Imagery Improves Reaction Time in Elite Sprinters

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Abstract: Motor imagery has been found to be helpful for developing skills in sport. Motor imagery (MI) helps an athlete to visualize simple or complex motor activities in the absence of physical practice. Few studies have inspected the effects of motor imagery on trained individuals. The purpose of this study was to investigate the effects of motor imagery on reaction time. Differences in reaction time can make a difference in terms of the overall performance (time, ranking). Twenty-four male and female National elite athletes (12 male; age: 22.92$\pm$1.73 years and 12 female; age: 22.67$\pm$1.67 years), who participated in this study, were classified into two (2) groups. Participants were classified according to data from a pretest in which they recorded their reaction time (ms) on starting blocks and a 30 meters race time (s). The control group (N=12) carried out the practice physically and the imagery (intervention) group (N=12) firstly carried out the practice mentally and then physically with the control group. Motor Imagery was conducted on the experimental group for fifteen (15) minutes every day for two (2) weeks. At the end of two (2) weeks, a post-test was conducted to examine any intervention effects. The data were analyzed by a paired t-test. The findings revealed that imagery group athletes improved more than the control group ($p < 0.05$). A couple of the athletes from the physical practice group (no intervention) showed better results than the imagery group, but the researcher observed the potential reason behind this enhancement might have been due to the competitive atmosphere created due the experiment for which they put their best to beat the other group in the post test.

1 INTRODUCTION

Motor learning is considered central to enhance motor skill acquisition. Furthermore, mental practice of these motor skills has the potential to supplement the practical experiences for a better and faster learning of motor skills. Mental practice involves athletes to review certain skills and perfecting them in their mind without performing them practically (Mohammadpour et al., 2012). Recent studies have found substantial evidence to support the fact that the use of imagery has little effect on the improvement of sport performance but when it comes to elite sporting endeavors, even an improvement in reaction time can have dramatic impact (Nelson et al., 1994). For example, difference between the world top sprinters are in milliseconds (i.e., Bolt: 9.58s, Gay: 9.69s, Blake: 9.69s, Powell: 9.72s, Gatlin: 9.74s, Carter: 9.78s). Thus, even a minor improvement in reaction time might have an important performance effect in athletic events. The objective of the present study is to assess the implications and role of mental practice on the effective reaction time responses (performance) of elite athletes.

The philosophy behind the emergence of sports psychology, as a branch of psychology, is focused partly on providing assistance to coaches in teaching motor skills to the athletes (Mohammadpour et al., 2012). Self-focused attention is a process that surges personal awareness as well as it is exceptionally connected with personal evaluation (Silvia and Phillips, 2013). As with other forms of self-focused attention, imagery is hypothesized to include a process of evaluation. The images generated are believed to prompt comparisons between the imagined activities and actual performances (Hall, 2001). In this manner, researchers have demonstrated the positive effects of imagery to enhance performance. Imagery can be used to help athletes who are injured to continue to develop their motor skills as well as a supplementary activity to physical practice.

The key difference between mental and physical practice is associated with the practical experience of the physical practice (Haier et al., 2005). All

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processes of motor planning and preparation are activated when an athlete initiates the mental imagination of a certain skill or practice, with the same magnitude of performing that activity. Motor imagery has been connected with neural changes (Davis et al., 2008; Davis et al., 2012) that are reliable with the methods that persuade self-focused attention (Ma and Han, 2011; Qin and Northoff, 2009).

Davis supports the idea that self-focused imagery used by athletes may stimulate personal evaluations that change psychological conditions as well as physiological conditions, which are considered beneficial for sport performance. For example, when presented with self-referenced stimuli and asked to imagine a previous performance, athletes with higher success rates report more positive impact, less negative effect, and amplified blood oxygen-level dependent (BOLD) activation in the appropriate premotor cortex, that is, the sensorimotor cortex (Davis et al., 2012). The slower the stimulus recognition, the slower the reaction movement. A delay of even one hundredth of a second can cost an athlete a podium position in the professional track and field sprint events.

