Imagery Speed and Self-Efficacy: How Fast (or Slow) To Go?

Samuel T. Forlenza  
Michigan State University

Robert S. Weinberg  
Miami University

Thelma S. Horn  
Miami University

Due to inconsistent findings regarding the effects of speed of imagery on performance, the purpose of the present investigation was to explore how different imagery speeds affected performance and self-efficacy beliefs on a golf-putting task. Sixty-two university students were randomly assigned to one of three imagery groups (slow-motion, real-time, fast-motion) or a control group. Participants completed a series a golf putts at two times. Results of a 4 × 2 × 2 (imagery × task difficulty × trials) mixed model MANOVA indicated the imagery groups’ performances were not significantly different from each other or the control group. However, nonsignificant differences emerged, as both the real-time and slow-motion imagery groups consistently improved their performances. Self-efficacy beliefs also did not differ across groups. Future imagery speed research should attempt to use a variety of tasks, differing in complexity and length of execution as well as different variations in imagery speed.

Keywords: imagery, imagery speed, self-efficacy, golf putting

Imagery is a mental process that uses most or all of the senses to create or recreate experiences in the mind (Vealey & Greenleaf, 2009). Through imagery, people can reimage what has already happened or imagine doing something in the future. Systematically using these images has been shown to enhance athletic performance in a variety of sports along with psychological states related to performance (e.g., improved self-efficacy beliefs) (Short et al., 2002; Vealey & Greenleaf, 2009; Weinberg, 2008). Many researchers have investigated characteristics of imagery that strengthen or diminish its effectiveness, such as whether it is positive or negative and the perspective taken while imaging (Nordin & Cumming, 2008; Ramsey, Cumming, & Edwards, 2008). Other types of imagery characteristics

Forlenza is with the Department of Kinesiology, Michigan State University, East Lansing, MI. Weinberg and Horn are with the Dept. of Kinesiology and Health, Miami University, Oxford, OH.
have been examined, and ultimately this line of research led to the formation of the PETTLEP (Physical, Environment, Task, Timing, Learning, Emotion, Perspective) Model of Motor Imagery, with each letter representing a characteristic of imagery (Holmes & Collins, 2001).

The PETTLEP model is based on functional equivalence, which means that similar neural networks are activated during motor preparation/movement and when representing those same movements in one’s mind (Holmes & Collins, 2001). As such, imagery should approximate reality to maximize the similarities in activation between imagined movements and physical movements. Stemming from this, seven characteristics are recommended for consideration when performing imagery.

Empirical investigations of the PETTLEP approach have generally yielded favorable results. For example, one study found that participants using PETTLEP imagery performed better on a field hockey penalty flick and gymnastics move, while other studies have found combining PETTLEP imagery with physical practice led to greater improvements than either alone (Smith, Wright, Allsopp, & Westhead, 2007; Smith, Wright, Cantwell, 2008; Wright & Smith, 2009). Thus, it appears that the PETTLEP guidelines are effective for designing imagery scripts and by extension, the performance of motor skills. However, some characteristics have received more attention in the research than others, which suggests a need for more research on these lesser-studied characteristics. One characteristic that has not received as much attention in sport settings is the timing element, or imagery speed.

In essence, imagery speed refers to how quickly or slowly the imagery is being performed. According to the PETTLEP model, it should take about the same amount of time to visualize an action as it does to perform that action (Holmes & Collins, 2001). Thus, the PETTLEP approach favors real-time imagery (RTI), or imagery performed at approximately the same speed as the actual motor task. For example, if it takes a sprinter 22 s to run the 200 m dash, the sprinter should take approximately 22 s to image herself performing that race. The recommendation for RTI is echoed by other researchers (Guillot, Hoyek, Louis, & Collet, 2012; Syer & Connolly, 1984; Vealey & Greenleaf, 2009, Weinberg, 2008). Syer and Connolly (1984) also recommend avoiding fast-motion imagery (FMI) (imaging tasks quicker than it normally takes to complete them) and suggest there are times when slow-motion imagery (SMI) (imaging a particular movement at a slower rate) may be useful, such as when a person is first learning a new skill or trying to improve technique. Holmes and Collins (2001) agree, arguing that although the dominant recommendation is RTI, there may be certain situations when SMI has its uses.

