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Vividness and Transformation of Mental Images in Karate

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Abstract

Background: Systematic reviews have shown that imagery improves performance in motor tasks. **Objective:** In order to observe the function of imagery in sport, this study investigated modifications in Imagery Ability, in terms of both controllability (i.e., the accurateness with which an image can be operated mentally) and vividness (i.e., the precision richness of an image), in competitive and recreational karateka. **Method:** Thirty volunteers karateka completed the Vividness of Visual Imagery Questionnaire, the Vividness of Movement Imagery Questionnaire-2, and the Subtraction of parts Task. **Results:** Competitive athletes reported higher scores on imagery ability than recreational athletes. No correlations were found between the variables of Vividness and the Subtraction of parts Task for any of the two groups. All analyses were two-tailed with α at .05. **Conclusion:** The study has risen the investigation in the particular ambit of imagery ability, providing an additional support for the multidimensional nature of mental imagery and for its usefulness in athletes.

Keywords: imagery, motor tasks, karate, static vividness

1. Introduction

"Mental imagery is an image that comes from stored images, not directly related to the sensory mode" (Kosslyn, 2007, p.94). Imagery is described as a psychological condition that reminds physical characteristics of any person, place, thing, or that is not present from our perception. Imagery is related to static and moving objects, acting as a device that enhances the memorization of kinesthetic acts and allows people to anticipate events (Denis, 1985). Furthermore, imagery could be a real increment to quotidian physical activity and a support for a certain amount of physical practice when athletes are not capable to exercise. If those kinesthetic acts can be differentiated, such as after a good skill action, then learning should be accelerated. It is suggested that if individuals are taught how to image, fewer errors and faster learning can occur (Guillot & Collet, 2010). In a sports context, Morris, Spittle and Watt (2005) claimed that "imagery may be considered as the intentional or unintentional conception or regeneration of an experience produced from memorial information, concerning quasi-affective and quasi-sensorial features which may occur in the absence of the tangible stimulus antecedents usually associated with the real experience" (Morris, Spittle & Watt, 2005, p. 19). In other words, Watt, Spittle and Morris (2002) described imagery as the condition in which persons imagine themselves in habits which may lead to increasing and performing skills. It is generally evaluated in terms of its mental and motivational characteristics. In this direction, imagery has been defined as a "central pillar of applied sport psychology" research (Morris, Spittle & Perry, 2004, p. 344). Many empirical research papers have enhanced knowledge about the effectiveness of imagery in sporting contexts (Morris, Spittle & Watt, 2005). Mental practice and visualization are terms used for relating to different aspects of mental imagery in sport (Hale, Seiser, McGuire & Weinrich, 2005). Independently from the perspective (third or first person) or the method applied (kinesthetic or visual), systematic reviews have shown that mental imagery improves performance in motor tasks (Moreau, Clerc, Mansy-Dannay & Guerrien, 2010). More specifically, meta-analysis studies conducted to define the results of mental training on motor execution have shown that any capacity can be trained and improved through mental practice, which aids learning and memorization of motor tasks. Though the efficacy of mental activity is tempered by dissimilar variables, such as the type of sporting context, interaction between practice and intervals of retention, the length of time over which mental imagery training takes place, and level of skill (athletes or novices); the fusion of physical and mental activity improves performance equivalent or more than no practice (Feltz & Landers, 1983; Weinberg, 2008). Furthermore, to enhance successive enhancements, motor imagery characteristics should remain near to features of physical execution, insofar as the same channels of the autonomous nervous system seem involved during effective performance of the motor activity as during mental visualization of it (Roure *et al*., 1999).

Several researches of the relation among mental imagery and physical athletic performance suggest that using multiple techniques of imagery improves sports performance, the mental imagery in actual competitive performance, and also decreases pre-match anxiety symptoms (Ligget, 2000; Munroe, Giacobbe, Hall & Weinberg, 2000; Smith, Wright, Allsopp & Westhead, 2007; Weinberg, 2008). Moreover, results of self-report questionnaires revealed that skilled players use visual imagery more than less skilled players (Eton, Gilner, & Munz, 1998; Cumming & Hall, 2002; Hammond, Davis, & Ziachowsky, 2015). Nordin and Cumming (2005) described that professional dancers, as athletes, use both perceptual and motivational functions of mental imagery during training and competitions.

