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Número 23
De los procesos técnicos a las narrativas con sentido

Enero 2023

Drawing Used for Embodied Simulation in Order to Improve Motor Ability

El dibujo para la simulación encarnada con el fin de mejorar la habilidad motora

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Investigación

Resumen

Una investigación de veinte años sobre la simulación encarnada ha aportado información sobre la correlación entre el sistema de neuronas espejo y la percepción visual de las expresiones faciales, los gestos, la pintura representativa y no representativa, y la fase mental de pensamiento y aprendizaje. El enfoque fisiológico ha demostrado el vínculo entre el pensamiento y el sistema sensoriomotor en ambas direcciones. Como deportista, artista e investigadora, considero la experiencia de autoidentificación en el dibujo y planteo la hipótesis de que puede utilizarse en el deporte como un poderoso instrumento de entrenamiento, recuperación y desarrollo de la propiocepción.

En el estudio participaron 14 niñas de primaria dedicadas al aprendizaje de ejercicios de gimnasia. Una parte del grupo realizó un módulo de aprendizaje motor basado en dibujarse a sí mismas realizando el movimiento elegido. En este trabajo se muestra el método de aprendizaje y se discute la mejora de estas jóvenes atletas, considerando finalmente el contexto para aplicaciones útiles y planificando nuevas vías para concretar el método.

Palabras clave: dibujo encarnado, conocimiento encarnado, simulación encarnada, autoidentificación, sistema de neuronas espejo.

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Enero 2023

Abstract

TA twenty year old research on embodied simulation has reported the correlation between the mirror neurons system and visual perception of face expressions, gestures, representative and non-representative painting, and the thinking and learning mental phase. The physiological approach has demonstrated the link between thinking and the sensorimotor system in both directions. As an athlete, artist and researcher I consider the experience of self-identification in drawing and I make the hypothesis that it can be used in sport as a powerful instrument for training, recovery and development of proprioception. The study involved 14 girls from primary school engaged in learning gymnastic movements. Part of the group carried out a motor learning module based on drawing themselves performing the chosen movement. This paper shows the learning method and discusses the improvement of these young athletes, finally considering the context for useful applications and planning new paths to specify the method.

Keywords: Embodied drawing; Embodied knowledge; Embodied simulation; Self-identification; Human mirror neuron system.

DOI: https://dx.doi.org/10.17561/rtc.23.7290
Investigación

Introduction

Literature

The Embodied Simulation Theory, developed after the discovery of mirror neurons and deepened in the last twentyfive years, provides a hypothesis on how people understand the actions and emotions of others. The key mechanism underlying this understanding is the activation of the mirror neuron system (hMNS) (Gallese et al. 2004). Premotor cortex activation also occurs when we are able to imagine the end act of an action directed towards an object and, exclusively in humans, when we are faced with a series of movements without a specific function or a mimed action (Rizzolatti - Craighiero, 2004). In addition, a study by Buccino et al. (2006), carried out on beginners learning guitar chords for the first time, examined the way in which mirror neuron areas are activated. The study found that the activation of these areas occurs during observation and to a greater extent during the rest period, i.e. when the subjects are engaged in learning and memorising the actions required to play the song. It follows that the mirror neuron mechanism seems to be directly related to learning by imitation, specifically in humans (Rizzolatti - Craighiero, 2004). Indeed, one of the most important ways in which movements are learned during childhood and adolescence is through imitation (Marshall & Meltzoff, 2014). Exposing children to play activities and physical activity education programs is an essential factor in the development of an effective hMNS, and in turn, a wellfunctioning hMNS has positive impacts on the development of motor skills. (Thanikkal, 2019).

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Enero 2023

Gallese and Lakoff (2005) explain the concept of 'action simulation' extensively: "Because sound and action are parts of an integrated system, the sight of an object at a given location, or the sound it produces, automatically triggers a "plan" for a specific action directed toward that location. What is a "plan" to act? We claim that it is a simulated potential action" (Gallese Lakoff, 2005, p. 6). Starting from the results that emerged in their study, the authors assume that action and intention, although part of an integrated perceptual system, are central in the acquisition of concepts, and concepts are indeed inseparable from the action and intention. The 'form' of concrete concepts, far from being abstract, is also established by embodied feedback concerning the action that can be performed on and with what we see and imagine. Art also fits into this construction of concepts as a general stimulus, but also as a special stimulus because it is artificial and not always in line with our idea of 'reality'.

