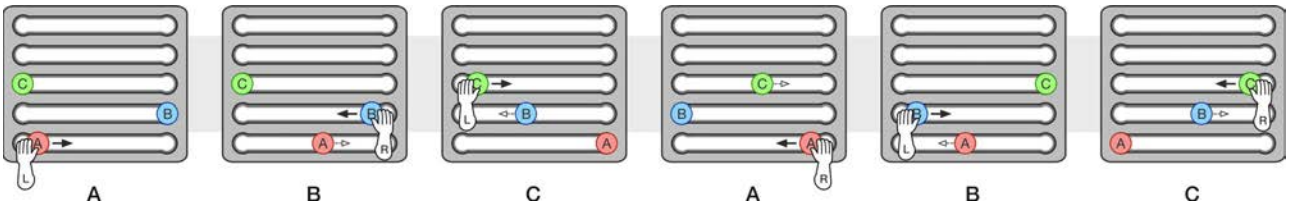




Vertical modality solo exercises
This exercises are usually practiced after one or more couple sessions. The notation is the same, but limited to the closed schemes.
The higher is the tilt of the board, the higher will be strength the participants need to make the balls roll. A higher tilt also increases their return speed.
The individual work requires a higher familiarity with the juggleboard and it is usually proposed when the participant shows a stronger confidence with the object, being able to cope with the eventual stress required by a Juggling training session.
The first sessions of individual work can be facilitated by an external support.

2.4.2 Horizontal modality

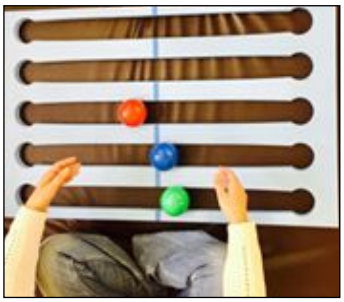
With this term we mean the use of the juggleboard fronting the longer side. It can be practiced alone or in couple. In this case the notation is alphabetic; each scheme responds to a series of letters that indicates the rows in which the balls move.



Horizontal modality couple exercises
In this mode, each juggler sits in front of one of the two longer side of the board. They make combined or synchronized movements, making the balls roll and using other Juggling objects or objects of ordinary use in the various Juggling schemes.
This kind of exercises have numerous variations and they are normally introduced after the vertical mode.
The horizontal mode exercises are very powerful instruments to interact more directly with the participant. They also offer more complex actions, in a more interactive and imaginative way, also because of the use of different objects.



Horizontal modality solo exercises
This kind of exercises are one of the stronger points of Quat Props Method. At this stage of work, the participant manage independently the balls movements.
In this situation, the participant has to deal with his/her performance anxiety and to cope with the deriving stress.



2.5 Juggleboard strong points

The juggleboard is a very versatile device and has various ways of employment. Thanks to his great availability, it can be proposed to everyone: children, aged people, people with disabilities, beginners and experts.
It is possible to distinguish four main strong points of the juggleboard. They are:

- *Easy comprehension of the task*: in the vertical working methods in couple exercises, the participant is only asked to push back the balls to the facilitator. This passive involvement, however, requires a good involvement of motor coordination skills;
- *Communication conveyed by the passing of the objects:* passing objects is officially considered a non-verbal form of communication. Through the juggleboard schemes, the participant and the facilitator establish a connection;
- *Transverse proposal*: the various working modalities of the juggleboard are all easily adjustable to different stages of complexity, starting from basic motions to proper technicality;
- *Amusing and motivating working conditions:* the neuro-motorial amount of work with the juggleboard is partially reduced by the deeply playful aspect of this activity. If the facilitation is correct, the participant improves exponentially her/his ability to respond to the various motor stimulation without actually realize it.



So far, the only study which demonstrate the positive effects of the juggleboard is "Beneficios de los juegos malabares adaptados en personas mayors" by Celso Antonio Pereira Varela, published in 2017 by the Educational Sciences Department of Vigo University (ES).
Pererira Varela demonstrates that practicing with the juggleboard improves the oculo-manual responsiveness, physical coordination, postural monitoring, rhythmic coordination, tonic monitoring and execution time of the various movements in aged people. For further insights, in attachment there is Pereira Varela's study (Pereira Varela 2017).

3. The project on the use of juggleboard

The main target of this project is to highlight a first monitoring of the effects of working with juggleboard with disabled people, applied to the development of specific technical abilities, transposed to general motor abilities.
The idea of this project came out from a scrupulous study of Quat's method and after two years of application of the juggleboard in multiple contexts.
Stimulated by the Valera's studies, I decided to test, as objectively as possible, but in an unusual context, that is working with disable subjects, the obvious results that I was already appreciating after each working session with the juggleboard, and try to give an objective outcome in my study.
One of the differences between my study and Varela's one, is the methodology: while Varela used the same technical proposals scheme for all the subjects, I decided to adapt the proposal of a session on the results of the preceding session.
That created a work system oriented on general guidelines (goals), but with a differentiation of physical proposals for each subject.
I decided to propose the project to the ETC of Torri (Rignano sull'Arno, Florence).
For two years the ETC has been supporting the work of ELC with disabled people, and the work groups that took part in the workshops proved to be ready and perceptive to a more structured proposal.
Up to that point, the work of ELC wasn't centered on the use of the juggleboard, but on the development of the postural maintenance, so that the juggleboard was presented occasionally and sporadically, without a pre-set schedule and planned objectives. It was mostly used as recreational than functional activity.