In addition to investigating the effectiveness of mental imagery in sports performance, cognitive psychology, through experimental differences studies, has shown that imagery skill might affect motor performance as well as motor accuracy (Yaguez, Nagel, Hoffman, Canavan & Wist, 1998; Lorey *et al*., 2010). Meanwhile, sport psychology found that athletes can increase the imagery skills through apposite exercise directed on achieving that specific goal (Weinberg, 2008), proposing that imagery skill can be developed with exercise. Moreover, several researchers have found an association among high performance in sport and ability in mental rotation (Fatemeh Pasand, Rekabi, Goodarzi, & Chahardahcheric, 2015; Moreau, Mansy-Dannay, Clerc & Guerrien, 2011) and between motor practice and imagery ability, related to the processes of mental rotation (Jansen, Titze & Heil, 2009). These outcomes advise a close connection among imagery ability and motor practice. In line with this relationship, cognitive psychology and sport psychology developed instruments which are useful to separate mental imagery ability into two components: *controllability*, i.e. "manipulate mentally an image in accurate way" (Moran, 1993; Guillot & Collet, 2010), and *vividness* of an image, i.e. "its sensory fullness" (Murphy, 2005). Vividness is measured by self-report questionnaires, which report on the subjective perception on the quality of the images, and hence may not report the precise quality of the image. Instead, controllability can be measured objectively by asking subjects to undertake tasks involving the mental manipulation of objects, where accuracy can be verified through objective criteria (MacIntyre, Moran & Jennings, 2002; Collet, Guillot, Lebon, Macintyre & Moran, 2011).

Factorial studies of imagery ability advise that the accurateness to manipulate mentally an image as measured by test performance is unrelated to the individual qualities of image as measured by self-report methods (Lequerica, Rapport, Axelrod, Telmet & Whitman, 2002; Ochsner & Kosslyn, 2013; Poltrock & Agnoli, 1986). In other terms, there are no relations between vividness and controllability.

Sport psychology shows inconsistent results on the association among these two components of sport performance and imagery. Highlighting the relation between vividness and sport or motor performance, some studies revealed that individuals with high vividness ability measured by self-report methods know new movements quicker than individuals with poor vividness ability (Goss, Hall, Buckolz & Fishburne, 1986). Moreover, they are more precise while performing accurate movements (Hall, Buckolz & Fishburne, 1989). However, other studies demonstrated better athletes' performance in controllability but not in vividness. In order to compare athletes and novices in three different sports (fencing, judo and wrestling), Moreau, Clerc, Mansy-Dannay and Guerrien (2010) found no significant results for variable levels of expertise for vividness, while there were positive effects on controllability.

By contrast, Di Corrado, Guarnera and Quartiroli (2014) found that dancers and karateka possessed upper scores for both vividness and controllability than the control group (non-athlete).

Traditional karate is a martial art, and students should train with the correct attitude, exemplifying the principles of the martial art and goals. A strong emphasis is placed on mental rehearsal, and not only on physical techniques. Appropriate training employs the application of the body and mind in conjunction. The karateka acts as a spectator: he trains his mind to deal directly with confrontation with the enemy, perform actions quickly and control anxiety. Meditation plays an important part in martial arts. Forgetting everything that surrounds him, the karateka focuses on the execution of techniques or kata (fighting figuratively) in a permanent conscious state. To become an accomplished martial artist, it is necessary to work on the speed of kicks and punches, with a balanced approach to both physical and mental development. There are two types of thinking: strategic thinking, that informs offensive and defensive systems, waiting for the right time to implement moves; and tactical thinking, or intuition, that allows kicks and punches to be foreseen, that uses experience and focusing on a sequence, without preset action plans. Highly complex combinations of techniques require considerable mental training to reinforce, rapidly and efficiently, the stimulus/response mechanisms that are developed through actual training. The purpose of the current study is to explore the roles of static and dynamic vividness and the controllability of mental images to distinguish between expert karateka and novices.

