The Effects of Attentional Focusing Instructions on Force Production During the Isometric Midthigh Pull

Israel Halperin,[1,2] Kym J. Williams,[1,3] David T. Martin,[1] and Dale W. Chapman[1,2]

[1]Physiology Discipline, Australian Institute of Sport, Leverrier Crescent, Bruce, Australia; [2]Centre for Exercise and Sport Science Research, School of Exercise & Health Science, Edith Cowan University, Joondalup, Australia; and [3]Strength and Conditioning, Australian Institute of Sport, Leverrier Crescent, Bruce, Australia

Abstract

Halperin, I, Williams, KJ, Martin, DT, and Chapman, DW. The effects of attentional focusing instructions on force production during the isometric midthigh pull. *J Strength Cond Res* 30(4): 919–923, 2016—Verbal instructions play a key role in motor learning and performance. Whereas directing one's attention toward bodily movements or muscles (internal focus) tends to hinder performance, instructing persons to focus on the movement outcome, or an external object related to the performed task (external focus) enhances performance. The study's purpose was to examine whether focus of attention affects maximal force production during an isometric midthigh pull (IMTP) among 18 trained athletes (8F & 10M). Athletes performed 3 IMTP trials a day for 3 consecutive days. The first day was a familiarization session in which athlete's received only control instructions. The following 2 days athletes received either control, internal, or external focus of attention instructions in a randomized, within-subject design. Compared to performance with an internal focus of attention, athletes applied 9% greater force when using an external focus of attention ($p < 0.001$, effect size [ES] = 0.33) and 5% greater force with control instructions ($p = 0.001$, ES = 0.28). A small positive 3% advantage was observed between performances with an external focus of attention compared with control instructions ($p = 0.03$, ES = 0.13). Focusing internally on body parts and/or muscle groups during a movement task that requires maximal force hinders performance, whereas focusing on an object external to the self leads to enhanced force production, even when using a simple multijoint static task such as the IMTP.

Key Words verbal instructions, coaching cues, maximal strength, athletic monitoring, motor learning

Address correspondence to Israel Halperin, Israel.halperin@ausport.gov.au.

30(4)/919–923

Journal of Strength and Conditioning Research

Introduction

Verbal instructions are reported to play a central role in motor learning and performance, whereas changing the style of verbal instruction is shown to have different effects on motor tasks. Specifically, instructions that direct one's attention toward bodily movement and muscles (internal focus of attention [IFA]) were found to hinder motor learning and performance (11,22). In contrast, directing attention toward the movement outcome or to an external object related to the task (external focus of attention [EFA]) tends to enhance motor learning and performance (11,22). For example, instructing a person to focus on shoulder and wrist motions during a basketball free throw illustrates IFA instructions; in contrast, focusing on the basket hoop represents EFA instructions. Indeed, fine motor tasks requiring accuracy, such as a basketball free throw (27), golf shot (26), and dart throws (9), were enhanced with EFA compared with IFA. In situations such as performing a simple balance task, it is hypothesized that participants improve performance by allowing for an unconscious automatic motor response with an EFA compared with an IFA (17,25).

Relevant to strength and conditioning specialists, there is growing body of evidence examining the effects of EFA and IFA on activities requiring maximal or near maximal force with results supporting previous simple fine motor tasks (5,7,10,11,13,21,23). Movement tasks, such as jumping for distance and height (21,23), shot put throwing performance (10), sprinting starts (7), and the number of completed repetitions in the bench press and squat, were all enhanced with EFA compared with IFA (12). Currently, only 2 studies have investigated tasks requiring maximal force production during constrained isolated joint movement tasks. Marchant et al. (13) first reported greater isokinetic concentric elbow flexion net joint torque with EFA (e.g., focus on pulling the strap) compared with IFA (e.g., focus on contracting the arm muscles) at a constant velocity ($60°·s^{-1}$). In further work, Greig and Marchant (5) used the same experimental constructs but investigated isokinetic concentric contraction velocities of 60°, 180°, and $360°·s^{-1}$. However, concentric joint torque was only greater with EFA than IFA at the slowest velocity. Interestingly, the elbow flexors surface electromyography was lower with EFA than IFA across all velocities in both studies suggesting greater movement efficiency. Although there is some evidence for EFA to be more effective in movements requiring maximal force, the available studies have only been conducted using isolated joint movements, did not use a control condition, and tested recreationally trained subjects. Maximal force generating capability is commonly monitored in athletes, understanding the effect of attentional focus instructions on maximal forces in multijoint tasks will improve the reliability and certainty in identifying change.