Given it is widely suggested that athletes use RTI, do they? Research has found that athletes voluntarily report using different imagery speeds for different functions across the stages of learning and at different stages of movement (Calmels, Lopez, Holmes, & Naman, 2006; O & Hall, 2009, 2013). Other research suggests the speeds at which athletes image are influenced by the reasons they have for creating those images (Fournier, Deremaux, & Bernier, 2008). SMI was used the most to learn new sequences, RTI was used once the sequences were understood, and FMI was used to increase arousal. The most recent research corroborates these findings, suggesting SMI is used to develop and refine skills, RTI is used to help develop the timing of a movement, and FMI is used to increase arousal,
confidence, and for developing strategies (O & Hall, 2013). Taken together, these studies suggest different imagery speeds are used across a variety of situations for a variety of purposes.

Investigations into how well people are able to accurately imagine the time it takes to perform a movement have generally concluded that athletes overestimate the actual movement time (Guillot & Collet, 2005; Guillot et al., 2012). However, behavioral investigations on the effects of different imagery speeds on the motor performance of sport skills have received limited attention throughout the years, with these studies yielding mixed results. Early research conducted by Andre and Means (1986) tested the effectiveness of SMI against RTI on the performance of a Frisbee golf putt. Results revealed no significant differences between the experimental groups (RTI, SMI) and control group, although the RTI group did improve more than the SMI group. A more recent study found SMI and RTI to be equally effective (O & Munroe-Chandler, 2008). On the performance of a soccer-dribbling task, it was found that the RTI, SMI, and SMI/RTI combined groups all improved their times and reduced the number of errors made. Thus, this limited research on sport skills is inconclusive.

Other studies have found an assimilation effect when varying imagery speed, which occurs when recall of a movement matches the speed at which it was performed originally. In essence, these studies found that SMI and FMI are assimilated into performances, causing the speed of execution to slow down or speed up accordingly (Boschker, Bakker, & Rietberg, 2000; Louis, Guillot, Maton, Doyon, & Collet, 2008). However, in each of these studies, while participants performed the task in real-time to establish a reference point, there was no RTI group, so these studies only compared SMI with FMI. More recent research directly compared RTI and FMI, finding that both imagery speeds led to faster performance times on different series of finger movement sequences (Debarnot, Louis, Collet, & Guillot, 2011). Interestingly, FMI seemed to be more effective than RTI for complex movement sequences. The results from these studies showing assimilation effects in relatively simple movement patterns, coupled with the previous research on imagery speed in sport settings, suggests that additional experimental research on sport skills is warranted to determine if the assimilation effects occur with sport skills and if this ultimately affects performance. Further, because task characteristics play a large role in whether people are able to imagine real movements at a similar or different speed, it seems worthwhile to extend the research to different types of tasks (Guillot et al., 2012).

To date, the empirical investigations have not compared the effects of three imagery speeds on one task and they have only used a small number of tasks (soccer dribbling, Frisbee golf putt, body or finger movements). To attempt to extend the literature, this research investigated the effects of three imagery speeds (SMI, RTI, FMI) on the performance of a golf-putting task at two different difficulty levels.