The average time spent using the juggleboard could be approximately of ten minutes per user within a year. With the word "user", I indicate both the members of what will later be called the Working group and the Sample group.
The group of users available to participate to the project counted about thirty subjects. A selection was made together with the staff of ETC and two groups of six elements each were created. The members of each group were similar in physical skills and intellectual abilities. The standard chosen for the subjects was a medium-high motor skill and average cognitive delay.
The groups were also created according to the attendance frequency of the Centre by the users during the summer months.
The users who had ensured their presence were included in the Working group, the others in the Sample group.
Once the two groups had been identified, the main goals were planned and agreed with the rehab staff, the working space was selected and the project began.

3.1 Working group

The members of the Working group will be identified using only the initials of their first and last name, to respect their privacy:

- C.S. male subject, 23 years old, average mental retardation, slight form of physical development delay;
- D.C. female subject, 23 years old, average mental retardation, decision-making and motivational difficulties, overweight;
- L.L. male subject, 45 years old, average mental retardation;
- C.T. male subject, 40 years old, average mental retardation, overweight;
- K.M. female subject, 15 years old, average mental retardation; she is subjected to a pharmacological therapy that decreases her learning processes;
- G.V. female subject, 17 years old, average metal disorder, low motivation to physical activity.

The six subjects have been selected by three different user groups: the day-frequency group, the minors residential group and the adults residential group.

3.2 Sample group

Even the users of Sample group have been selected by their psycho-physical abilities, in line with the Working group; they also attend the Center, although they are sort in the three previously listed groups. During the period of study, while the Working group was participating in sessions, the Sample group did normal daily activity (*Chart 2*).

Chart 2. Aspects of the first draft study of the use of juggleboard on subjects with intellectual disabilities.

Number of participants	12 users
Working group	6 users
Sample group	6 users
Characteristics of the users	- Medium/high motor skills - Medium cognitive delay
Number of meetings	14
Frequency of meetings	Bi-weekly
Number of tests	2 (first test/final test)
Number of working sessions	12
Length of a session	10 minutes individuals
Total working length	120 minutes per user

3.3 The goals of the project

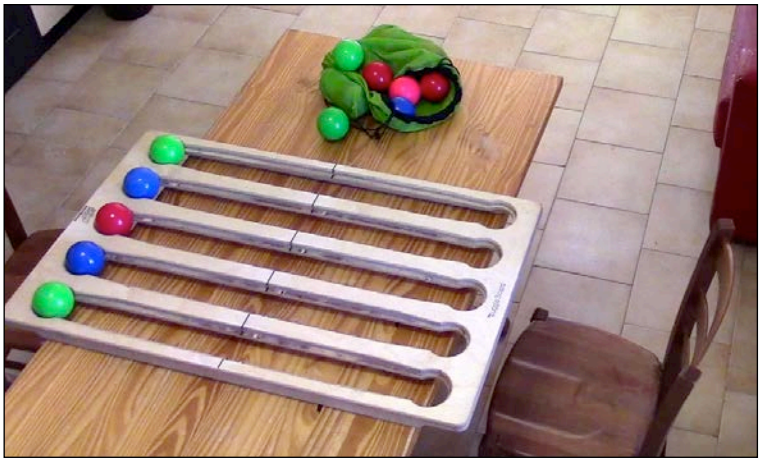
It is possible to divide the targets of my Juggling project with the use of the juggleboard into general, specific and technical goals.

3.3.1 General goals
The general goals of the project were:
- Motor skills development;
- Qualitative and quantitative increase of the attention abilities;
- Acquire the Juggling of technical abilities.

3.3.2 Specific goals
The specific goals of the project were:
- Learn new oculo-manual skills, simple and complex;
- Optimize the tone of the gesture;
- Get involved and accept your own failures;
- Maintain 10 minutes of attention in Juggling working session with the juggleboard;
- Juggling in autonomy, managing their emotions;
- Juggling with music.

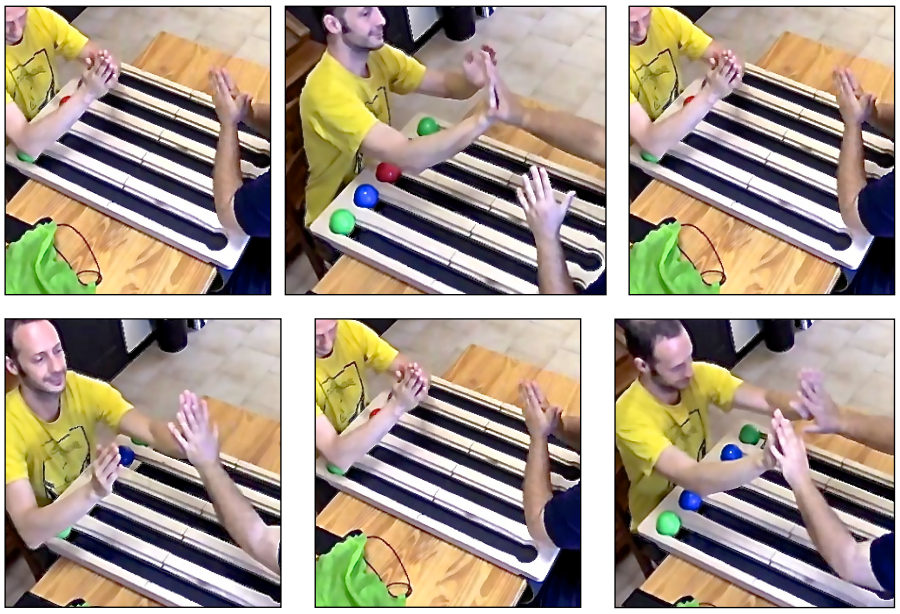
3.3.3 Technical goals
The technical goals of the project were:
- Passively Juggling the primary composition;
- Passively Juggling the open schemes;
- Try a role change between facilitator and participant;
- Manage the primary composition without interruption on tilt table;
- Accomplish the train with balls and common objects in passive/active states in the horizontal mode;
- Juggling in horizontal individual mode (ab) and abc schemes.