2. Methods

2.1 Participants

The research was conducted with thirty volunteers karateka (11 females and 19 males), ranging from 18 to 28 years (M = 23.53; SD = 3.29), were recruited as follows:

- fourteen novices with yellow, red and green belts. Their karate training ranges from one to four years, with 2/3 hours per week (two weekly workouts);
- sixteen athletes practicing karate at a high and medium competitive level, with leading positions both nationally and internationally. In this case, karate training is five or more years with almost 6/8 hours per week (three/four weekly workouts).

We considered experienced players the athletes having more than four years of experience in the positions both nationally and internationally.

2.2 Procedure

Measurements were conducted individually, in a private location near the training facilities but not directly before or after competitions in an effort to minimize external interferences. Once the participants completed the questionnaires, the subtraction of parts task was administered. Each participant received a full description of the scope and the protocol of the study. Privacy of the answers was also guaranteed. Before starting the protocol, each participant signed the informed consent.

2.3 Instrument

2.3.1 The Vividness of Visual Imagery Questionnaire.

The *Vividness of Visual Imagery Questionnaire* (VVIQ; Italian translation by Antonietti & Crespi, 1995) is a 16-item self-report tool developed to evaluate how vividly individuals experience visual mental images (e.g., features of a friend or parent, the climate, and the country). Once persons have imagined a scene, they must rate the images on clearness and vividness on a five-point scale: 1: "*No image at all* (only "*knowing" that you are thinking of the object*)"; 2: "*Vague and dim*"; 3: "*Moderately clear and vivid*"; 4: "*Clear and reasonably vivid*"; and 5: "*Perfectly clear and vivid as normal*." Higher scores indicate greater vividness (Antonietti & Crespi, 1995). Researchers reported a mean Cronbach's α of .89 (McKelvie, 1995) and a 2-week test-retest reliability oscillating from $r = .62$ (Eton, Gilner & Munz, 1998) to $r = .86$ (Parrott & Strongman, 1985). The validity of the measure is supported by the literature (Campos, 2011). McKelvie (1995) described a criterion validity coefficient of $r = .27$, and defined that usually the evidence sustains the Vividness of Visual Imagery Questionnaire as a valid measure. Campos and Pérez-Fabello (2005, 2009) and Burton and Fogarty (2003) have found that the Vividness of Visual Imagery Questionnaire correlated between .49 and .58 with Betts' Questionnaire Upon Mental Imagery (Betts' QMI; Sheehan, 1967). Pérez-Fabello and Campos (2004) and Campos and Pérez-Fabello (2009) found that the Vividness of Visual Imagery Questionnaire correlated between −.40 and −.24 with the Gordon Test of Visual Imagery Control (Gordon test; Richardson, 1969). Moreover, Burton (2003) and Burton and Fogarty (2003) obtained positive correlations (.32) with the Gordon Test of Visual Imagery Control because elevated scores on the Gordon test designated poor imaging ability and vice versa.

2.3.2 The Vividness of Movement Imagery Questionnaire-2.

The *Vividness of Movement Imagery Questionnaire-2* (VMIQ-2; Roberts, Callow, Hardy, Markland & Bringer, 2008) is a self-report questionnaire for assessing imagery of movement. The VMIQ-2 evaluates capacity to kinesthetically and visually image a diversity of moves, and includes 24 items. The vividness is graded along a 5-point scale. Low vividness scores correlate with accuracy. The VMIQ-2 measures three diverse kinds of imagery: 1. *external visual imagery,* that denotes to an image obtained by observing movement performed by the subject from an outside perspective; 2. *internal visual imagery*, that indicates an image obtained observing the subject him/herself while making a movement; 3. *kinesthetic imagery,* that allows an image to be obtained of the way the subject perceives and feels during the execution of a movement, as if they were really running. A test-retest coefficient of $r = .76$ was described by Isaac, Marks and Russel (1986). The VMIQ-2 also confirms acceptable simultaneous validity with the Vividness of Visual Imagery Questionnaire with beginner, expert, and international-level trampolinists. The correlations were 0.75, 0.45, and 0.65 respectively (Isaac *et al*., 1986).