In addition, experimental research has not yet examined the effects of imagery speed on any psychological variables, such as self-efficacy beliefs. This could be important to study because previous research has identified imagery as a significant contributor to feelings of self-efficacy, so it is plausible that manipulating the speed of imagery would affect beliefs about the capability to perform the task (Short et al., 2002). Therefore, a secondary purpose was to explore any influence of imagery speeds on self-efficacy beliefs.
Method

Participants

A total of 64 undergraduate and graduate students were recruited for participation from kinesiology courses at a Midwestern university. Students interested in volunteering were told the experiment was exploring the effects of mental practice on golf-putting and that their participation would take 45–60 min. Two were excluded for different reasons (poor MIQ-R score, statistical outlier), therefore, the final study sample was 62 participants ($M_{\text{age}} = 21.97$, $SD = 6.10$) who were mostly female ($n = 40$), Caucasian ($n = 57$), and in their junior/senior years ($n = 41$). Participants had a variety of prior golf experience, ranging from none ($n = 18$) to 1–5 years ($n = 29$) to more than five years ($n = 15$). Many participants ($n = 44$) reported having prior experiences with imagery. Of those who did, most reported using imagery in other sports ($n = 31$), golf ($n = 6$), and an academic class ($n = 5$).

Design

The study design was a randomized groups design, with repeated measures components to assess the effects of task difficulty and time. Participants were randomly assigned to a no-imagery control group ($n = 15$) or to one of three experimental groups: fast-motion imagery (FMI) ($n = 15$), real-time imagery (RTI) ($n = 15$), or slow-motion imagery (SMI) ($n = 17$). Each participant completed a golf putting task at two difficulty levels (2.13m putts, 4.27m putts) and at two different times (preintervention, postintervention).

Measures

Demographics. Participants completed a demographic questionnaire, which asked them to self-report their gender, age, race/ethnicity, class year, and prior golf experience.

Imagery Ability. Participants completed the Movement Imagery Questionnaire—Revised (MIQ-R; Hall & Martin, 1997) to ensure all participants had a general level of movement imagery ability. The MIQ-R asks participants to perform movements and then use visual or kinesthetic imagery to picture themselves performing those same movements. Participants rated on a 7-point Likert scale ranging from 1 (very hard to see/feel) to 7 (very easy to see/feel) the ease of which they are able to ‘see’ or ‘feel’ the images. The original MIQ displayed adequate psychometric properties (Hall, Pongrac, & Buckholz, 1985). The revised version, the MIQ-R, displayed significant correlations between the visual and kinesthetic subscales (-0.77 each) of the MIQ and MIQ-R and each subscale showed high alpha coefficients (visual = .87, kinesthetic = .86) (Abma, Fry, Li, & Relyea, 2002; Hall & Martin, 1997). The researcher read the MIQ-R directions to the participants out loud and allowed participants to read the instructions themselves. Participants were allowed to ask questions before completing the questionnaire on their own. One individual from the recruited sample of 64 scored below a 16 on the MIQ-R and was thus excluded from the study. A criterion score of 16 was selected because this score represents an average response of 4 (“neutral”) for each item on the scale, thus
indicating the respondent to have average imagery ability. Therefore, scores lower than 16 suggest that it may not be easy for such participants to manipulate their imagery as they have below-average imagery ability. A score of 16 has also been the cut-off in previous imagery research (O & Munroe-Chandler, 2008; Smith et al., 2008).

**Self-Efficacy Beliefs.** Participants rated the level and the strength of their certainty that they could perform progressively harder tasks (Feltz, Short, & Sullivan, 2008). Participants were asked if they believed they could perform a given task by marking either "yes" or "no." The level of self-efficacy was the number of times "yes" was selected. Participants rated the strength of that choice using a 0% (I am certain I cannot do this) to 100% (I am certain I can do this) scale. Each question contained the stem, “Rate your confidence that you can…” followed by the individual item. Participants started by rating the certainty with which they believed they could sink one putt, then rated the certainty they believed they could sink two putts, and so on, with the last question asking the certainty they believed they could sink all seven of their putts at each difficulty level.

**Postexperimental Questionnaire.** Following completion of the experiment, participants were administered a questionnaire, which assessed whether experimental procedures were followed. Specifically, questions centered on prior imagery experience and how they used it during the experiment. Participants in the control group completed a similar questionnaire, except they were asked questions about their nonuse or use of spontaneous imagery.