3.4 Working sessions



The participants were taken from their hosting structures to the place designated for the working session. During the journey they were alone or in small groups (for a maximum of 3 people per group), in order to create a good temper. We chatted about ordinary and pleasant topics, trying to make the participants feel relaxed, in order to prepare them to the working session.
The sessions were carried out in a silent place (villa Carla in ETC of Torri). The juggleboard and the five balls was placed on a table, while the other balls, to be used in more complex exercises, where beside the board, to be easily taken during the working session.
Each session was carried out in individual mode (if the participants where in group, the ones who were waiting had been given something different to do, such as mandalas drawings to color or

circus magazines to read and flip through). Each session lasted from a minimum of ten minutes, to a maximum of fifteen minutes, in case the subject did not show up stress or tiredness symptoms.



The session began with an oculo-manual coordination exercise without the juggleboard. The game that I proposed was a very popular one (see photos).

After the introductive game, we passed to the use of the juggleboard. Each session could have had one or more specific technical goals, depending on the answer and the improvements of each participant.

All the sessions were filmed to be watched at a later stage. This observation was useful to establish the basis of the following sessions, as far as the adaptation of individual technical proposals was concerned.

The individual technical proposals were, in any case, a variation of the common specific technical goals, known by all the participants. Each session included a short analysis and a double clapper between the facilitator and the participant.

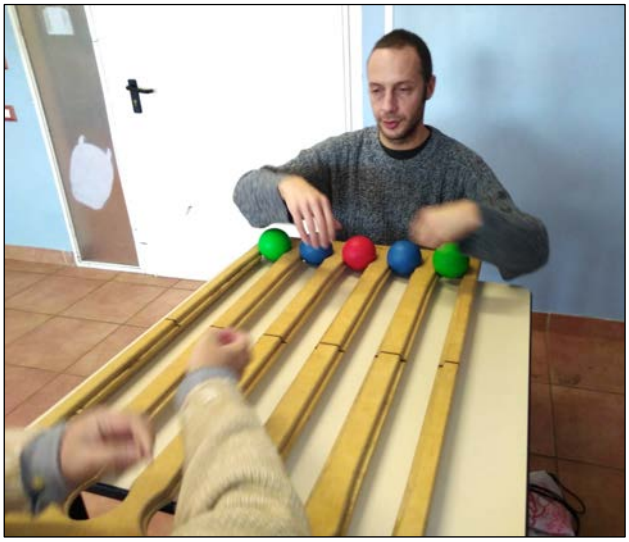
In the initial phase of the study (the first eight working session), it was preferable to maintain a silent atmosphere to encourage concentration; only in the final four sessions the participants were asked if they would have welcomed some music.

The selection of the music was focused on neutral tracks, with a clear path and rhythm, to which the participants could relate. Therefore, Reggae, Funk and Hip Hop music were the most proper choices, taking into consideration an expressed preferences of the users.

In *Chart 3*, a working session synthesis with juggleboard is given.

Chart 3. Synthesis of a working session with the juggleboard (working session with the user and her/his personal and private analysis).

Working session with the user	
Setting of the working space	Setting of the board and disposition of balls and any object added, camera disposition
Drive of the participant/participants	Emotion testing before the working session and monitoring of the user's motivation
Oculo-manual coordination exercise	Three repetition of the exercise
Specific technical phase	Last of 10-15 minutes
Session feedbacks	Feedbacks through oral questions about pro and cons of the work
Ending with a physical contact	Double clap
Separately	
Analysis of the videos	To point out and cons of the user work
Planning the content of the next session	Planning possible adjustment in the following working sessions according to the project specific goals







Demonstrative session of Juggling with the juggleboard. Cyclical performance of the synchronous closed scheme (41) (23) (15).

4. Valuation of the outcomes of the project

The results of the Juggling project with the use juggleboard have been analysed by splitting the outcomes up into three main categories: specific goals, technical goals and goals related to motor coordination abilities.

4.1 Valuation of the achievement of specific goals

To fulfil this evaluation, I only based my observation on the change that each subject made towards the established goals during the working sessions. The following paragraphs contain a qualitative evaluation.

Learning of a new oculo-manual abilities, either simple and complex. Starting from the fact that the users did not have any specific skills as far as the use of the juggleboard was concerned, during the twelve working sessions they learned different Juggling schemes in different modalities. This goal was, then, considered acquired. To establish a quality indicator of the achievement, it is possible to check the "Achieved technical objective goals evaluation chart", in the experts dedicated section.

Optimized the eutony of the gesture. This goal has not been implicitly achieved with the learning of complex technics. However, the observation of the videos makes it evident how each participant operates an adjustment of the strength during the repetition of the exercises. A good indicator of this goal is the decrease of the leak of the balls from their rows and the precision of the throws in lonely mode with tilt board.

Getting involved and accepting your own failures. An indicator for the achievement of this goal was the users will to participate to the working sessions. It was not to be taken for granted that all the users showed such a deep interest in the project, since the sessions resulted involving and sometimes hard.

Keeping the focus for a session of 10 minutes with the juggleboard. This objective has been reached in time; the first sessions did not reach the last of 10 minutes with all users. Only after the first half of the whole period of study, the working time was stable to 10 minutes for all the members of the group. In some cases, the sessions even reached fifteen minutes of length, surpassing the established last.