Supporting and anticipating the previous argument is the psychophysiological theory of aesthetic experience theorised by Ruggieri in 1997. The author investigates the physiological changes that the body has in relation to the stimulus and the processes of "imitative decoding" that synthesise and conceptualise the stimulus before and after cognitive processing. These processes are crucial in the construction of self-image and sensation.

The activation of brain areas involved with movement, which in art is expressed by the concept of empathy, also takes place when faced with an artificial product such as paintings depicting figures or naturalistic subjects, and is demonstrated by Di Dio's et al. research (2016). It occurs both through imitation of a figure's action and exploratory behaviour in naturalistic images. Even when faced with non-representational pictures in which it is possible to identify the trace of a gesture, the activation of the motor areas of the cerebral cortex is detected. (Umiltà & colleghi, 2012)

In art, therefore outside the scientific context, we find an important sense of identification of the artist in the subject portrayed and even more so if it is a self-portrait. Those who find themselves in the role of the artist know this feeling during the execution of a portrait, this is the effect that interests us most in this study.

Despite the recognised potentials of drawing, there are very few examples of research using drawing as a medium, and also very few investigations with participants as active subjects. Lyons (2009) proposed the use of drawing to complement research on Fibrodysplasia Ossificans Progressiva. This approach was also successful due to its drawing skills. Gravestock (2010) applies drawing to figure skating and via this use identifies the ability to make the choreographer's intentions understood by the dancer thanks to the embodied simulation. Furthermore the choreographer himself is able to improve and comprehend the gesture to be communicated. Finally, Gravestock identifies embodied simulation and recognition of gestures through the drawn figure as a more direct tool for sports learning than cognitive understanding, which involves a more abstract step.

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Número 23
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Enero 2023

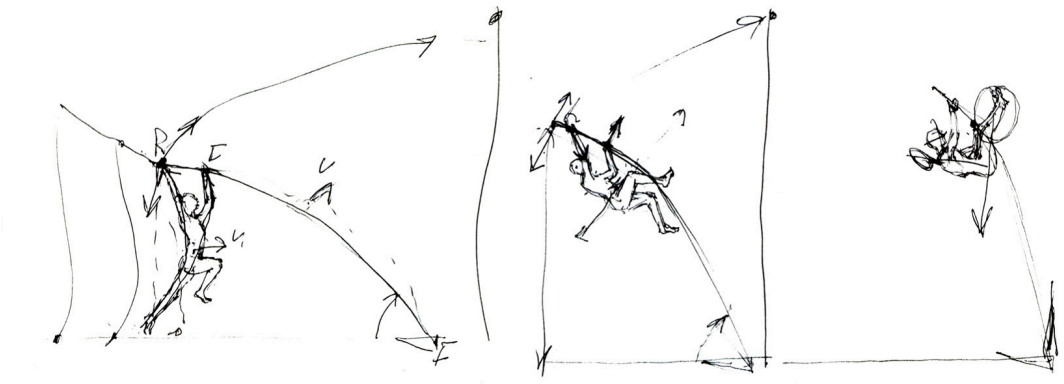

Figure 1: Vian Giorgia, Drawing to improve pole vault technique (and coach's corrections), 2010. pen on paper. 29,7 cm x 21 cm. Vian, G. Collection, Milan.

The use of drawing as a trace of an embodied gesture has also recently been applied in education. Stewart (2019) conducted a study with small drawing groups after yoga practice. From her findings we understand how drawing linked to the sensations of the body, stimulated by the yoga practice, makes explicit the sense of unity or disintegration of the individual through the representation of the subject and the nature world context: "the appearance of the natural world present in the drawings (but not in practice) rendered visible the emotionally connected transcendent body feeling as-an-aspect-of-the-world, and the subsequent disappearance of an environment and a body disconnected from the world in moments of disruption" (Stewart, 2019, p. 13). The researcher also introduces the question of drawing education and art language, which becomes increasingly more important if we introduce embodied drawing in the educational field. Ruggieri's (1997) work also refers to the unitary construction of Self that is created through sensory stimuli that at each step are conceptualised as far as the neural tissue and the constitution of the mental body image. This construction is also linked to the unitary perception of the experience of space, which, thanks to memory, connects the sensations of before and after, providing a sensory space which we inhabit with ease.

