Placebo Effect on Motor Skill Learning: A Randomized, Double-Blind, and Placebo-Controlled Study

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ABSTRACT

The purpose of this investigation was to determine the effects of placebo treatment on the performance of a motor skill. One-hundred eight college students participated in the study. Four experimental conditions were created: (1) near infrared activating group with placebo instructions, (2) near infrared activating group without placebo instructions, (3) placebo group with placebo instructions, and (4) placebo group without placebo instructions. Participants performed four blocks of 10 trials each for the acquisition phase. ANOVAs with repeated measures on the last factor were performed on the various dependent variables: Absolute error, variable error, directional error, and radial error. The results of this investigation revealed significant main effects for group on the absolute error and variable error. The present study suggests that the placebo effect does not influence motor skill tasks in which perception and cognitive information processing are important.

1. Introduction

The placebo effect arises from the use of nonspecific psychological and physiological effects to influence a subject's belief that they have received a beneficial treatment (Clarke, Hopkins, Hawley, & Burke, 2000). Such placebo effects are generally investigated through placebo-controlled experiments, mainly in controlled medical experiments to investigate whether the effects of a new drug are the result of pharmacological activity or a placebo effect (Shapiro & Shapiro, 1997; Iverson, 2005). Many studies have also examined placebo effects in sports performance (Beedie, Stuart, Coleman, & Foad, 2006; Beedie, 2007; Benedetti, Pollo, & Colloca, 2007; Pollo, Carlino, & Benedetti, 2008); however, the majority of these studies concern substances or equipment relevant to athletic performance, such as anabolic steroids (Maganaris, Collins, & Sharp, 2000), caffeine (Beedie et al., 2006), ergogenic aids (Foster, Felker, Porcari, Mikat, & Seebach, 2004), and refined carbohydrates (Clark et al., 2000). These studies examine performance factors such as power, the ability to continue to exercise, running, cycling, and endurance, and research on the psychological aspects of placebo effects on motor skills is rare.

In addition, no studies have followed-up on Singer, Llewellyn, and Darden's (1973) original investigation of placebo effects on motor skills, where the original studies by Singer et al. did not find placebo effects with regard to motor skill learning. Although Singer et al. concluded that there are no motor skill placebo effects, placebos might affect motor skills if they affect the psychological factors related to motor skill execution, such as motivation, confidence, or emotion. Therefore, this randomized, double-blind, and placebo-controlled study examined the effects of wearing a sports garment lit with near-infrared light (used as an aid to improve motor skills) on motor function, as assessed in golf-putting performance. The hypothesis is based on the findings of Shiraishi et al. (1996), and posits that the increased motor skill performance related to infrared light technology is the result of psychological factors such as a placebo effect, rather than a physiological mechanism.

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2. Method

2.1 Participants

One hundred eight (male =108) college students, whose age ranged from 19 to 27 years (means ± SD: 23.3 ± 2.15 years) voluntarily participated in this study. Subjects were randomly assigned to one of four conditions: (1) near infrared (NIR) activating group with placebo instructions: AG (27), (2) NIR activating group without placebo instructions: AGW (27), (3) placebo group with placebo instructions: PG (27), and (4) placebo group without placebo instructions: PGW (27). All subjects were healthy with no experiences in other placebo, golf or NIR-light protocols.

2.3 Apparatus and Task

An indoor mini-golf set was made especially to simulate a golf green. The golf- putting target consisted of a 2m × 2m square grid with lines drawn lengthwise and crosswise at 5 cm intervals. A hole nearly 10.8 cm in diameter was placed at the center and served as the target. A putting line (5 cm width) was marked at one end, 5m from the target. After each putt, the subject's score was observed and recorded on a score sheet. Lower scores represented a better performance with each score potentially ranging from 0 to 20 points. Each point indicated an error of 5 cm from the target.

2.4 Procedures

Upon arriving at the testing place, participants completed an informed consent form and were provided with standardized general instructions for each group. They have watched a video which containing golf putting instructions (holding a club, putting stance, swing, aiming, and striking the ball) and demonstrations by a professional golf for 10min. After watching the video, NIR energy-emitting products (socks, underwear, patent no. 10-0900683, Korea) with instructions were applied to subject about 10 min before testing. We tried to persuade subjects to believe the effects of NIR on performance by showing some scientific evidence of NIR. NIR energy applied attires were known to facilitate muscle relaxation (Kim, Kim, & Kim, 2005). Three practice trials were allowed for all subjects. Subjects performed 4 blocks of 10 trials. Approximately 10 s were allowed for each shot.

2.5 Statistical Analyses

Separate 4 x 4 (Group x Trial Block) ANOVAs with repeated measures on the last factor were measured for directional error (DE), radial error (RE), absolute error(AE), and variable error(VE) on putting performance. Above mentioned dependent measures were analyzed by Kim, Chung, Tennant, Singer and Janelle's (2000) two dimensional target measurement methods.

3. Results

3.1 Absolute Error

The analysis for AE revealed significant main effects for Group ($F_{3, 104} = 5.25$, $p < .05$, $\eta^2 = .131$) and Trial Block ($F_{3, 312} = 5.56$, $p < .001$, $\eta^2 = .051$). Tukey's HSD indicated that subjects both in the AG ($M = 5.96$, $SD = 2.35$) and AGW ($M = 5.87$, $SD = 2.38$) performed significantly better than the PG ($M = 7.37$, $SD = 2.36$) and PGW ($M = 7.22$, $SD = 2.61$), respectively. However, the Group × Trial Block interaction was not significant ($F_{9, 312} = 1.36$, $p > .05$, $\eta^2 = .038$).