The isometric midthigh pull (IMTP) is a commonly used multijoint, maximal force task in which participants are required to isometrically pull a stationary Olympic bar located at the midthigh area while standing on a force plate. The IMTP is a reliable test (4,19) that is regularly used to monitor athletes' progression and to assist in the design of training programs (1,6,19,20). Most published studies and/or guidelines emphasize the need to instruct participants to perform the IMTP in a "hard and fast" manner (1,6,8,15,20). Such guidelines are supported by a number of studies reporting optimal force and speed production in various tasks when instructions were provided using this combination of words compared with each word in isolation (2,3,18). However, reference to attentional focus instructions in relation to maximal effort isometric tests such as the IMTP is lacking. In fact, some published guidelines suggest that during maximal effort isometric tests "the subject should be instructed to contract as hard as possible throughout the test to ensure that force is maximized" (14). Although the hard and fast instructions have been shown to be useful, instructing one to "contract" a muscle group may shift the attentional focus inwardly and hinder performance. Accordingly, the purpose of this study was to investigate the effects of EFA, IFA, and control instructions on peak force during the IMTP among trained athletes. In agreement with previous research, it was hypothesized that EFA instructions would lead to greater peak force compared with IFA and control instructions.

Methods

Experimental Approach to the Problem

The aim of this study was to examine the effects of 3 different verbal instructions on peak force production in the IMTP in a randomized, counter balanced, blinded, within-subjects study design. Well-trained and motivated athletes performed 3 maximal effort trials of the IMTP a day for 3 consecutive days. The first testing day consisted of a familiarization session in which participants received similar control instructions, whereas in the following 2 days subjects received 3 types of instructions in randomized counter-balanced order. Detailed information about the 3 days and instructions are presented below.

Subjects

Twenty-two healthy and trained athletes from various sporting backgrounds (Rugby, Judo, Australian football, and athletics) volunteered for this study (age range: 17–28 years). All athletes participated in at least 3 sport-specific training sessions per week and were experienced with resistance training for a minimum of 2 years with at least 2 weekly sessions. Other than one athlete, none had ever performed the IMTP before the study. Athletes were provided with a verbal description of the study, which was carefully presented so as to not compromise the study design. Informed consent was obtained from each athlete or from athlete and parent or guardian if below 18 years of age. The Australian Institute of Sport Human Research Ethics Committees both approved this investigation.

Procedure

All data collection was performed in a noise sensitive exercise Physiology laboratory by the same 2 investigators, thereby controlling for possible influence of audience and noise effects. Importantly, testing on the second and third occasion occurred at the same time of day (8:00-10:30 AM) to control for any possible diurnal effects on performance. Each athlete was requested to avoid a heavy meal an hour before testing and any type of training immediately before testing. Athletes were blind to the true goal of the study and were told that testing was conducted to measure the reliability of their force production. During the first testing day, subjects were familiarized with the IMTP and only provided control instructions. Each athlete received a detailed explanation on the test, how it should be performed, and the importance of performing it with maximal intent on every trial. Additionally, the athletes were informed about the importance of maintaining a straight gaze during the test thereby eliminating possible vision confounders as a result of the instructions. Athletes performed a standardized warm-up, which was administered by the same investigator before testing. The warm-up consisting of 3 minutes of cycling at a constant intensity on a Watt bike, a series of dynamic stretches of the major muscles groups, a set of 10 body weight squats and push-ups, two 3 seconds IMTP trials while applying 50% and a trial at 80% of their perceived maximum. After the warm-up, 30 seconds of rest was provided before completing the first of 3 maximal efforts, with each contraction lasting 3 seconds. After each maximal effort, athletes were seated for 150 seconds, they then completed a 3 seconds 50% of perceived maximum effort warm-up trial, rested for a further 30 seconds, and then completed the next maximal effort contraction.