Juggling autonomously and managing individual sensitivity. The evaluation marker of this goal were the resulting values of the exercise named "managing the primary composition without interruption on a tilt board". This exercise was based on the emotional control of the participants, when s/he finds her/himself alone, coping with the balls and the Juggling schemes. The videos show that at this stage of the project, each participant has reached a good control of sensitivity.

Juggling with music. This is an extension of the previous goal. Juggling with music indicates relax and openness from the participant point of view to the external input, while playing a technical routine. Music has been proposed just during the exercise that included the managing of the primary composition without interruption on the tilted board. Five subjects out of six agreed to the music playing and tried to adapt their movements to an external rhythm. The only subject who refused the addition of the music was D.C., according to her lack of confidence with individual work (*Chart 5*).

4.2 Technical goals achievement evaluation

This evaluation is related to interpersonal technical levels, that is the acquisition of Juggling schemes with the juggleboard. Since the subjects did not have a starting technical level and not all

the Juggling schemes can be proposed in T0, it was not possible to make a comparison between T0 and T1. The sample group cannot be used in a comparison on the acquisition of this objective, since they did not participate to the working sessions. A numerical value was given to each technical objective (from 0 to 5) in order to record the level of acquisition. This evaluation was based on the ceiling acquisition ability of each scheme, so that 5 indicates the perfect execution of the aforesaid scheme. In the *Chart 4* there is the explanation of each value in number.

Chart 4. Technical goals acquisition: level scheme.

0	The subject is unable to understand/answer/reproduce the scheme
1	The subject understands/respond/reproduce the scheme only with a verbal physical support
2	The subject understands/respond/reproduce the scheme individually but occasionally and roughly
3	The subject understands/respond/reproduce the scheme individually in a continuous way but his coordination is rough
4	The subject understands/respond/reproduce the scheme individually in a continuous way and his coordination is good
5	The subject understands/respond/reproduce the scheme individually in a continuous way and is relaxed and in eutony

Taking the subjects target in account, the values from 2 to 3 means a good acquisition of the technical skills.
To make an effective evaluation of the technical goals acquisition, all the seven results in the *Chart 5* had been summed up and the average was worked out. The satisfactory score was 2.5.

Chart 5. Valuation chart of individual technical goals acquisition.

Technical skill	**Participant**					
	C.S.	**D.C.**	**L.L.**	**C.T.**	**K.M.**	**G.V.**
Passive Juggling of the primary composition	4	3	4	3	3	4
Passive Juggling of open schemes	3	2	4	4	5	4
Role changing between participant and facilitator	1	2	3	2	2	3
Managing primary composition without interruption on tilted board	3	2	3	3	3	4
Perform Juggling session with balls and different objects in passive horizontal mode	3	2	4	3	3	4
Juggling individually (ab) scheme	3	2	4	3	3	4
Juggling individually abc scheme	2	0	4	3	2	3
Average of the acquired technical abilities	**2,7**	**1,9**	**3,7**	**3**	**3**	**3,1**

4.2.1 Discussion on the achievement of technical goals

The average of the reached technical objectives is higher than expected, except from D.C. case. This peculiar subject was much more penalized than the others because of the significant low level of his motor skills and his learning motivation, in contrast with the other members of the group.
For all the other participants the valuation is higher than expected. The results suggest that a planned, methodical work with the juggleboard can lead to a significant technical development than single sessions.
An accurate and methodical planning, adapted to specific subjects, enables to acquire specific technical skills that were initially unpredicted.
This encourages the creation of individual working trials, which are specifically structured to give a high rendering in disabled subjects, that can, then, reach a level which is close to the one of able bodied in some technical acquisition.

4.3 Evaluation of acquired skills in relation to coordinative abilities

The evaluation of the improvement of motor skills, in contrast with the technical objectives, is based on the individual increase of the participants, and not on the comparison with other subjects. In this evaluation, an essential role has been played by the comparison with the sample group.
The motor skills put under specific analysis were sequencing ability, motor ability and responsiveness to a visual input. To measure the effective development of this abilities, two tests were suggested, the first one took place before the working period with the juggleboard and the second followed the sessions. The two tests were either related to the oculo-manual responsiveness and to sequencing motor abilities, and were both aimed to value problem solving.

4.3.1 Oculo-manual responsiveness test

The test consists on a videogame played on a tablet, to stimulate responsiveness of reflexes. It is called "Reflex Test" (Responsiveness Test) by Out of Pixel Company (www.outofpixel.com/), available on Google Play.
The game screenshot has nine blue rings. On a triple acoustic signal, one of the nine ring changes its color, from blue to pink. The subject has to touch the pink ring. Once it has been done, another ring changes color (without a preventive acoustic signal), the subject has to spot the change and touch the other ring and so on, for fifteen seconds. To evaluate this test, the higher is the number of pink rings touched (called figures), the better is the result (*Chart 6*).