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Investigación

Background

In 2008, after her academic studies in art, the author began a career as a pole vaulter. She first tried the method of drawing pictures of herself to improve her jumping technique (fig. 1). The drawing, subdivided into several stills, showed the mistakes that the author repeated on the track (where she was not "seen" from the outside). The muscular, respiratory, and emotional tension proved to be far greater than the mental training sessions, and it was all the more tiring to draw those parts of movement that were not very precise even in motor practice. During the Sport Pulito Italia project for the Presidency of the Council, Pilot Area Palermo (2018), Vian tested the application of motor design on students from the Bachelor in health and exercise science of the University of Palermo during their first pole vault lesson (Test 0).

Tercio Creciente
Revista de Estudios en Sociedad, Artes y Gestión Cultural
ISSN: 2340-9096
Número 23
De los procesos técnicos a las narrativas con sentido
Enero 2023

Test 0.

The graphic and motor activity lasted a total of three hours and focused on the use of the pole on a flat surface whose aim was to make a long jump. The movement was shown and explained to the fifteen students, focusing on how to transfer the thrust to the pole in an ascent phase and how to use it to move further in a descent phase. The movement was not repeated in the imagination and drawing phase to avoid providing a model to copy.

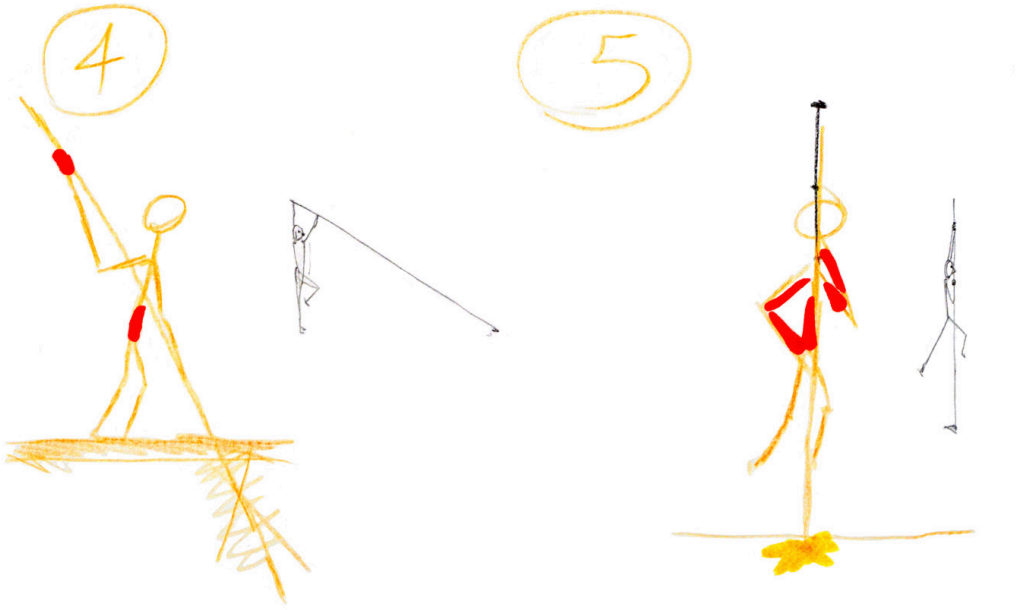

Figure 2: Sport and health student di scienze motorie, Drawing for learning first pole vault's lesson (revised in pencil by Vian G.), 2018. pennarello e matita 29,7 cm x 42cm. Vian, G. Collection, Milan.

The practical tests show that the use of a "long stick" as an effective prothesis for bridging a distance is not part of the basic motor skills of the adolescents tested. While a certain reasonable but not technically optimal use can be seen in the practical tests, it is clear from the drawings that a graphic translation of an effective gesture is lacking. We assume this is due to the complexity of coordination of the gesture chosen as example and the lack of motor culture mediated by tools of this sort. On the other hand, some stereotypes emerge from the drawings that are functional for other purposes such as "holding a spear", "climbing", and " planting the tool in the ground" (fig. 2). It therefore seems important, in order to test this drawing module in its completeness, to extend the preparation to several days and to commence from a clear starting level.