On the first day, athletes only received control instructions before each of the 3 maximal effort trials. These control instructions consisted of "Focus on going as hard and as fast as you possibly can." This set of instructions was considered a control condition as no internal or external point of reference was provided to the athlete. On the second and third

Table 1. Characteristics of athletes by gender (mean ± *SD*).

	Age	Height (cm)	Weight (Kg)
Males (n = 10)	21 ± 2.6	180 ± 6.3	83 ± 13
Females (n = 8)	24 ± 4	168 ± 7	63 ± 7

day, athletes repeated the same procedure as the first day with the exception that 3 types of instructions (control, IFA, EFA) were provided once before each of 3 maximal efforts in a randomized counter-balanced manner. To further control for a possible order effect, each athlete received a different order of instructions on each of the testing days. The IFA instructions consisted of "Focus on contracting your leg muscles as hard and as fast as you possibly can." In contrast, the EFA instructions were "Focus on pushing the ground as hard and as fast as you possibly can." Other than the single instructional sentence no other guidelines, encouragement, verbal, or visual feedback were provided.

Measures

The IMTP was performed in a customized power rack (Crossrig, Aussie Strength Equipment) using custom cold drawn steel bar (25 mm diameter; 460 MPa [minute] tensile strength; 370 MPa [minute] yield stress) with the athlete standing on a commercially available portable force plate (9290AD Quattro Jump, Kistler, Switzerland) to record ground reaction forces. The customized power rack was similar to power rack arrangement described by Haff et al. (6). The force plate was interfaced with a personal computer by an 8 channel data acquisition system (ADInstruments, Bella Vistal NSW, Australia) with PowerLab software (ADInstruments) sampling at 1,000 Hz that allows for direct measurement of force-time characteristics (force plate). The ground reaction forces were analyzed using PowerLab software and custom macros of the operating software. Before all data collection procedures, the force plate was calibrated using a range of known loads. Each athlete's initial positioning in the customized power rack was set such that their knee flexion angle ranged between 130° and 145° (15), this range in knee flexion angles reflected the maintenance of a bar height that was individually positioned at the midthigh with a resolution of 25 mm. Precise recording of the equipment setup was made to ensure replication. Participants were asked to hold the bar shoulder width apart and individually choose their grip (overhand or mixed grip) which remained constant across the 2 testing days.

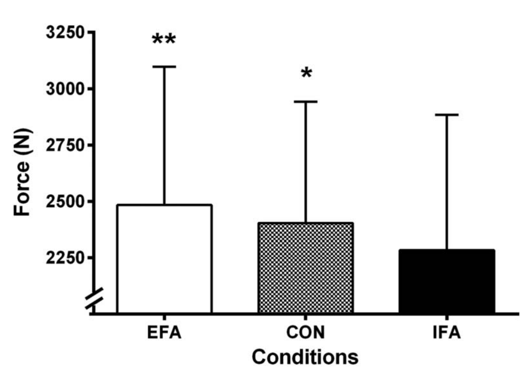

Figure 1. Demonstrates the absolute mean (*SD*) force differences between 3 instructional conditions: external focus of attention (EFA), control instruction (CON), and internal focus of attention (IFA). **Illustrates significantly ($p \leq 0.05$) greater peak force compared with control and IFA. *Illustrates significantly ($p \leq 0.05$) greater peak force between control and IFA.