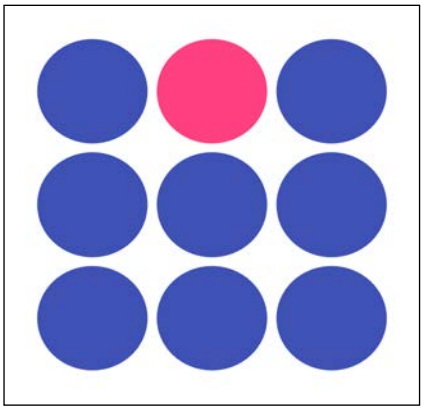
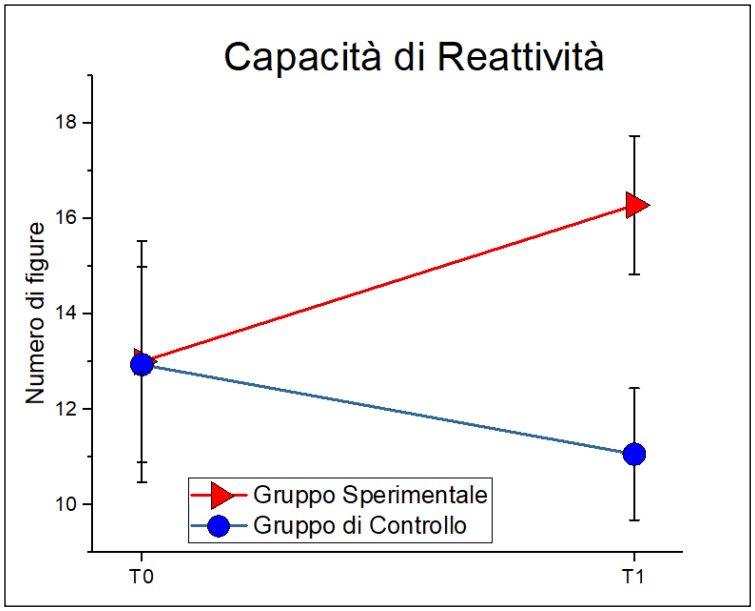


Chart 6. Aspects of the "Reflex Test".

Test structure	Videogame on a tablet (app)
Test last	15 seconds
Test challenge	Touch the ring which changes color
Test value	Number of touched rings
Repetition of the test	3 times



Aside. Graph on the outcomes of the oculo-manual responsiveness test taken on the Working group and the Sample group.

Paired Samples T-Test ▾

Paired Samples T-Test

			t	df	p	Cohen's d
PreSP2	-	PostSP2	−2.943	5	0.016	−1.202

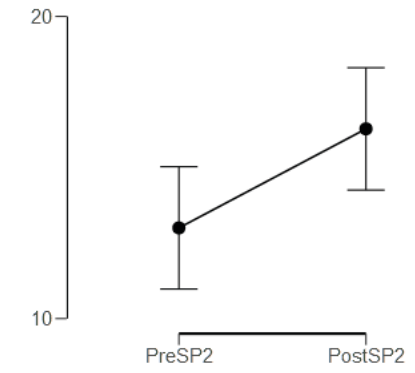
Note. Student's t-test.
Note. All tests, hypothesis is measurement one less than measurement two.

Descriptives

Descriptives

	N	Mean	SD	SE
PreSP2	6	13.00	6.215	2.537
PostSP2	6	16.28	3.568	1.457

Descriptives Plot



Paired Samples T-Test

Paired Samples T-Test

			t	df	p	Cohen's d
PreCntrl2	-	PostCntrl2	1.898	5	0.116	0.775

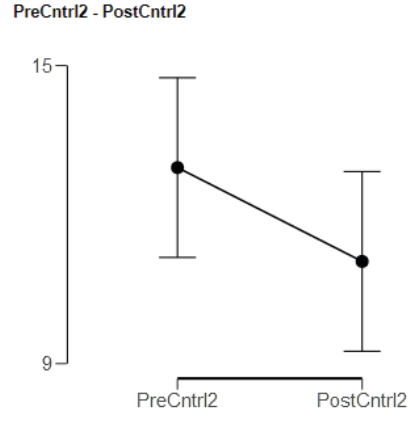
Note. Student's t-test.

Descriptives

Descriptives

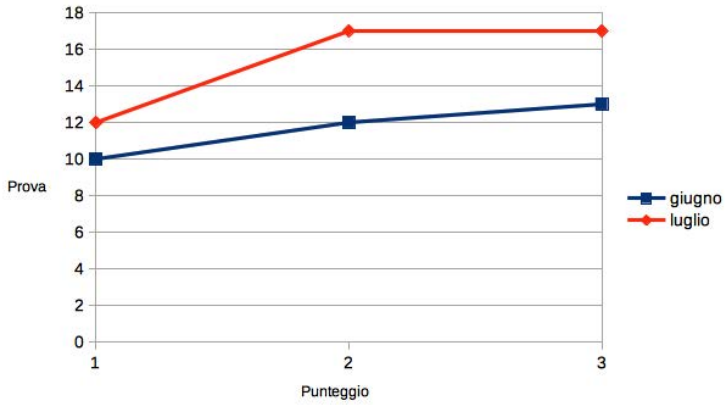
	N	Mean	SD	SE
PreCntrl2	6	12.94	5.022	2.050
PostCntrl2	6	11.06	3.376	1.378

Descriptives Plot

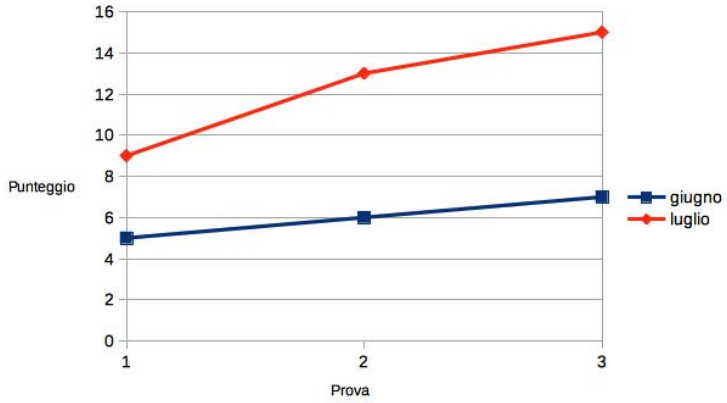


Paired Samples T-Test on the outcomes of the oculo-manual responsiveness test taken on the Working group and the Sample group