Hypothesis

The process of identification occurs through viewing abstract paintings, naturalistic landscapes, but above all by perceiving human movements and expressions (Ruggieri,

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Investigación

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Número 23
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Enero 2023

1997, Di Dio et al., 2016, Humility & colleagues, 2012). Life drawing produces a silent and empathetic dialogue between the portrayed subject and the artist. In our hypothesis, imagination drawing, and more precisely that of imagining oneself making a movement, is the type of imagination that entails the highest degree of psychophysical involvement of the author while drawing.

Based on literature, we hypothesise that a drawing program applied to sports training, based on the mechanism of embodied simulation, could be more effective than sports training alone in learning technical gestures and correcting errors.

Objectives of the study

Due to the small amount of scientific studies that apply drawing to sport, and the peculiarity of this specific program, the study aims, firstly, to verify whether the drawing program applied to sports training can be a valid didactical tool to involve female young athletes, to compare execution errors with those that emerged in the drawing and to assess the degree of identification.

Secondly, the study aims to evaluate the effect of a graphic training program on the performance of a group of girls in artistic gymnastics compared to a control group trained solely with regular sports training.

Finally, the application of the method will allow the author to refine it thanks to the spontaneous re-sponses and behaviour of the participants.

Methodology

The observational study took place in July 2020 during the summer break in a school in Milan in a summer sports camp context.

All girls were tested (Observational qualitative test) before and after the teaching module, and it took 5 days from the introduction test to the end of the study.

Participants

Fourteen girls aged 10-13 years participated in the study, the mean age being 11.7±1.3. They were selected from a sports centre during a summer camp in which they participated in various sports, including artistic gymnastics. The girls were divided into two distinct groups: an experimental group that participated in a drawing intervention program (4x45') alternated with artistic gymnastics training (4x35'-40'), and a control group that did not participate in the drawing intervention program and did reading or other recreational activities during that time. The control group, who, due to the contingent needs of sample availability did not meet an age range comparable to the experimental group (12.6±0.9 and 10.5±0.7 respectively) is analysed here only for the intrinsic comparison of the parameters. Girls with more than one year of experience in artistic gymnastics were excluded from the study.

Stimuli, materials

The participants were provided with A4 sheets of normal paper, pencils, and yellow and red crayons. The trainer/experimenter was provided with a blue crayon. For the

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Enero 2023

training sessions, equipment necessary for performing introductory exercises in artistic gymnastics was available.

Procedure

For both groups, the first gymnastics session began with an initial warm up followed by the explanation and demonstration of a number of movements, from the simplest to the most complex. In this case, the movements chosen were "cartwheel" and "round off" (Scotton C. & Senarega D., 2003). Afterwards, the children were asked to try out the movements in order to identify which movement represented the objective to be achieved by each child during the week.

The children in the experimental group were asked to draw a picture of themselves as gymnasts, choosing a simple position. Once they had started working, they were asked to identify the head with the nose and eyes, the arms with the elbows and wrists, the torso with the shoulders, the frontal representation of the foot, and the legs with the knees and ankles - important articulations for the work that followed.

The second drawing, next to the first and of the same size, again illustrated the female sketcher-gymnast in the same position as before, but viewed in profile. Here they were asked to understand and illustrate some elements that are difficult to imagine from the point of view of the human figure, but essential for understanding the orientation in space of the head and body. For example, the triangle of the nose in profile, the ponytail of the hair (if the girl was wearing one), the curve of the gluteus, and the waist being thinner than the rest of the torso.

During the second drawing session the subjects were asked to make a drawing in stills of how they thought they were doing the cartwheel/round-off, trying to represent themselves in the correct way. There was no limit to the number of frames, but they had to follow one after the other, on the same line, keeping the same size. Where there was difficulty in understanding a single pose, they were allowed to stand up and place themselves in the position and then imagine looking at themselves from the chosen viewpoint. At this stage, it is centrally important to the method to avoid posing as coach or ha-ving others pose as models to copy. It is essential that the subjects imagine the drawing through the sensations they feel when they imagine posing themselves.