Statistical Analyses

The control condition maximal contractions performed on each of the 2 testing days were analyzed using interclass correlation coefficient (ICC) and coefficient of variation (CV). This was performed to determine the between day reliability of the athletes and to assure that the investigated effects are due to the interventions and not because of inconsistency in performance. A 2-way analysis of variance (ANOVA) with repeated measures (instructions [3] × gender [2]) was used to compare the collapsed mean peak forces across the 2 days. If the assumption of sphericity was violated, the Greenhouse-Geisser correction was used and an ANOVA post hoc test was used if a main effect was identified. Significance was accepted as $p \leq 0.05$. Cohen d effect sizes (ESs) were calculated, and the magnitudes of these ES were classified using the scale advocated by Rhea (16) for highly trained athletes of <0.25, 0.25–0.5, 0.50–1.0, and >1.0, which were termed trivial, small, moderate, and large, respectively. All data are presented as mean + *SD* values and 95% confidence intervals (CI) for the mean difference when appropriate.

Results

The ICC and CV of the control condition for the peak force was 0.81 and 15%, respectively. However, due to variations in peak force production ≥15% between the 2 testing days, 4 male subjects were excluded from the final analysis, as their values were larger than 2 *SD*s between testing days in the control condition. The physical characteristics of the included athletes ($n = 18$) are presented in Table 1. This was performed to insure that the reported effects are a result of the instructions and not because of random variability in performance. Excluding these 4 subjects increased the ICC to 0.95 and decreased the CV to 6%. It should be noted that other than increasing the ICC and decreasing the CV, the exclusion of the 4 participants did not change the overall results of the final analysis. Thus, the 2-way ANOVA analysis was performed with an $n = 18$. No significant interaction was identified between instructional conditions and gender ($p = 0.134$); however, a significant main effect was observed for the instructional conditions ($p < 0.001$) (Figure 1). Peak force production in EFA was significantly 9% greater compared with IFA ($p < 0.001$; ES = 0.33; CI 95% [114–280 N]) and 3% greater than control ($p = 0.025$; ES = 0.13; CI 95% [9–133 N]). Athletes applied 5% greater peak force in control compared with IFA ($p = 0.040$; ES = 0.22; CI 95% [42–209 N]). A gender effect was observed ($p < 0.001$) with males producing 29% greater force than females across all conditions ($p < 0.001$; ES = 1.84; CI 95% [496–1,066 N]).

Discussion

We report that IFA instructions lead to substantial decrements in peak force production compared with both EFA (9%) and control (5%) conditions in motivated trained athletes. Furthermore, EFA instructions result in a significantly greater (3%) peak force than control instructions. Considering that the athletes were trained and motivated and that the IMTP is a reliable and relatively simple test, the 9% difference in peak force output between EFA and IFA is a small meaningful effect. Although males were found to be considerably stronger than females (29%), both genders responded to set of instructions in a similar fashion.

The observed outcomes support previously published findings demonstrating the negative effects of IFA on performance during activities requiring high force and power production. For example, instructing subjects to focus on the vanes of the Vertec device (EFA) led to enhanced jumping performance compared with focusing on the tips of the fingers (IFA) (23), with comparable results reported for horizontal jumps (21). When resistance-trained subjects focused on exerting force against a loaded barbell (EFA) they completed more repetitions in the free weight bench press and squat exercises compared with focusing on exerting force with the legs or arms (IFA) (12). Similarly, focusing on the isokinetic dynamometer lever arm (EFA) led to greater elbow flexion torque compared with focusing on the arm muscles (IFA) (13). Finally, trained athletes were able to throw a shot put further after instruction to focus on throwing to a visible target (EFA) compared with focusing on extending their arms rapidly (IFA). When the athletes were asked to focus on performing the task to the best of their abilities (control), their performance was also better than IFA (10).