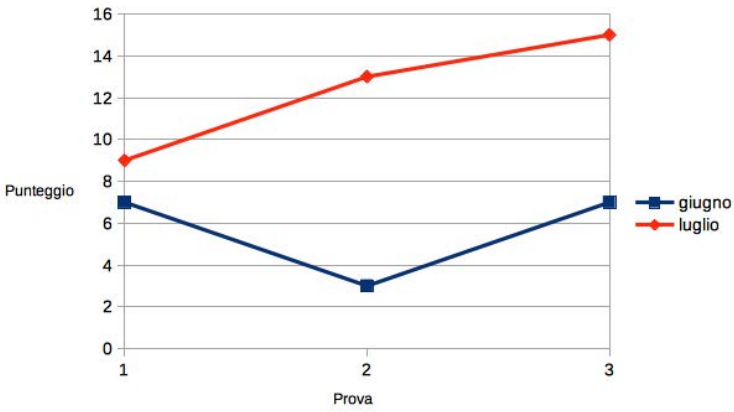
C.S.



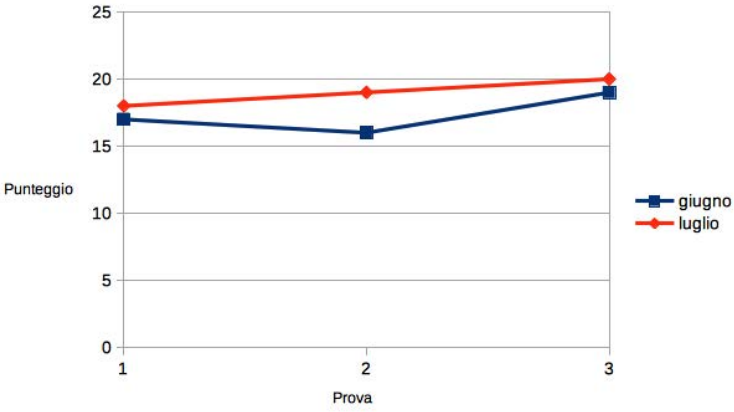
D.C.



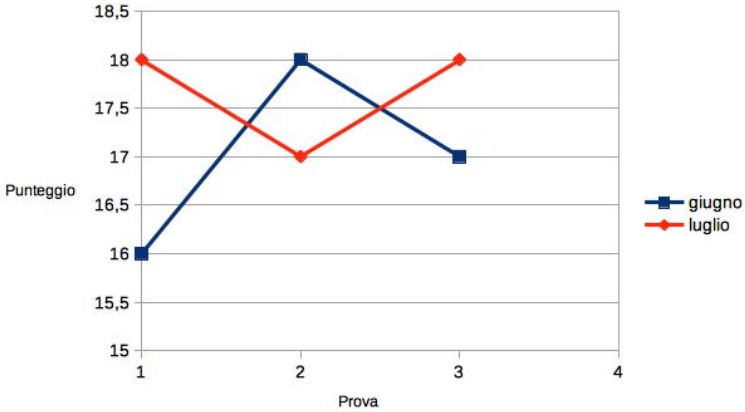
L.L.



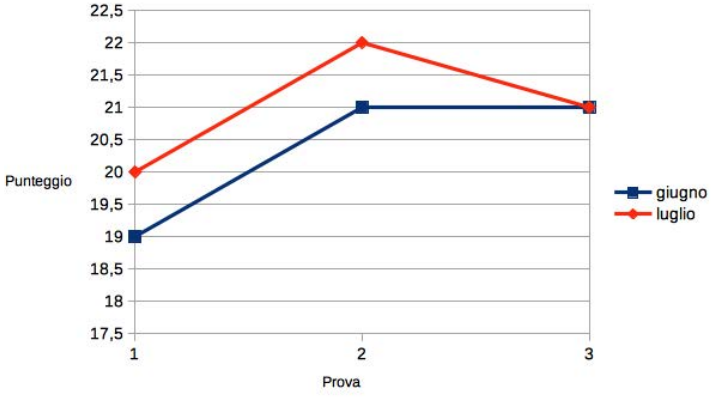
C.T.



K.M.



G.V.



Individual test on the oculo-manual responsiveness test taken on the six users involved in the project.

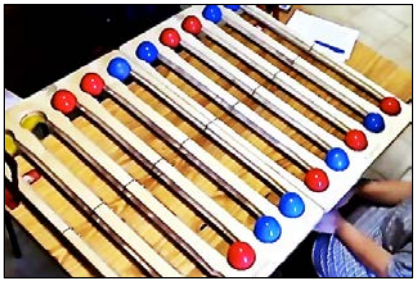
4.3.2 Test on motor sequencing abilities

This test is divided in two parts. The first implies the use of eight balls in two different colors, while the in second there are nine balls of three colors.

The test setting consider two contiguous juggleboards with a different number of balls of the same color in the pockets on each side (four red and for blue in the first part, three red, three blue and three green balls in the second part).

The test starts with the facilitator and the participant sat in front of the boards. They have the same number of balls of the same colour disposed in the same position in the pocket. The facilitator hides his balls under a cloth and changes their position, then he reveals the new setting to the participant taking the cloth away (*Figure and Chart 7*).