The third session consisted in selfcorrecting and finalising the previous drawn sequence, along with a second exercise that entailed imagining having coloured hands and feet, and drawing the footprints that would be left on the paper if it were the mat and importantly, to number the footprints according to the progression of the movement. In this work, if there were difficulties in drawing a right foot or hand as opposed to a left, examples were given to differentiate them (clarification of big toe, arch of foot, thumb ecc...).

The fourth and final session involved drawing by frames, as in the second session, but with the viewpoint behind the figure of the sketcher-gymnast, the movement being represented from this point of view. In an extra drawing session, the previous or corrected drawing was finished and an elementary mannequin of the human figure made, which was moved by the girls to perform the chosen movement.

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Enero 2023

Correction by the coach took place whilst each drawing session was in progress, without intervention on the paper but indicating the way forward, and only directly on the drawings at the end of the session. A solution was never drawn in the same graphic style as the sketcher. At the end of each drawing, the correction was made together with the subject, on her own work, with a simplified style and blue pencil. Finally the participant was asked to correct the drawing.

The second and third drawing sessions were enhanced with two additional tools: the red and yellow pencils, colours chosen by the girls to identify strength and speed respectively. The limbs or parts of the body on which the girls thought they needed to exert force were coloured in red in the various freeze frames, while the parts that needed to move with momentum and speed were coloured in yellow.

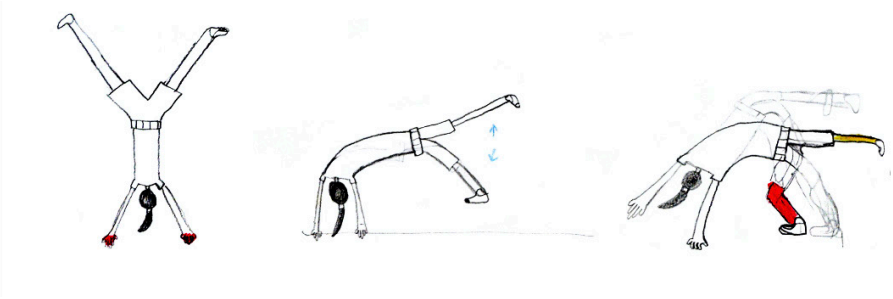

Figure 3: EB, Drawing as I imagine myself doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on pa-per. 29,7 cm x 21 cm. Author Collection, Milan.

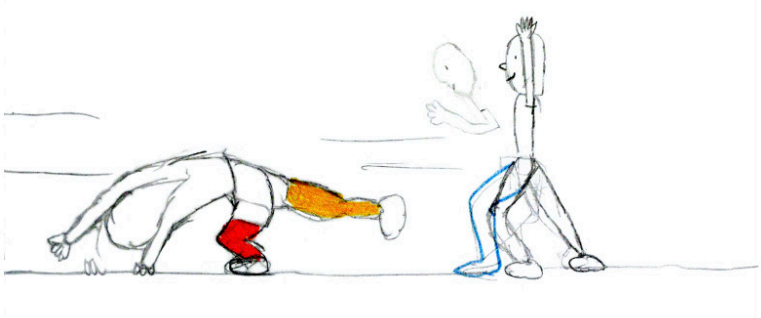

Figure 4: ES, Drawing as I imagine myself doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on pa-per. 29,7 cm x 21 cm. Author Collection, Milan.

Evaluation

The evaluation was carried out by a judge who differed from the two experimenters who gave n.4 votes on n.4 parameters. This was inspired by the evaluation of the score code of the Italian Gymnastics Federation: P1: Passage from the handstand, P2: Supporting limbs in succession/arm thrust, P3: Orientation: start rotation finish/orientation and arm release at the same time, P4: Precision: Toes and legs stretched/ Dynamism and final leg thrust. The gymnast could score from a minimum of 4 points (1 point for each parameter) to a maximum of 20 points (5 for each parameter).

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Enero 2023

Results

During the execution of the experiment, confirmations were found between this work and that previously done by the author on her own jumping technique. Firstly was the perception of fatigue in the execution of these tasks, a strong involvement in imagining and determining how the body parts should effectively be placed on the sheet. Another thing that coincided was that in the figures drawn by the girls, the same errors were seen as when they were performing the movement. From this we can deduce a relationship between the ability to imagine and translate a movement into a drawing (external eye) and the ability to carry it out. In figs 3-4 we see the numerous erasures of EB and ES who were explicitly asked several times to complete the movement with the last drawing, an initially omitted ending which is also lacking in the practical execution. In Figs. 5-6, drawings of VV and EC, we see the difficulty of the authors to orient themselves, the same way it was experienced in motor activity.