2.3.3 The Subtraction of Parts Task.

The *Subtraction of Parts Task* consists of mentally taking away a part of an image in order to compose or decompose complete figures. This task was extracted from the Mental Imagery Test (Di Nuovo, Castellano & Guarnera, 2014). Di Nuovo and colleagues reported an α coefficient of $r = .78$ relative to the whole score of the Mental Imagery Test. The participants were shown two 17 × 12 cm cards representing a full lighted digital clock on the first card, while the second card contained the part(s) of the picture that needed to be taken away. The participants were asked to image figure A (complete clock) without figure B (the subtracting parts) and name the resulting image. Specifically, the participants received the following verbal instructions: "Look at this (pointing to figure A: complete clock) without this (pointing to figure B: subtracting parts). What does this (pointing to A) become?" The participants received three trials and were tried separately in an only meeting lasting about 10 min.

2.4 Data Analyses

Statistical analyses were processed with SPSS version 16.0 (SPSS Inc., Chicago, IL). First, suppositions on the homogeneity of variances were confirmed (Kolmogorov-Smirnov and Levene's tests being non-significant in all cases). All analyses were two-tailed with α at .05.

3. Results

A *t-test* was carried out, to verify the existence of differences in the performances of novices and experts in the various areas under investigation (Table 1). We considered experienced players the athletes having more than four years of experience in the positions both nationally and internationally. We had fourteen novices trained from one to four years and sixteen athletes trained from five or more years.

Table 1. T-test results

		Group	M	SD	*t*	*p*
Vividness of Visual Imagery		Novices	66.57	7.07	-4.62	0.00
		Experts	75.50	2.94		
Vividness of Movement Imagery	External visual imagery	Novices	21.00	5.51	2.51	0.02
		Experts	16.81	3.54		
	Internal visual imagery	Novices	24.50	5.85	2.70	0.01
		Experts	19.56	4.11		
	kinesthetic imagery	Novices	24.36	6.49	2.61	0.01
		Experts	19.37	3.79		
Subtraction of parts Task		Novices	3.93	2.84	-2.09	0.05
		Experts	5.69	1.70		

Results showed that competitive athletes have higher scores on imagery ability than recreational athletes (novices).

Pearson correlational analyses were applied separately for the two groups, of novices and experts. Results for both groups showed that external visual imagery, internal visual imagery, and kinesthetic imagery correlate significantly with each other, but not with static imagery (Table 2).

Table 2. Pearson correlation matrix Beginners

	Vividness of Visual Imagery	External visual imagery	Internal visual imagery	kinesthetic imagery	Subtraction of parts Task
Vividness of Visual Imagery	1.00				
External visual imagery	-0.45	1.00			
Internal visual imagery	-0.46	0.88*	1.00		
Internal visual imagery	-0.44	0.94*	0.97*	1.00	
Subtraction of parts Task	0.30	-0.54	-0.31	-0.43	1.00

*$p < .01$.

There are no significant correlations between Vividness (both for Visual Imagery and Movement Imagery) and Subtraction of parts Task (Table 3).

Table 3. Pearson correlation matrix Experts

	Vividness of Visual Imagery	External visual imagery	Internal visual imagery	kinesthetic imagery	Subtraction of parts Task
Vividness of Visual Imagery	1.00				
External visual imagery	0.28	1.00			
Internal visual imagery	0.34	0.85*	1.00		
Internal visual imagery	0.35	0.83*	0.94*	1.00	
Subtraction of parts Task	0.03	0.18	0.14	0.28	1.00

*$p < .01$.

4. Discussion

These findings showed higher scores on static and dynamic vividness in competitive athletes than in recreational athletes (or novices). According to Isaac and Marks (1994), while competitive athletes produced vivid and clear mental images, novices visualize no clear images. Furthermore, Callow, Roberts and Fawkes (2006) have shown that a group of participants undergoing imagery testing evidenced a higher capacity to produce clear and vivid images, confronted to the control group. Furthermore, in both the groups of novices and expert karateka, positive correlations emerge between External Visual Imagination, Internal Visual Imagination and Kinesthetic Imagination. In partial confirmation of such findings, Jowdy and Harris (1990) and Hale, Seiser, McGuire and Weinrich (2005) claim that it is easier, through internal visual imagination, to feel the sensation of movement (kinesthetic imagination), hence internal visual imagination seems to be linked with kinesthetic imagination.