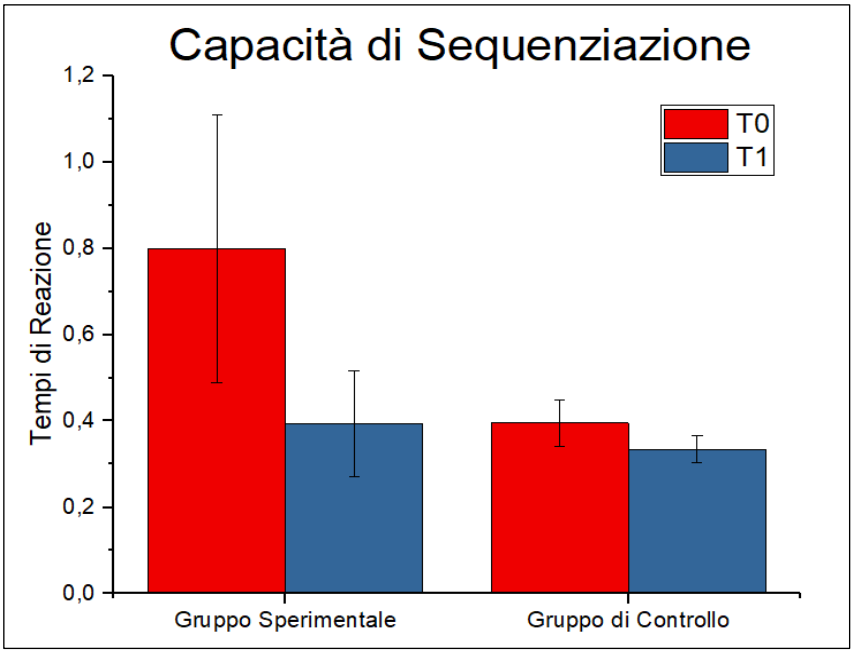


The participant has to set his balls following the facilitator scheme as quickly as possible. Once the participant has reached the goal, the facilitator hides the balls and changes their position again. This exercise has to be repeated eight times per test.

For the test valuation, the lower is the time value in each time of repetition, the better is the result (see following illustration).

Chart 7. Aspects of the test with the juggleboard on motor sequencing abilities

Test structure	Two contiguous juggleboard with some balls placed in the pockets
Test last	Changes with the subject
Test challenge	Setting the balls following the facilitator scheme
Test value	Time employed to reset the balls
Test repetitions	Eight different settings



Aside. Graph on the outcomes of the motor sequencing abilities test taken on the Working group and the Sample group.

Paired Samples T-Test

Paired Samples T-Test

			t	df	p	Cohen's d
preSp	-	postSp	2.024	5	0.049	0.826

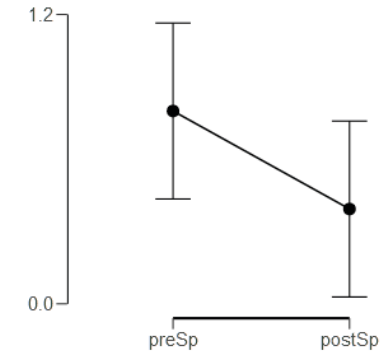
Note. Student's t-test.
Note. All tests, hypothesis is measurement one greater than measurement two.

Descriptives

Descriptives

	N	Mean	SD	SE
preSp	6	0.799	0.762	0.311
postSp	6	0.393	0.301	0.123

Descriptives Plot



Paired Samples T-Test ▾

Paired Samples T-Test

			t	df	p	Cohen's d
preCntrl	-	postCntrl	2.264	5	0.073	0.924

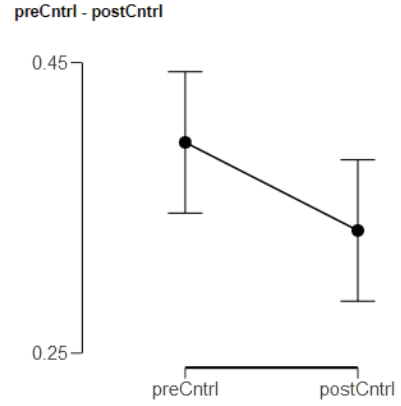
Note. Student's t-test.

Descriptives

Descriptives

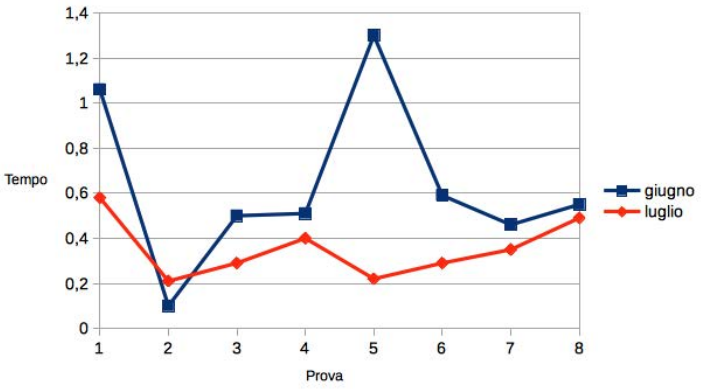
	N	Mean	SD	SE
preCntrl	6	0.395	0.129	0.053
postCntrl	6	0.334	0.076	0.031

Descriptives Plot

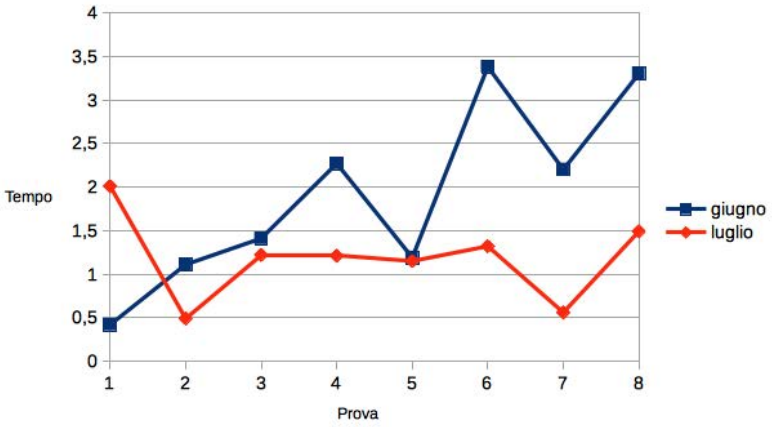


Paired Samples T-Test on the outcomes of the motor sequencing abilities test taken on the Working group and the Sample group.