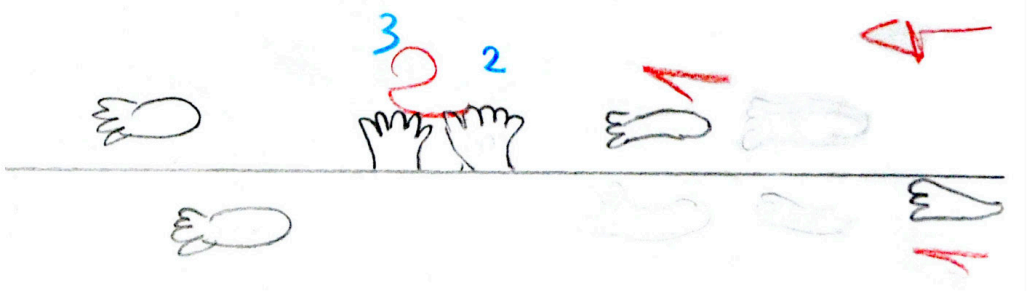

Figure 5: VV, Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 6: EC, Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Even when ES is asked to place the footprints and handprints on a line instead of along an arch as she had initially done and the guideline is drawn, the two subsequent drawings persist in a "halfmoon" pattern. Only when two lines are drawn, as a "bench" on which to perform the cartwheel and place the hands and feet, are they then drawn, with difficulty, along a line (see fig. 7.).

In the experimental group there were two participants who from the beginning placed themselves in a defeatist and renunciatory position towards the possibility of learning the chosen movement possibly due to the fact that they saw themselves as starting

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Enero 2023

from the lowest level in the group. Their drawings on the contrary, apart from highlighting some athletic errors, gave good results from a graphic point of view, distinguishing them from the others. This fact motivated them more and more during the course of the week until they manifested a certain enthusiasm and desire to prolong the training, a desire that was initially absent.

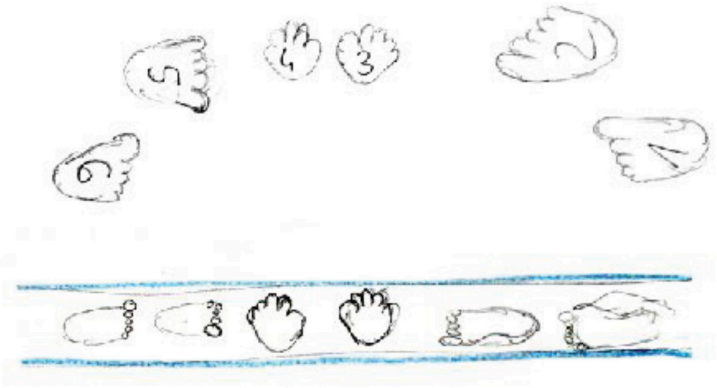

Figure 7: ES, First and third Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian, G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