In this regard, Hall, Rodgers and Barr (1990), decided that internal viewpoint has the potential to integrate kinesthetic imagery, while external viewpoint is not sufficient to create such feelings. Kinesthetic imagery needs the subject to mentally perceive muscle contractions, and this cannot occur if the subject visualizes the movement from a third-person perspective (Denis, 1989). Correlation between kinesthetic and external imagery in karate could be connected to specific training that improves external perspective in karateka when compared with other athletes.

According to previous studies (Jansen, Titze & Heil, 2009; Moreau, Mansy-Dannay, Clerc & Guerrien, 2011), competitive karateka (experts) reported higher scores for ability to manipulate mental images (controllability) than recreational karateka.

Furthermore, no significant correlations were observed between vividness and controllability components for either of the two groups. These data seem to confirm studies claiming that mental imagery is not a unitary construct (Campos & Perez-Fabello, 1990; Dean & Morris, 1991; Campos, 1998; Moran, Campbell, Holmes & MacIntyre, 2012). Furthermore, other studies have demonstrated that abilities with imagery are dissociable (Kosslyn, Thompson & Ganis, 2006; Ochsner & Kosslyn, 2013). In particular, Lequerica, Rapport, Axelrod, Telmet and Whitman (2002) found that no significant correlation was observed between static and kinesthetic imagery and objective measures of visual-spatial manipulation. Hishitani and Nishihara (2007) claimed that vividness and controllability, measured through tasks involving rotation of images, are independent components of imagery.

This study is characterized by few limitations. Although the addition of the objective task as added some interesting reflection about the ability of individuals to transform and control images, the value of it in this study might have been limited by the nature of the task. Despite the simplicity of the task, the picture of a digital clock could have been distracting not necessarily being part of the karate world. Future research might want to explore the possibility to develop activity-specific transformation tasks, aiming to be more accurate to assess the ability of the participant of create and control images, which could possibly influence also the relationship scores. Additionally, future researchers could look at the use of imagery, as well as the ability to developed vivid and controlled images, in other active performers.

5. Conclusion

Considering that imaginative capacity is found in all individuals but can be modified through practice (Weinberg, 2008), further research in this area might expand the study to include similar sports such as judo or tai-chi, in order both to demonstrate the importance of mental training and to further clarify the relationship between the different components of imagery in athletes who practice disciplines in which mental training is especially significant.

Reference

Antonietti, A. & Crespi, M. (1995). Analisi di tre questionari per la valutazione della vividezza dell'immagine mentale (Analysis of three questionnaires for assessing the vividness of mental image). Department Of Psychology, Catholic University Of The Sacred Heart, Technical Report, Milano. http://www.neurovr.org/psylab/ricerca_pc_im.html

Burton, L. J. & Fogarty, G. J. (2003). The factor structure of visual imagery and spatial abilities. *Intelligence*, *31*(3), 289-318. http://dx.doi.org/10.1016/s0160-2896(02)00139-3

Burton, L. J. (2003). Examining the relation between visual imagery and spatial ability tests. *International Journal of Testing*, *3*(3), 277-291. http://dx.doi.org/10.1207/s15327574ijt0303_6

Callow, N., Roberts, R., & Fawkes, J. Z. (2006). Effects of dynamic and static imagery on vividness of imagery, skiing performance and confidence. *Journal of Imagery Research in Sport and Physical Activity*, *1*(1), 1-15. http://dx.doi.org/10.2202/1932-0191.1001

Campos, A. & Perez-Fabello, M. J. (1990). A factor analytic study of two measures of mental imagery. *Perceptual and Motor Skills*, *71*, 995-1001. http://dx.doi.org/10.2466/pms.1990.71.3.995

Campos, A. & Pérez-Fabello, M. J. (2005) The Spanish version of Betts' Questionnaire Upon Mental Imagery. *Psychological Reports*, *96*(1), 51-56. http://dx.doi.org/10.2466/pr0.96.1.51-56

Campos, A. & Pérez-Fabello, M. J. (2009). Psychometric quality of a revised version Vividness of Visual Imagery