The results of this study are consistent with the *constrained action hypothesis* proposed by Wulf (22,24). This hypothesis proposes that EFA promotes an automatic motor response, that is, in line with the desired outcome, whereas IFA directs participants to be conscious of their movements, which disrupts the automatic control of the involved motor systems. Particularly, it can be speculated that IFA instructions led athletes to focus on just one component of a complex movement that is typically completed by an integration of many muscles and body parts. Thus, IFA may degrade the overall contribution of other body parts and muscles leading to suboptimal performance. In contrast, the EFA encourages athletes to organize all the relevant contributors around the task (a) without omitting any one of the contributors and (b) allowing greater automaticity of the movement.

Although studies have examined the effect of attentional focusing instructions on maximal force production activities, to the best of our knowledge, this study is the first to investigate this question with the IMTP test. This study demonstrated the significance of verbal instructions on the performance of this test with a clear observation that EFA instruction enhanced performance. Common guidelines on the verbal instructions for the IMTP emphasize the need to perform it hard and fast. This guideline is based on a number of studies that have shown better performance with the combination of these words compared with emphasizing a single word in isolation (2,3,18). However, few, if any, studies referred to the attentional feedback literature when discussing verbal instructions during the IMTP. In fact, one guideline suggests focusing on contracting as hard as possible throughout the maximal effort isometric test (14). Collectively, IFA instructions should generally be avoided, whereas EFA instructions should be favored during physical performance tests and exercises that require maximal levels of force and/or power, such as the IMTP.

Practical Applications

The reported results offer practical and relevant information for sports scientists and coaches, which can be applied to learning and maximizing performance. The IMTP is a test that requires the application of maximal force and is commonly used to monitor training progress and to design training programs. The results point to the importance of maintaining consistency with verbal instructions across testing days because of their substantial effects on performance even during a relatively simple isometric, complex multijoint exercise. Specifically, instructing athletes to "contract" an activated muscle group hinders performance and should be avoided, whereas instructing athletes to focus on an external object or device, enhances performance and should be strongly encouraged.

Acknowledgments

The authors thank all athletes involved in the study. The authors also express gratitude to Robyn Squires for her help in data collection.

References

1. Beckham, G, Mizuguchi, S, Carter, C, Sato, K, Ramsey, M, Lamont, H, Hornsby, G, Haff, G, and Stone, M. Relationships of isometric mid-thigh pull variables to weightlifting performance. *J Sports Med Phys Fitness* 53: 573–581, 2013.