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Investigación

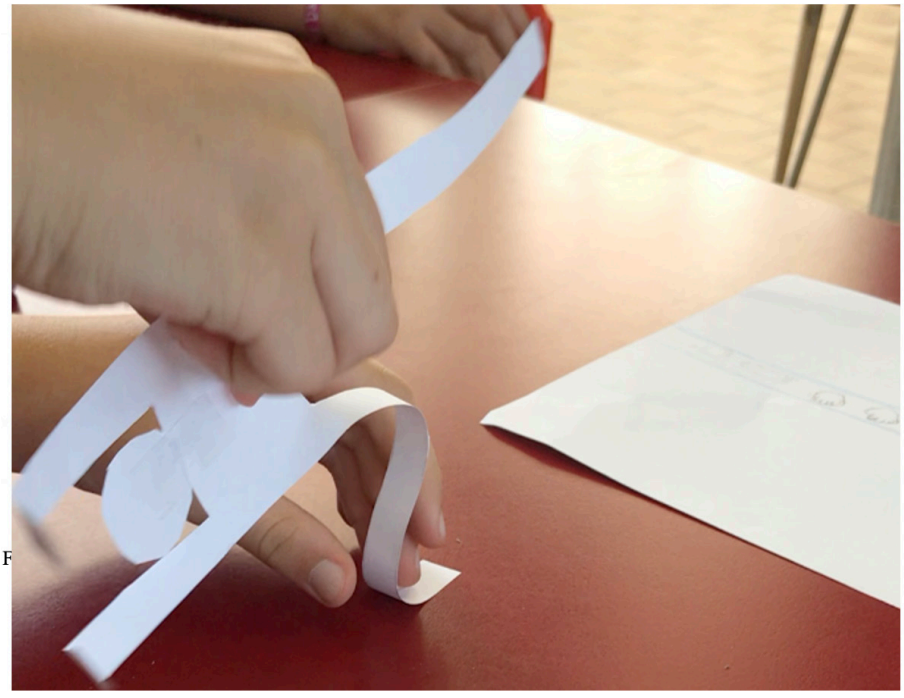

Figure 8: Vian Giorgia, EB moving paper model in order to play a cartwheel. Digital photography. Vian, G. Collection, Milan.

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Número 23
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Enero 2023

To conclude, the following reactions were also collected. Faced with the movement of the paper model (fig. 8), we noticed a certain ease in making it move correctly. There was no effort to construct the model as in the drawing, it was simply a question of making a preexisting model move. Viewing a film of their practice made at the end of the work, the girls who had learned less were unpleasantly surprised not to recognise a "cartwheel" or a "round-off". The use of the film in motor learning at the end of the intervention period caused a separation between the idea they had of themselves in move-ment and the image of themselves taken by the camera. This resulted in a reduction of involvement: as opposed to what happened during the drawing.

A detailed tables and discussion follow. The total scores for each subject were obtained by adding up all the parameters, and the percentage of improvement calculated from the total number of points collected are shown (Tab. 1). At the end is shown the average and standard deviation of age and the percentage of improvement. In table 2, the details of the scores of each parameter of both groups are shown with their average increase (and their percentage compared to the total).

	Years/months	EL	TOT 1 PRE	TOT 2 POST	Variation
GS			Pti /20	Pti /20	Δ%
BE	11,0	RU	5	6	5%
SE	10,9	RU	6	6	0
VV	10,4	RU	6	14	40%
CE	11,3	RO	13	11	-10%
VA	9,8	RO	8	13	25%
AS	9,7	RO	5	15	50%
M±DS	10,5±0,7				18,3±23,8

Tab. 1

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Número 23
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Enero 2023

	EL	Score PRE				Score POST			
GS		P1	P2	P3	P4	P1	P2	P3	P4
BE	RU	1	2	1	1	1	2	2	1
SE	RU	1	2	2	1	1	2	2	1
VV	RU	2	2	1	1	3	3	4	4
CE	RO	3	3	3	4	4	2	2	3
VA	RO	3	2	1	2	3	3	4	3
AS	RO	1	2	1	1	4	3	4	4
μ		1,8	2,2	1,5	1,7	2,7	2,5	3	2,7
Δ μ % P						**4,5%**	**1,5%**	**7,5%**	**5%**
GC		P1	P2	P3	P4	P1	P2	P3	P4
VG	RU	1	2	1	2	3	4	3	4
MA	RU	1	2	2	1	2	2	3	2
GC	RU	2	3	2	3	3	4	3	3
AG	RU	3	3	2	2	3	4	4	3
BL	RO	2	2	2	2	4	3	2	3
FS	RO	2	2	2	1	4	3	2	4
BS	RO	3	2	2	1	3	2	2	3
BG	RO	2	2	1	1	5	3	3	4
μ		2	2,3	1,8	1,6	3,4	3,1	2,8	3,3
Δ μ % P						**7%**	**3,5%**	**5%**	**8,5%**

Tab. 2

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De los procesos técnicos a las narrativas con sentido