Questionnaire. *Perceptual and Motor Skills*, *108*(3), 798-802. http://dx.doi.org/10.2466/pms.108.3.798-802

Campos, A. (1998). A measure of visual imaging capacity: A preliminary study. *Perceptual and Motor Skills*, *87*, 1012-1014. http://dx.doi.org/10.2466/pms.1998.87.3.1012

Campos, A. (2011). Internal consistency and construct validity of two versions of the Revised Vividness of Visual Imagery Questionnaire. *Perceptual and Motor Skills*, *113*(2), 454-460. http://dx.doi.org/10.2466/04.22.PMS.113.5.454-460

Collet, C., Guillot, A., Lebon, F., Macintyre, T., & Moran, A. (2011). Measuring motor imagery using psychometric, behavioral, and psychophysiological tools. *Exercise and Sport Sciences Reviews*, *39*(2), 85-92. http://dx.doi.org/10.1097/JES.0b013e31820ac5e0

Cumming, J. & Hall, C. (2002). Deliberate imagery practice: The development of imagery skills in competitive athletes. *Journal of Sports Sciences*, *20*(2), 137-145. http://dx.doi.org/10.1080/026404102317200846

Dean, G. & Morris, P. E. (1991). Imagery and spatial ability: When introspective reports predict performance. In R. H. Logie and M. Denis (Eds.), *Mental images in human condition*. Amsterdam: Elsevier. Pp. 331-347. http://dx.doi.org/10.1016/S0166-4115(08)60522-1

Denis, M. & Carfantan, M. (1985). People's knowledge about images. *Cognition*, *20*(1), 49–60. http://dx.doi.org/10.1016/0010-0277(85)90004-6

Denis, M. (1989). *Image et cognition*. Paris: Presses Universitaires de France. Revised English version: *Image and cognition*. New York: Harvester Wheatsheaf, 1991.

Di Corrado D., Guarnera M., & Quartiroli A. (2014). Vividness and transformation of mental images in karate and dance. *Perceptual and Motor Skills*, *119*(3), 764–773. http://dx.doi.org/10.2466/22.24.PMS.119c30z6

Di Nuovo, S., Castellano, S., & Guarnera, M. (2014). *MIT mental imagery test*. Florence, Italy: Hogrefe Editor.

Driskell, J. E., Copper, C., & Moran A. (1994). Does mental practice enhance performance? *Journal of Applied Psychology*, *79*(4), 481-492. http://dx.doi.org/10.1037/0021-9010.79.4.481

Eton, D. T., Gilner, F. H., & Munz, D. C. (1998). The measurement of imagery vividness: A test of the reliability and validity of the vividness of visual imagery questionnaire and the vividness of movement imagery questionnaire. *Journal of Mental Imagery*, *22*(3-4), 125-136.

Fatemeh Pasand, F., Rekabi, A., Goodarzi, A. M., & Chahardahcheric, M. (2015). The Comparison of Mental Rotation Performance in Team and Individual Sports of Students. *International Journal of Kinesiology and Sports Science*, *3*(1), 21-26.

Feltz, D. L. & Landers, D. M. (1983). The effects of mental practice on motor skill learning and performance: A meta-analysis. *Journal of Psychology*, *5*, 25-57.

Goss, S., Hall, C., Buckolz, E., & Fishburne, G. (1986). Imagery ability and the acquisition and retention of movements. *Memory and Cognition, 14*(6), 469-477. http://dx.doi.org/10.3758/BF03202518

Guillot, A. & Collet, C. (2010). *The neurophysiological foundations of mental and motor imagery*. Oxford: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780199546251.001.0001

Hale, B. D., Seiser, L., McGuire, E. J., & Weinrich, E. (2005). Mental imagery. In J. Taylor and G. Wilson (Eds.), *Applying sport psychology*. *Four perspectives*. Champaign: Human Kinetics. Pp. 117-136.

Hall, C. R., Rodgers, M. W., & Barr, K. A. (1990). Athletes in Selected Sports. Applied Research. *The Sport Psychologist*, *4*, 1-10.

Hall, C., Buckolz, E., & Fishburne, G. (1989). Searching for a relationship between imagery ability and memory of movements. *Journal of Human Movement Studies,17*, 89-100.

