Effects of Imagery on Force Production and Jump Performance

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ABSTRACT

Avila BJ, Brown LE, Coburn JW, Statler TA. Effects of Imagery on Force Production and Jump Performance. JEPonline 2015;18 (4):42-48. The purpose of this study was to examine the effects of functionally equivalent imagery on absolute and explosive force production. Twenty five male subjects were asked to make three visits to the lab. The first visit consisted of familiarization with the equipment and procedures. During the following two visits, the subjects completed a countermovement jump (CMJ) and a mid-thigh isometric-pull under control or experimental conditions. For the experimental condition, the subjects listened to a 30-sec specific imagery script immediately preceding the tasks. For the control condition, the subjects read a passage on the sliding filament theory for 30 sec immediately preceding the tasks. Results demonstrated that ground reaction force in the isometric-pull was significantly greater than the control, but there was no significant difference in the CMJ performance. The isometric-pull was a novel task for most subjects. Therefore, imagery may have allowed subjects to rehearse and become familiar with the new movement as well as increased motivation and confidence.

Key Words: Imagery, Force, Vertical Jump
INTRODUCTION

Previous research has demonstrated the effect thoughts and images have on muscle activation (5,6,7,12). This relationship may be useful when training to improve maximum force production, but an individual must create an experience in the mind that is specific to the task. This includes what one would hear, smell, taste, feel, and see, as well as experience the physiological, behavioral, and emotional responses that might occur (4,13). For example, when implementing an imagery program, the feel of the bat, the sound of the crowd, the smell of freshly cut grass, the taste of sweat dripping from one’s face, the emotions experienced in high pressure situations, and the physiological and behavioral responses to the emotional event itself are of great importance (4,13).

A variety of research has investigated the effects of imagery on force production (9,13,14), but few studies have looked at the effect of a functional imagery intervention on complex movements (such as a back squat or power clean) to improved athletic performance. Studies have investigated the effects of a functional imagery program on a biceps curl, leg press, standing long jump, bench press, and a variety of other movements and have found that a functional program can increase some elements of force production (9,13,14). What is less well known is what specifically constitutes an individualized, functional imagery program and how it can be used to increase force output.

Athletes are constantly training in the weight room to increase force output so they can run faster, jump higher, and hit harder than the competition (8). Many athletes and coaches also use imagery to improve performance (11). However, little research exists on the effects of functional imagery on force production in complex, athletic movements. The purpose of this study was to investigate the effects of imagery on absolute and explosive force production.

METHODS

Subjects
Twenty five resistance trained males between the ages of 20 to 29 (age 24.84 ± 2.77 yrs; ht 179.82 ± 8.63 cm; mass 90.01 ± 16.90 kg) volunteered to participate. Although they had been participating in a resistance training program at least 3 d·wk⁻¹ for 6 months, they had no prior formal imagery training with a sport psychology consultant or coach. All subjects read and signed a University IRB approved informed consent prior to testing.

Procedures
The subjects performed 3 countermovement jumps (CMJ) with arm swing and 3 isometric mid-thigh pulls (IMTP) while standing on a force plate. During the IMTP, they performed maximum pulls for 3 sec inside a power rack. The barbell was secured to the safety bars of the power rack at 135° of knee flexion for each subject. The subjects performed the tasks under both experimental (imagery) and control (no-imagery) conditions. The best repetition of all variables was used for further analysis.

Equipment
Maximal jump height was measured to the nearest quarter inch using an EPIC vertical jump testing device (Athletic Performance Inc., Colorado Springs, CO) that was positioned next to the force plate. An AMTI force plate (Advanced Mechanical Technology, Inc., Watertown, MA) sampled at 1,000 Hz. It was interfaced with a personal computer running custom LabVIEW software (version 2013, National Instruments, Austin, TX) that collected and analyzed dependent variables of peak ground reaction force (GRF) and rate of force development (RFD). The rate of force development was calculated from the slope of the force-time curve (i.e., ΔForce/ΔTime). Force plate jump height was calculated by the time in the air equation simultaneously with the EPIC system.
Day 1
The subjects performed three rounds of a 40-ft dynamic warm-up consisting of walking lunges, high knees, and forward gate swings (120 ft total per exercise). Immediately after, they were familiarized with the CMJ and IMTP procedures and equipment. During the familiarization, each subject completed 3 trials of each task to assess variability. If the trials exceeded 5% difference, they completed another 3 more trials until the criterion was met.