Electrophysiological studies on the brain have confirmed that cerebral potential amplitude surges when a new skill is acquired, specifically in the premotor prospective, which is the “decision-to-act” part of reaction time; elite athletes have higher potential of predictability compared to novice athletes (Collet, 1999). This neuroscientific research supports the view that reaction time is both learned and trainable.

An elite athlete can prepare himself for the optimal performance before any major competition by mentally rehearsing a routine before physically engaging themselves. Through imagery, athletes can build their confidence for a match and focus on playing at their peak. The value of imagery is supported by research, in the absence of physical practice, such as during travel, weather conditions, injury or any other unfortunate circumstances. It allows an athlete to review former actions and skills, so they can add accuracy and correct errors (Morris et al., 2005). Motor imagery is very useful for rehabilitation in order to boost an athlete’s performance in the future and it is currently categorized as a very important area of work regarding the motor imagery researchers (Poolton et al., 2006). International athletes like Michael Johnson, gold medalist of four Olympic and eight World Championships, former world and Olympic record holder in the 200m and 400m as well as the world record holder in the indoor 400m, talks about of what he calls the “danger zone” in which he creates a competitive mind-set on the day of the race, in which he uses positive thoughts and images to block out all the distractions (Vealey and Greenleaf, 2001).

Visual self-processing approaches like imagery are repeatedly applied to enhance sport performance through various affective and motivational functions (Martin et al., 1999). Like other forms of self-perception, mental imagery is an internal psychological activity that stimulates conscious poly-sensory experiences of objects observed in the past practices or may follow (Hall, 2001; Vealey and Greenleaf, 2001). Motor imagery is one of the most significant processes for mental practice. This process involves reviewing of a certain sport skill in their mind without practically performing it. Learners review different parts of performance and visualize doing it successfully and even become the world champions.

According to Personnier and colleagues (2008), mental and physical practice have a shared neural mechanism, and the required time for performing a task is equivalent to the time needed for imagining the same. And when the level of a task elevates, the time required for practically performing it along with mentally imagining it also increases.

Experimental research by Brouziyne and Molinaro (2005) shows that the novice athletes could achieve the skill of performing a golf shot. In this research, the highest level of improvement, among the three groups, was observed in the combined physical and mental practice group. This research also revealed that imagery is capable of developing motor skills and performance enhancement, even in the novice performers (Brouziyne and Molinaro). Preliminary evidence exists to support the idea that development in motor performance next to physical practice has higher effect than mental practice alone, but mental practice empowers an athlete to learn motor prediction and motor learning (Gentili et al., 2006).

Majumdar and Robergs (2011) researched on two different parts of a sprinter’s response time, reaction time and movement time. From the beginning of motion of the rear foot, off the block, until that same foot hits the ground; so, the response time is a collective measure of both reaction time and movement time that is from initial stimulus to initial foot strike (Majumdar and Robergs, 2011). Reaction time is the ability of an individual to move the whole or a part of his body in the shortest possible time, for example: swimmer leaving the starting pad; a thrower putting the shot; karate player moves his hand, or a wrestler makes a certain move to perform a wrestling technique. Reaction time is the interval between reception of the stimulus by a certain part of the body and responding to it. (Mohammadpour et al., 2012).

Reaction time is known as a vital feature in the world of Track and Field. This technical resource makes the elite athletes superior from the rest. Magill and Anderson defined reaction time as the time interval between the inception of a stimulus to the initiation of a response (Magill and Anderson, 2013). According to Iulian, 2012, foundation of the one's reaction pathway to the brain is the neuromuscular and psychomotor connections. Athlete's ability to react against a stimulus is dependent upon his learning experience, age, gender and his mental state (Iulian, 2012).

Multiple researchers have explored the effects of imagery on the force production (Guillot, and Collet, 2008; Lebon et al 2010). Studies have inspected the effects of imagery on a bicep curls, leg presses, standing long jumps, bench presses and a range of other movements, and found positive results on some fundamentals of force production (Guillot and Collet, 2008; Lebon et al., 2010). Many athletes and coaches already use imagery to improve performance (Holmes and Collins, 2001) but few studies have observed the effects of imagery contribution on reaction time to improve athletic performance.