Hammond, T. G., Davis, H., & Ziachowsky, L. (2015). The effects of self-focus on affect and vertical jump performance of NCAA athletes. *International Journal of Kinesiology and Sports Science*, *3*(2), 9-16.

Hishitani, S. & Nishihara, S. (2007). A measurement of the ability to assess imagery vividness based on a model of working memory and signal detection theory. *The Japanese Journal of Cognitive Psychology*, *4*, 103-115. http://dx.doi.org/10.5265/jcogpsy.4.103

Isaac, A. R. & Marks, D. F. (1994). Individual differences in mental imagery experience: developmental changes and specialization. *British Journal of Psychology*, *85*(4), 479-500. http://dx.doi.org/10.1111/j.2044-8295.1994.tb02536.x

Isaac, A., Marks, D. F., & Russell, D. G. (1986). An instrument for assessing imagery of movement: The vividness of movement imagery questionnaire (VMIQ). *Journal of Mental Imagery*, *10*(4), 23-30.

Jansen, P., Titze, C., & Heil, M. (2009). The influence of juggling on mental rotation performance. *International Journal of Sport Psychology*, *40*(2), 351-359.

Jowdy, D. P. & Harris, D.V. (1990). Muscular responses during mental imagery as a function of motor-skill level. *Journal of Sport and Exercise Psychology*, *12*(2), 191-201.

Kosslyn, S. M., Thompson, W. L., & Ganis, G. (2006). *The case for mental imagery*. Oxford: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195179088.001.0001

Kosslyn, S.M., Shephard, J.M., & Thompson, W.L. (2007). Spatial processing during mental imagery: a neurofunctional theory. In F. Mastand and L. Jancke (Eds.), *Spatial Processingin Navigation, Imagery, and Perception*. NewYork: Springer. Pp. 1–16. http://dx.doi.org/10.1007/978-0-387-71978-8_1

Lequerica, A., Rapport, L., Axelrod, B. N., Telmet, K., & Whitman, R. D. (2002). Subjective and objective assessment methods of mental imagery control: Construct validations of self-report measures. *Journal of Clinical and Experimental Neuropsychology*, *24*(8), 1103-1116. http://dx.doi.org/10.1076/jcen.24.8.1103.8370

Liggett, D. R. (2000). Enhancing imagery through hypnosis: a performance aid for athletes. *American Journal of Clinical Hypnosis*, *43*(2), 149-157. http://dx.doi.org/10.1080/00029157.2000.10404267

Lorey, B., Pilgramm, S., Walter, B., Stark, R., Munzert, J., & Zentgraf, K. (2010). Your mind's hand: motor imagery of pointing movements with different accuracy. *NeuroImage*, *49*, 3239–3247. http://dx.doi.org/10.1016/j.neuroimage.2009.11.038

MacIntyre, T., Moran, A., & Jennings, D. (2002). Is controllability of imagery related to canoe-slalom performance? *Perceptual and Motor Skills, 94*(3), 1245–1250. http://dx.doi.org/10.2466/PMS.94.2.1245-1250

McKelvie, S. J. (1995). The VVIQ as a psychometric test of individual differences in visual imagery vividness: a critical quantitative review and plea for direction. *Journal of Mental Imagery*, *19*, 1-106.

Moran, A. P. (1993). Conceptual and methodological issues in the measurement of mental imagery skills in athletes. *Journal of Sport Behavior*, *16*(3), 156-170.

Moran, A. P., Campbell, M. J., Holmes, P. S., & MacIntyre, T. (2012). Mental imagery, action observation and skill learning. In M. A. Williams, N. J. Hodges and A. M. Williams (Eds.), *Skill Acquisition in Sport*. New York: Routledge. P. 385.

Moreau, D., Clerc, J., Mansy-Dannay, A., & Guerrien, A. (2010). Assessing movement imagery ability: self-report questionnaires vs. performance based tests. *Europe's Journal of Psychology*, *4*(4), 93-109. http://dx.doi.org/10.5964/ejop.v6i4.225

Moreau, D., Mansy-Dannay, A., Clerc, J., & Guerrien, A. (2011). Spatial ability and motor performance: assessing mental rotation processes in elite and novice athletes. *International Journal of Sport Psychology*, *42*(6), 525-547.