Day 2 and Day 3
On days 2 and 3, the subjects did the same warm-up as Day 1, then, they performed either the CMJ task or the IMTP task separated by a 5-min rest. For the CMJ, the subjects were instructed to begin in an erect posture, bend their knees to a self-selected depth then jump as high as possible and touch the vanes of the testing device with their dominant hand (2). They performed 3 jumps with a 30-sec rest. For the IMTP, the subjects were instructed to assume a position equal to 135° of knee flexion, grasp the barbell with both hands, and pull up as hard and fast as possible for 3 sec. The subjects performed 3 pulls with a 30-sec rest. After 48 hrs of rest, they returned to perform the same warm-up and tasks but under the condition not done on Day 2.

For no-imagery, they were instructed to step onto the force plate and read one of three separate passages on the sliding filament theory for 30 sec immediately prior to each task repetition. A total of six different passages were read (3 CMJ and 3 IMTP). For imagery, they were instructed to step onto the force plate, close their eyes and listen to one of three separate recordings of a task specific imagery script prior to each repetition. A total of six different recordings were used (3 CMJ and 3 IMTP).

Imagery
The imagery script was broken down into three, 30-sec recordings for each of the two tasks, totalling six different recordings. The subjects were asked to step onto the force plate where the task would ultimately be performed, close their eyes, and listen to the recording. Each of the scripts built upon the previous and included the use of the senses, emotional, and physiological responses to help create an experience as close to the actual completion of the task as possible (3,4,13).

Three imagery recordings were specific to the CMJ task. The script started broad and included what the subjects might see around the room if their eyes were open, “See the weight equipment to the left, the jump device in front of you, and the computer to the right.” Immediately before the jump, the subjects’ focus narrowed, seeing only that which was necessary to complete the task or directly in front of them, “your attention narrows so that all you see is the jump device in front of you and the arms of the device directly overhead.” Senses such as feeling “the tightness in your legs, shoulders, and arms” and the sounds of the arms of the device being struck and feet landing on the force plate were also included. Physiological responses such as “your heart is beating a little quicker” and “body temperature is increasing” were included as well as the “excitement felt before seeing how high you can jump.”

The other three recordings were specific to the IMTP. Similar to the recordings for the CMJ task, these started with a broad focus, observing the weights to the left and right, but instead of seeing the jump testing device overhead they saw the power rack in front of them. As the subjects got closer to completing the pull, their focus narrowed, focusing only on “the power rack directly in front of you.” For this task, the subjects focused on feeling their “thighs touching the barbell” and “hands wrapping around cold steel.” The sound of the barbell being pulled against the safety bars and physiological responses such as “the muscles in your body, especially your legs and forearms, are activated” and
“your body vibrates, your face turns red, and your temperature elevates even more” were also included.

Statistical Analyses
SPSS 21.0 was used to perform all statistical analyses (IBM Corporation, Somers, NY). Descriptive statistics (means and standard deviations) were calculated for all variables. Paired t-tests were used to determine differences between imagery and no-imagery conditions for all dependent variables for the IMTP (GRF and RFD) and CMJ (GRF, force plate, and EPIC jump height). An a priori alpha of 0.05 was used to determine statistical significance.

RESULTS
IMTP peak GRF was significantly greater (P<0.05) for imagery versus no-imagery (Figure 1). There were no significant differences (P>0.05) in other variables between imagery and no-imagery (Table 1).

Figure 1. Peak Ground Reaction Force (GRF) Between Conditions. *Significantly Greater Than No Imagery.

Table 1. Paired t-test Between Conditions Comparing Isometric Mid-Thigh Pull (IMTP), Rate of Force Development (RFD), Countermovement Jump (CMJ) Height and Ground Reaction Force (GRF). No significant Differences (P>0.05) Between Imagery and No-Imagery for any Variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Imagery</th>
<th>No Imagery</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMTP RFD (N/s)</td>
<td>2014.74 ± 871.30</td>
<td>2266.91 ± 1191.39</td>
</tr>
<tr>
<td>EPIC CMJ Height (cm)</td>
<td>58.97 ± 7.97</td>
<td>58.06 ± 7.44</td>
</tr>
<tr>
<td>Force Plate CMJ Height (cm)</td>
<td>41.73 ± 7.16</td>
<td>41.17 ± 8.25</td>
</tr>
<tr>
<td>Force Plate CMJ GRF (N)</td>
<td>2246.06 ± 434.17</td>
<td>2256.28 ± 446.00</td>
</tr>
</tbody>
</table>
DISCUSSION

The purpose of this study was to examine the effects of imagery on absolute and explosive force. Results demonstrated that peak GRF in the isometric pull was significantly greater under the imagery condition compared to no-imagery. In contrast, IMTP RFD and CMJ peak GRF and jump height were not significantly different. While all the subjects had resistance training experience prior to the study, the isometric pull was a novel exercise for many of them. Imagery may have helped the subjects rehearse and become familiar with the movement and, therefore, decrease the uneasiness and awkwardness that accompanies the learning of a new movement.