3.2 Variable Error

The VE analysis revealed significant main effects for Group ($F_{3, 104} = 3.31$, $p < .05$, $\eta^2 = .087$) and Trial Block ($F_{3, 312} = 5.82$, $p < .001$, $\eta^2 = .053$). Tukey's HSD indicated that the AGW ($M = 5.70$, $SD = 1.52$) showed more consistent performance than the PG ($M = 6.65$, $SD = 1.67$) and PGW ($M = 6.53$, $SD = 2.09$). No significant Group × Trial Block interaction was observed ($F_{9, 312} = 1.70$, $p > .05$, $\eta^2 = .047$).

3.3 Constant Error

In the CE analysis, neither the Group main effect ($F_{3, 104} = 0.03$, $p > .05$, $\eta^2 = .001$), nor the Group × Trial Block interaction ($F_{9, 312} = 1.28$, $p > .05$, $\eta^2 = .036$) were significant. In addition, no Trial Block effect was found ($F_{3, 312} = 1.72$, $p > .05$, $\eta^2 = .016$).

Radial Error

The RE analysis revealed no significant main effect for group ($F_{3, 104} = 1.00$, $p > .05$, $\eta^2 = .028$) or group by

trial block interaction ($F_{9, 312} = 1.37$, $p > .05$, $\eta^2 = .038$). No significant trial block effect was observed ($F_{9, 312} = 1.40$, $p > .05$, $\eta^2 = .013$).

Table 1: The Mean Golf-putting Errors of Four Experimental Groups across Trials

		Trial 1		Trial 2		Trial 3		Trial 4	
Error	**Group**	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
DE	**AG**	173.90	93.13	149.54	85.68	121.40	73.77	112.51	58.96
	AGW	135.22	74.01	139.05	74.85	145.07	74.98	138.54	85.89
	PG	141.29	78.07	128.04	79.24	143.73	87.28	135.23	93.06
	PGW	153.98	75.15	115.78	73.29	139.09	95.10	135.34	82.88
RE	**AG**	2.76	2.01	3.33	2.45	2.86	1.83	2.73	2.09
	AGW	4.50	3.43	2.90	1.84	2.71	2.63	2.93	2.36
	PG	3.82	2.46	3.94	2.87	3.67	2.88	3.63	3.09
	PGW	3.48	2.45	3.75	3.11	3.38	2.73	3.59	2.38
AE	**AG**	6.04*	2.32	6.16	2.31	6.12	2.34	5.54	2.44
	AGW	6.95	3.17	5.74*	1.58	5.55*	2.52	5.26	2.25
	PG	7.62	2.02	8.01	2.32	6.90	2.75	6.98	2.37
	PGW	7.87	2.27	6.91	2.83	7.57	2.64	6.54	2.71
VE	**AG**	6.08	1.97	6.05	1.78	6.32	2.16	5.51	2.06
	AGW	5.95	2.23	5.70*	1.52	5.33*	1.77	5.31	1.62
	PG	7.09	1.63	7.23	1.73	6.15	2.05	6.14	1.74
	PGW	7.18	1.76	6.09	2.00	6.88	2.45	5.97	2.16

AG = near infrared (NIR) activating group with placebo instructions, AGW = NIR activating group without placebo instructions, PG = placebo group with placebo instructions, PGW = placebo group without placebo instructions.
DE = directional error, RE = radial error, AE = absolute error, VE = variable error.
*$p < .05$.

4. Discussion

This study showed that the placebo effect does not affect motor skill improvement. Therefore, this study supports the claim that the placebo effect has a limited capacity to improve motor skills (Singer et al., 1973). Furthermore, this study suggests that placebo effects may improve muscle power in the context of exercise physiology, but that it is difficult to improve motor skills by placebo effects alone. In general, the placebo effect arises from the belief that a treatment or substance will have a certain effect; however, because the acquisition of motor skills involved in learning processes such as perceptual and cognitive stages (unlike merely improving muscle), placebo effects may be less likely to occur. For example, the early stages of learning require cognitive abilities such as recollection, unification, and comparison (Abernethy, Neal, & Koning, 1994; Abernethy, Baker, & Cote, 2005; Abernethy, & Zawi, 2007), where the association stage necessitates trial-and-error learning. However, because placebo effects cannot substitute for this process, they are not able to influence learning processes such as the acquisition or improvement of motor skills.

Thus, motor skills cannot be acquired through beliefs and expectations alone. Conversely, muscle power is the result of voluntary movements, such that performance can be improved by changes in arousal, confidence, belief, and motivation as the result of a placebo effect (Beedie, Foad, & Coleman, 2008; Beedie & Foad, 2009). Maganaris et al. (2000) have also argued that heightened arousal during a simple motor task might produce a significant effect (e.g., a weightlifter successfully lifting increasing weights), and that placebo effects can influence this arousal. In conclusion, the placebo effect does not influence motor skill tasks in which perception and cognitive information processing are important.

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