Undoubtedly, in a sporting performance, the athlete needs to perform a certain skill as fast as possible, as the key to success relies on that certain reaction time in which he makes that decision psychologically and applies it physically. The importance of reaction time is revealed when you observe an athlete wins over his opponent only with a fraction of a second's difference. Many examples can be observed in a 100m sprint event where milliseconds can separate medalists from non-medalists. Furthermore, a good versus poor start might provide sprinters with increased self-efficacy to perform at their best in a race.

1.1 Objective of Study and Hypothesis

The primary aim of this study was to assess the role of imagery on improving reaction time responses (performance) of elite athletes in Pakistan. The primary hypothesis was that imagery will improve reaction time in elite sprinters.

2 METHOD

2.1 Participants

The sample comprised of twenty-four (24) elite national athletes, twelve (12) male and twelve (12) female, were selected for this study. Average age of the athletes was 22.83$\pm$1.69. Although they had been participating sprint training for at least three (3) days a week for more than four (4) months, but they had no prior formal imagery training with a sport psychology consultant or coach.

2.2 Research Instruments

Motor Imagery, Starting Blocks and Electronic Timer.

2.3 Study Design

2.3.1 Procedure

Sample of twenty-four (24) male and female athletes performed three (3) block starts and 30-meter runs, from which the best time for both variables were recorded for further analyses. Based on pretest performance, athletes were divided into two groups, controlled and experimental. Controlled group comprised six (6) male and six (6) female elite athletes with the mean age of 23$\pm$1.76 years. Same number of male and female athletes were included in the experimental group with average age of 22.67$\pm$1.67 years.

Controlled group of twelve (12) athletes' camp training under their coaches was not interrupted during the two (2) weeks experiment. Experimental group was physically trained for two (2) weeks along with controlled group and before their physical training session, they had Motor Imagery (MI) practice every day for fifteen (15) minutes.

For Motor Imagery (MI), PETTLEP model (Holmes and Collins, 2001) was used. Fifteen (15) minutes of imagery was divided into two components: for the first five (5) minutes the athletes were guided through deep breathing, so that they can relax and gain control of their physiological responses such as heart rate. For the next ten (10) minutes sport specific motor imagery script was created, in which athletes were instructed to focus on their event-specific personal feelings and thoughts. The athletes were guided through the event-specific imagery and asked to use the last three (3) minutes for their own imagery in which they could concentrate on minute details when taking a crouch start.

At the end of two (2) weeks training period, all the athletes were asked to record their reaction time (ms) and 30 meters time (s) again for the posttest.

2.3.2 Data Analysis

IBM SPSS Statistics 22 was used to perform the statistical analyses. Descriptive statistics (means and standard deviations) were calculated for all variables. Paired samples *t*-tests were applied to conclude differences between treatment and no-treatment conditions for all dependent variables. To compare the improvement in both the groups independent sample t-test was used. The statistical significance level was set at $p<0.05$.

3 RESULTS

To test the main hypothesis, a paired sample t-test was conducted on the pretest and the posttest results of control (see Table 2) and Imagery (see Table 4) groups respectively. The results of paired t-test showed non-significant ($p>0.05$) difference between mean times of pre and post results of the participants of the control group. The results of the Imagery group (intervention) showed that there was a significant ($p<0.05$) difference between mean times of pre and post results for the participants in this study. Indeed, the motor imagery training showed a significant ($p<0.05$) effect on the performance of the elite athletes (imagery intervention).