After examining the effects of imagery on leg press and bench press, Lebon and colleagues (9) concluded that imagery contributed to strength gains in the leg press only. The authors explained that the subjects' perception of leg press training was more physically painful and uncomfortable. Therefore, imagery may have helped to reduce their anxiety that allowed for improvement in their motivation and confidence. Throughout data collection in the current study, the subjects expressed how excited they were to find out how high they jumped, but during the IMTP, their confidence and motivation levels were visibly reduced. During the initial familiarization session, a significant amount of time was spent learning how to properly perform the IMTP. Similar to the previous study, listening to a task specific imagery script may have allowed the subjects to rehearse the movement, which increased their confidence and motivation (1,3,9,10).

Beauchamp et al. (1) examined pre-competition imagery, self-efficacy, and performance in collegiate golfers. Their results demonstrated that pre-competition imagery led to improved golf performance as measured by total score for a round of golf. The specific type of imagery used was motivational general-mastery imagery, which is a type of imagery that involves imagining a successful outcome to help increase confidence and motivation. A similar study explored the effects of pre-competition positive imagery and self-instruction on accuracy of serving in tennis (10). The results revealed that use of both imagery and self-instruction immediately prior to serving in tennis improved accuracy. This is akin to the present study where the imagery script provided instruction, allowing the subjects to imagine performing the entire task successfully from beginning to end.

Wu and colleagues (14) looked at the effect of attentional focus strategies on peak force and performance in the standing long jump. Their results revealed that using an external focus of attention benefitted jump performance significantly greater than using an internal focus of attention. The authors proposed that this was likely due to the constrained action hypothesis, which states that consciously focusing on performing physical movements disrupts the automatic motor control process. In general, they concluded that the subjects' performance may have suffered due to “paralysis by analysis.” That is, when consciously thinking about the movements to be performed, the natural process and fluidity of the movement deteriorate and the performance suffers (14). The CMJ is a dynamic task that requires explosive force production and a greater number of moving parts than the IMTP and, while novel for most subjects, is a simpler movement, making it less susceptible to the constrained action hypothesis. Future research should examine the effect of attentional focus strategies on a variety of movements, as well as explore the effects on novel tasks compared to familiar ones.

Two important aspects of imagery are quality and organization (4,13). In a study that focused on these aspects while attempting to increase strength in a biceps curl task (13), the subjects were placed into one of five groups: (a) PETTLEP model of imagery that takes into account seven different components (e.g., physical, environmental, task, timing, learning, emotion, and perspective) to create or recreate an actual competitive experience; (b) physical practice; (c) imagery and physical practice
combination; (d) traditional imagery; and (e) control. The subjects performed pre- and post-1RM bicep curl tests. The results indicated that the physical practice, PETTLEP, and combination groups demonstrated significant improvement in bicep curl strength from pre- to post-test. Physical practice has long been the standard for improving strength, but this study showed that quality and organized imagery can also improve strength (at least in the bicep curl). Future research should investigate the effects of a PETTLEP imagery program on complex movements such as a CMJ.

An important factor when studying the effect of imagery on strength is creating an imagery program specific to the task (3,4,13). Another important factor is the movement task (3). Prior research has examined the effect of imagery on simple movements such as the biceps curl, but future research should investigate the effects of a functionally equivalent imagery program on complex movements that increase force output in the weight room that may lead to improved athletic performance.

CONCLUSIONS

The results of this study indicate that task specific imagery increased ground reaction force in a novel isometric strength test compared to no imagery. The imagery script used was specific to the task and individual, and it was also functionally equivalent. It took into account what the subjects saw, heard, smelled, and felt through haptic (touch) sense, the physiological changes they would experience, and what they would feel emotionally. It is important that the subjects listened to the imagery script in the environment in which they performed the task to ensure consistency, and for them to become familiar with the environment, equipment, and movements prior to introducing the script. Future research should encourage subjects to create their own imagery scripts based on individual experiences and compare the effects on force production between those who have had formal imagery training and those who have not. Future research should also examine the effects of imagery on a variety of complex movements that translate to increased athletic performance and what constitutes an effective imagery program.

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**References**


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