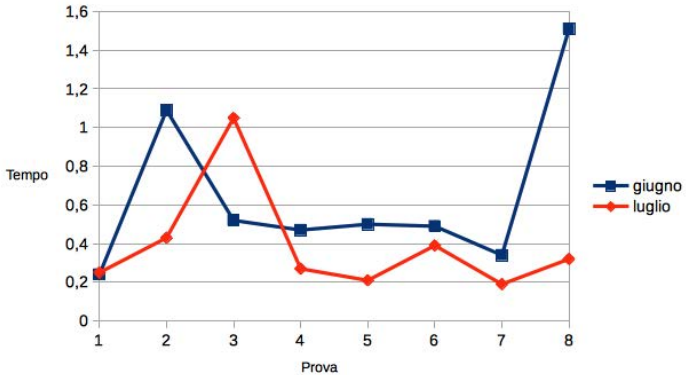
C.S.



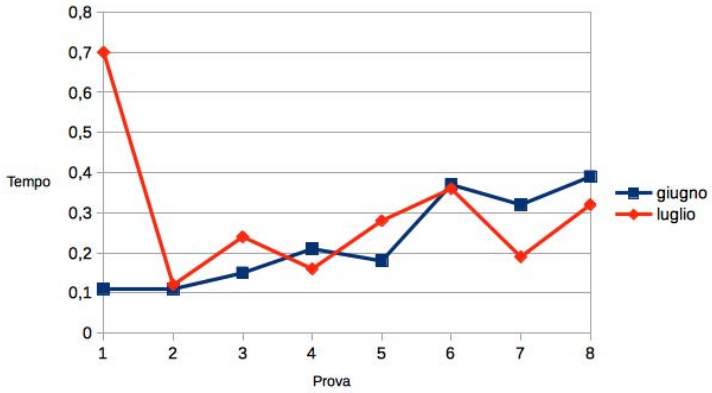
D.C.



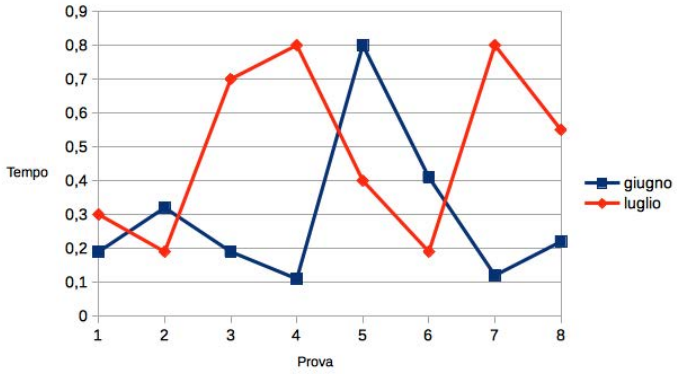
L.L.



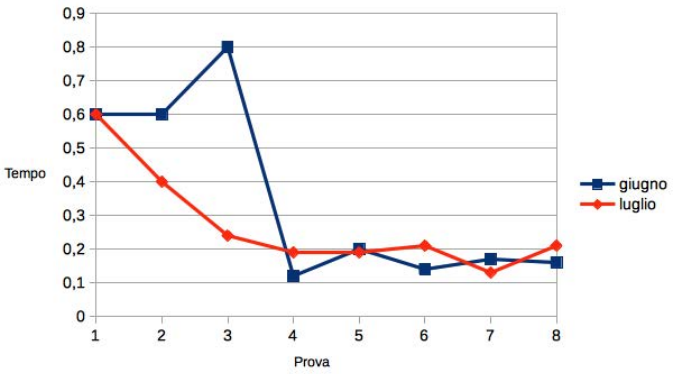
C.T.



K.M.



G.V.



Individual test on the motor sequencing abilities test taken on the six users involved in the project.

4.3.3 Discussion on the accomplishment of the coordination abilities goals

Tests on selected coordination abilities widely shows the development on the aforesaid abilities, due to the inputs given during the training with the juggleboard.

The gap between the results of the Sample group and the Working group shows the effectiveness of the methodical and continuous work with the juggleboard for the last of two months, in contrast with a traditional manual and motor activity.

The conclusion this tests lead to is that a methodical and planned work with the juggleboard is an extremely useful instrument to develop coordinative and motor sequencing abilities.

4.4 General impressions on the study

The results of the various studies concerning the effects of working with the juggleboard on disabled subjects are definitively positive.
It is possible to state that a working period, which had been precisely structured on the needs of each participant, develops remarkable abilities in the use of the juggleboard. Furthermore, it deeply stimulates the development of coordinative, sequencing and reactiveness abilities.
Finally, analyzing the test results of each participant, as far as reactiveness and sequencing abilities are concerned, and putting them in contrast with the acquired technical abilities, it is possible to notice that in some cases, even if their scores were low in technical abilities, the result of their development of coordinative abilities are higher than the average results.
This project demonstrates that, as far as throwing Juggling (Draganski 2004) and juggleboard are concerned, the neuroplastic development is not linked to a technical execution of movements, but on its ideo-motor planning. Although this research will possibly highlight some limits or bring out some criticisms, it is our aim to solve this occurrence, opening the research to further users and their will to enlarge the collection of data.

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