4 DISCUSSION

The aim of this study was to investigate the effects of motor imagery on reaction time. An experimental research was conducted to analyze this issue. The study on reaction time revealed positive impact of mental practice while comparing pre and post test results. In this experiment all the participants were very interested and put their best efforts in two (2) weeks training session and on the other hand the imagery group showed great enthusiasm and focus in their both physical and mental practice sessions. The analysis of the current study has been analyzed by paired t-test. The findings revealed that Experimental group improvement was more rapid and significant than the controlled group. Within the first half of the experiment, improved running style and body coordination in the imagery group participants was observed by the researcher and the coaches, which leads the author to believe that they were not only rehearsing the crouch start but also the other components in the imagery sessions. Couple of athletes from the physical practice group showed better results than the imagery group, but the researcher observed the reason behind this enhancement was due to the competitive atmosphere created due the experiment for which they put their best to beat the other group in the post test. Future studies may target these intrinsic factors that might help in improving training effort.

There were 24 participants in this study and results cannot be generalized to the whole sprinting population in Pakistan, future studies might look into greater sample size for more accurate results. This investigation contributes to the current knowledge that Motor Imagery (MI) can be used to improve reaction time in Pakistani elite sprinters which leads to a better race time.

All the athletes included in this research were highly motivated and showed maximum interest. The study was conducted in a limited time; for more intensive results, this kind of research should be conducted for longer period and should also focus on different components of the race.

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APPENDIX

Table 1: Paired Samples Statistics for Reaction Time (ms) and 30m time (s) Control Group.

		Mean	N	Std. Deviation	Std. Error Mean	Correlation= *r*	Sig.
Pair 1	Reaction Time Pretest	204.33	12	48.044	.983	.994	.000
	Reaction Time Posttest	202.75	12	42.879			
Pair 2	30m Pretest	4.433	12	.563	.975	.994	.000
	30m Posttest	4.425	12	.557			

SD=Standard deviation, SE=Standard error of mean, r=Correlation, p=Probability value

Table 2: Paired Samples Test for Reaction Time (ms) and 30m time (s) Control Group.

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Reaction Time Pretest - Reaction Time Posttest	1.583	7.280	2.101	-3.042	6.209	.753	11	.467
Pair 2	30m Pretest - 30m Posttest	.008	.0607	.0175	-.0302	.0469	.475	11	.644

SD=Standard deviation, SE=Standard error of mean, CI=Confidence Interval, Df= Degree of Freedom, p=Probability value

Table 3: Paired Samples Statistics for Reaction Time (ms) and 30m time (s) Experimental Group.

		Mean	N	Std. Deviation	Std. Error Mean	Correlation= *r*	Sig.
Pair 1	Reaction Time Pretest	207.50	12	57.450	16.584	.983	.000
	Reaction Time Posttest	195.83	12	48.889	14.113		
Pair 2	30m Pretest	4.411	12	.513	.148	.975	.000
	30m Posttest	4.315	12	.482	.139		

SD=Standard deviation, SE=Standard error of mean, r=Correlation, p=Probability value

Table 4: Paired Samples Test for Reaction Time (ms) and 30m time (s) Experimental Group.

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Reaction Time Pretest - Reaction Time Posttest	11.667	12.950	3.738	3.439	19.895	3.121	11	.010**
Pair 2	30m Pretest - 30m Posttest	.097	.115	.0332	.023	.170	2.906	11	.014**

SD=Standard deviation, SE=Standard error of mean, CI=Confidence Interval, Df= Degree of Freedom, p=Probability value

Table 5: Group Statistic Pre-Post Difference.

		N	Mean	Std. Deviation	Std. Error Mean
Reaction Time	Imagery	12	11.667	12.95	3.738
	Control	12	1.583	7.280	2.101
30m Time	Imagery	12	0.966	0.115	0.033
	Control	12	0.008	0.061	0.018

SD=Standard deviation, SE=Standard error of mean

Table 6: Independent Samples Test for Pre and Post Difference.

	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RT Improvement (ms)	2.351	22	.028	10.083	4.288	1.190	18.977
30m Improvement (s)	2.349	22	.028	8.833	3.760	1.035	16.631

SD=Standard deviation, SE=Standard error of mean, CI=Confidence Interval, Df= Degree of Freedom, p=Probability value