Morris, T., Spittle, M., & Perry, C. (2004), Mental imagery in sport. In T. Morris and J. Summers (Eds.), *Sport psychology: Theory, applications and issues* (2nd ed., pp. 344-387). Brisbane: John Wiley and Sons.

Morris, T., Spittle, M., & Watt, A.P. (Eds.) (2005). Technical aids to imagery. In *Imagery in Sport.* Champaign, IL: Human Kinetics. Pp. 237-266.

Munroe, K., Giacobbe, P. R., Hall, C. R., & Weinberg, R. S. (2000). The Four Ws of imagery use: when, where, what, why. *Sport Psychologist*, *14*, 119-137.

Murphy, S. M. (2005). Imagery: Inner theater becomes reality. In S. M. Murphy (Ed.), *The Sport Psych Handbook*. Champaign, IL: Human Kinetics.

Nordin, S. M. & Cumming, J. (2005). Professional dancers describe their imagery: Where, when, what, why, and how. *The Sport Psychologist*, *19*(4), 395-416.

Ochsner, K. & Kosslyn, S. M. (2013). *The Oxford handbook of cognitive neuroscience* (Vol.1). Oxford: Oxford University Press. http://dx.doi.org/10.1093/oxfordhb/9780199988709.001.0001

Parrott, C. A. & Strongman, K. T. (1985). Utilization of visual imagery in creative performance. *Journal of Mental Imagery*, *9*(1), 53-63.

Pérez-Fabello, M. J. & Campos, A. (2004). Factor structure and internal consistency of the Spanish version of the Gordon Test of Visual Imagery Control. *Psychological Reports*, *94*(3), 761-766. http://dx.doi.org/10.2466/pr0.94.3.761-766

Poltrock, S. & Agnoli, F. (1986). Are spatial visualization ability and visual imagery ability equivalent? In R. J. Sternberg, *Advances in the psychology of human intelligence*. Hillsdale, NJ: Lawrence Erlbaum. Pp. 255-296.

Richardson, A. (1969). *Mental Imagery*. New York: Springer Publishing Company. http://dx.doi.org/10.1007/978-3-662-37817-5

Roberts, R., Callow, N., Hardy, L., Markland, D., & Bringer, J. (2008). Movement imagery ability: development and assessment of a revised version of the Vividness of Movement Imagery Questionnaire. *Journal of Sport and Exercise Psychology*, *30*(2), 200-221.

Roure, R., Collet, C., Deschaumes-Molinaro, C., Delhomme, G., Dittmar, A., & Vernet-Maury, E. (1999). Imagery quality estimated by autonomic response is correlated to sporting performance enhancement. *Physiology and Behavior*, *66*(1), 63–72. http://dx.doi.org/10.1016/S0031-9384(99)00026-8

Sheehan, P. W. (1967). A shortened form of Betts' questionnaire upon mental imagery. *Journal of Clinical Psychology*, *23*(3), 386-389. http://dx.doi.org/10.1002/1097-4679(196707)23:3<386::AID-JCLP2270230328>3.0.CO;2-S

Smith, D., Wright, C., Allsopp, A., & Westhead, H. (2007). It's all in the mind: PETTLEP-based imagery and sports performance. *Journal of Applied Sport Psychology*, *19*(1), 80-92. http://dx.doi.org/10.1080/10413200600944132

Watt, A.P., Spittle, M., & Morris, T. (2002). Evidence related to the evaluation of measures of sport imagery. *Journal of Science and Medicine in Sport*, *5*(4), 29. http://dx.doi.org/10.1016/S1440-2440(02)80093-7

Weinberg, R. (2008). Does imagery work? Effects on performance and mental skills. *Journal of Imagery Research in Sport and Physical Activity*, *3*(1), 1-21. http://dx.doi.org/10.2202/1932-0191.1025

Yaguez, L., Nagel, D., Hoffman, H., Canavan, A. G., Wist, E., & Homberg, V. (1998). A mental route to motor learning: Improving trajectorial kinematics through imagery training. *Behavioral Brain Research*, *90*(1), 95-106.