Enero 2023

The aim of the present study was to evaluate the effect of a drawing training program on the motor performance of artistic gymnastics in a group of girls, and to check whether a drawing program applied to sports training could be a valid teaching tool. The global results of the experiment tell us that the girls in the experimental group improved on average by 18.3 per cent. It is to be noted that there was a counter-performance in the group by a girl who had a very good standard during the training sessions but during the test trial made two evident mistakes. The average percentage of improvement with the exclusion of the CE test becomes even more significant: 24 percent. An interesting fact derives from the outstanding improvement in the experimental group of the third parameter, that of spatial orientation: 7.5 per cent, when the other parameters reach a maximum of 5 per cent. In the control group, the parameter that increased the most is the fourth, while the third remains at 5 per cent. The result of the experimental group is even more relevant (10 per cent) when looked at without the EC counter-performance. We deduce that there may be a correlation between the drawing module and the development of proprioception, which is defined by the Medical Dictionary as the "set of functions responsible for the control of body position and movement" (AA.VV., 2010, Translation of the author). Looking at the results in detail, we notice that, despite the motivation to train detected during the drawing sessions, BE and SE, who started from a low score, did not achieve significant improvements at the end of the course. The girls who started from a higher level all improved significantly, except for CE. Finally, the variance in the results of the experimental group is rather high.

Conclusions

Overall, it can be said that the girls' participation in the drawing sessions had a positive effect on lear-ning the tested movement, and on motivation.
In Calvo-Merino's experiment (2004) a direct proportional relationship was found between the embodied response and the competence to perform the observed movement detected, which is consistent with the minimal improvement obtained in this study by the less expert girls. It is hypothesized that a longer, qualitative course involving specific adult athletes, and with the collaboration of two figures, that of the coach and that of the drawing teacher, could lead to a greater depth of the method and more relevant results. It is also suggested that the use of imaginative drawing in the recovery phases or during rehabilitation from injuries, or in situations where it is impossible to train, is already an applicable tool with a prospect of success.
In order to better frame the results in the future, we think it would be interesting to add tests to evaluate spatial abilities and the perceived self-efficacy. It is also proposed that the drawing be accompanied by verbal feedback from participants.
The very high standard deviation data suggests that the results could be more accurate in statistical terms if the sample were larger, but it also tells us something else. Considering that the way of learning is characterised by different "styles" (Kolb, 1984) and different

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Investigación

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Revista de Estudios en Sociedad, Artes y Gestión Cultural
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Número 23
De los procesos técnicos a las narrativas con sentido.
Enero 2023

intelligences (Gardner, 1983), this data explains to us that the method can be useful for everyone because it is complementary to the usual practices, but more successful for some than others. Once the potential involved in learning through identification or embodied drawing has been better investigated, it will be possible to generalise practices that can be followed in the school curriculum to complement the "spatial" and "kinaesthetic" organic development of the various types of intelligence

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Investigación

Table's contents:

GS.:	Experimental group
GC:	Control group
EL:	Gymnastic exercise to learn
RU:	Cartwheel
RO:	Round-off
TOT 1:	Total points collected in preliminary test (min 4 max 20)
TOT 2:	Total points collected in the end test (min 4 max 20)
P1,2,3,4:	Parameter 1, 2, 3,
4	
Δ %:	Total improvement for each gymnast in second test, percentage of the total could be collected (20)
μ:	Average result of all gymnast separated for each parameter
Δ μ % P:	Average improvement in percentage between the whole sample divided into the various parameters
M±DS	Average +- Standard deviation

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Revista de Estudios en Sociedad, Artes y Gestión Cultural
ISSN: 2340-9096

Número 23
De los procesos técnicos a las narrativas con sentido

Enero 2023

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Investigación

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Revista de Estudios en Sociedad, Artes y Gestión Cultural
ISSN: 2340-9096
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Investigación

Visual References

Figure 1: Vian Giorgia, Drawing to improve pole vault technique (and coach's corrections), 2010. pen on paper. 29,7 cm x 21 cm. Vian, G. Collection, Milan.

Figure 2: Sport and health student di scienze motorie, Drawing for learning first pole vault's lesson (revised in pencil by Vian G.), 2018. pennarello e matita 29,7 cm x 42cm. Vian, G. Collection, Milan.

Figure 3: EB, Drawing as I imagine myself doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 4: ES, Drawing as I imagine myself doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 5: VV, Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 6: EC, Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 7: ES, First and third Drawing as I imagine my hand and footprints doing a correct cartwheel (revised in blu by Vian, G.), 2020. Pastels on paper. 29,7 cm x 21 cm. Author Collection, Milan.

Figure 8: Vian Giorgia, EB moving paper model in order to play a cartwheel. Digital photography. Vian, G. Collection, Milan.