2. Bemben, MG, Clasey, JL, and Massey, BH. The effect of the rate of muscle contraction on the force-time curve parameters of male and female subjects. *Res Q Exerc Sport* 61: 96–99, 1990.
3. Christ, CB, Boileau, RA, Slaughter, MH, Stillman, RJ, and Cameron, J. The effect of test protocol instructions on the measurement of muscle function in adult women. *J Orthop Sports Phys Ther* 18: 502–510, 1993.
4. Comfort, P, Jones, PA, McMahon, JJ, and Newton, R. Effect of knee and trunk angle on kinetic variables during the isometric mid-thigh pull: Test–retest reliability. *Int J Sports Physiol Perform* 10: 58–63, 2014.
5. Greig, M and Marchant, D. Speed dependant influence of attentional focusing instructions on force production and muscular activity during isokinetic elbow flexions. *Hum Mov Sci* 33: 135–148, 2014.
6. Haff, GG, Carlock, JM, Hartman, MJ, Kilgore, JL, Kawamori, N, Jackson, JR, and Stone, MH. Force–time curve characteristics of dynamic and isometric muscle actions of elite women olympic weightlifters. *J Strength Cond Res* 19: 741–748, 2005.
7. Ille, A, Selin, I, Do, M-C, and Thon, B. Attentional focus effects on sprint start performance as a function of skill level. *J Sports Sci* 31: 1705–1712, 2013.
8. Kawamori, N, Rossi, SJ, Justice, BD, Haff, EE, Pistilli, EE, O'bryant, HS, Stone, MH, and Haff, GG. Peak force and rate of force development during isometric and dynamic mid-thigh clean pulls performed at various intensities. *J Strength Cond Res* 20: 483–491, 2006.
9. Lohse, KR, Sherwood, DE, and Healy, AF. How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Hum Mov Sci* 29: 542–555, 2010.
10. Makaruk, H, Porter, JM, and Makaruk, B. Acute effects of attentional focus on shot put performance in elite athletes. *Kineziologija* 45: 55–62, 2013.
11. Marchant, DC. Attentional focusing instructions and force production. *Front Psychol* 1: 210, 2011.
12. Marchant, DC, Greig, M, Bullough, J, and Hitchen, D. Instructions to adopt an external focus enhance muscular endurance. *Res Q Exerc Sport* 82: 466–473, 2011.
13. Marchant, DC, Greig, M, and Scott, C. Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions. *J Strength Cond Res* 23: 2358–2366, 2009.
14. Miller, T. *NSCA's Guide to Tests and Assessments.* Champaign, IL: Human Kinetics, 2012.
15. Nuzzo, JL, McBride, JM, Cormie, P, and McCaulley, GO. Relationship between countermovement jump performance and multijoint isometric and dynamic tests of strength. *J Strength Cond Res* 22: 699–707, 2008.
16. Rhea, MR. Determining the magnitude of treatment effects in strength training research through the use of the effect size. *J Strength Cond Res* 18: 918–920, 2004.
17. Rotem-Lehrer, N and Laufer, Y. Effect of focus of attention on transfer of a postural control task following an ankle sprain. *J Orthop Sports Phys Ther* 37: 564–569, 2007.
18. Sahaly, R, Vandewalle, H, Driss, T, and Monod, H. Maximal voluntary force and rate of force development in humans–importance of instruction. *Eur J Appl Physiol* 85: 345–350, 2001.
19. Sheppard, J, Chapman, D, and Taylor, KL. An Evaluation of a strength qualities assessment method for the lower body. *J Aust Strength Cond* 19: 4–10, 2011.
20. West, DJ, Owen, NJ, Jones, MR, Bracken, RM, Cook, CJ, Cunningham, DJ, Shearer, DA, Finn, CV, Newton, RU, and Crewther, BT. Relationships between force–time characteristics of the isometric midthigh pull and dynamic performance in professional rugby league players. *J Strength Cond Res* 25: 3070–3075, 2011.
21. Wu, WFW, Porter, JM, and Brown, LE. Effect of attentional focus strategies on peak force and performance in the standing long jump. *J Strength Cond Res* 26: 1226–1231, 2012.
22. Wulf, G. Attentional focus and motor learning: A review of 15 years. *Int J Sports Psychol* 6: 77–104, 2013.
23. Wulf, G, Dufek, JS, Lozano, L, and Pettigrew, C. Increased jump height and reduced EMG activity with an external focus. *Hum Mov Sci* 29: 440–448, 2010.
24. Wulf, G, McNevin, N, and Shea, CH. The automaticity of complex motor skill learning as a function of attentional focus. *Q J Exp Psychol* 54: 1143–1154, 2001.
25. Wulf, G, Mercer, J, McNevin, N, and Guadagnoli, MA. Reciprocal influences of attentional focus on postural and suprapostural task performance. *J Mot Behav* 36: 189–199, 2004.
26. Wulf, G and Su, J. An external focus of attention enhances golf shot accuracy in beginners and experts. *Res Q Exerc Sport* 78: 384–389, 2007.
27. Zachry, T, Wulf, G, Mercer, J, and Bezodis, N. Increased movement accuracy and reduced EMG activity as the result of adopting an external focus of attention. *Brain Res Bull* 67: 304–309, 2005.