**Experimental Conditions**

For participants in the experimental groups, the lead researcher defined imagery as, “a mental practice technique that uses the senses to create or re-create an experience in the mind.” An example was given of how a golfer could use imagery (e.g., a golfer may visualize a perfect swing, seeing the ball go into the hole, feeling a warm breeze, and hearing the sound of the putter hitting the ball). Participants were instructed to include all relevant aspects of performance in their imagery (task, environment, current emotions, multiple senses) and to keep their imagery positive by seeing the ball going into the hole. Participants were instructed to hold the putter in their stance while imaging along the putting green.

Participants in the RTI group were instructed to visualize for about the same amount of time it took them to perform the task. Participants in the SMI group were instructed to visualize the task at a slower speed (50% slower was suggested) while participants in the FMI group were instructed to visualize the task at a faster speed (50% faster was suggested). The suggested slower and faster speeds were not required rates, but were instead general targets, similar to previous research (O & Munroe-Chandler, 2008).

Participants imaged themselves performing the task a total of seven times, with their imagery starting from the moment they stepped up to the mat to begin their preshot routine and ending when they imaged the ball going into the hole. All participants were told to include their preshot routine as part of the task because a consistent preshot routine is essential for the successful performance of a putt (McCann, Lavallee, & Lavallee, 2001). The lead researcher provided feedback
(knowledge of results) after each imagery trial and informed the participants if they went too fast, too slow, or at about the right speed. This was done to ensure participants manipulated their imagery correctly.

The control group followed a similar process, except they did not receive the imagery intervention. Instead, they were given putting-irrelevant golf articles to read. In total, the imagery and control manipulations took roughly 7–10 minutes.

**Task**

All participants completed the golf-putting task at two difficulty levels and at two different times, thus resulting in a within-subjects repeated measures design. The number of trials used to measure participants’ performance was determined by pilot testing. To avoid the possibility of order effects, a counterbalanced procedure was used, with the study participants randomly assigned to complete the two levels of task difficulty in different orders.

The task was a golf putt performed on a combination of two putting mats in a laboratory setting, totaling about 4.88 m (16 feet) in length. Participants were asked to putt the ball into the hole from marked starting locations at 2.13 m (7 feet) and 4.27 m (14 feet) away from the hole and were instructed that their primary objective was to sink the ball into the hole, but if they missed, to have the ball stop as close to the hole as possible. Two performance measures were taken: number of putts holed and average distance from the hole, with the best score obtainable on a putt being zero (putting the ball into the hole) (Ramsey et al., 2008).

Participants were instructed to use a preshot routine before each putt. The experimenter modeled a sample routine, which included elements such as checking the lie of the ball, taking a deep breath, and using a practice swing (McCann, Lavallee, & Lavallee, 2001). Participants were allowed to personalize their routine slightly if desired (e.g., two practice swings instead of one) and practice it until it was consistent. Participants who already had a preshot routine were allowed to use their own. These preshot routine procedures were done as an attempt to keep participants’ routines relatively consistent from person to person while still allowing them some freedom for personalization, which would add realism to the routine, enhancing external validity.

**Procedure**

When participants arrived at the laboratory, they completed the consent form, demographic questionnaire, and MIQ-R. After completing the initial forms, preshot routine instructions were given, followed by the pretest, which was the first set of seven golf putts at each difficulty. Before the pretest, participants were told their scores would be compared with group norms and that they should do their best. This was done to encourage participants to put forth their best effort.

During the pretest, the experimenter recorded the length of time it took the participant to perform each trial with a stopwatch. Participants were told the stopwatch would start when they stepped up to the mat to begin their preshot routine and would stop when the ball came to a rest, thus capturing their entire performance. The averaged time of all trials served as the real-time reference point for the imagery speed manipulations for participants in the experimental groups. After the ball came to a rest, the researcher measured its distance from the hole if it was not in.
Participants in the experimental groups performed seven practice imagery trials at the speed to which they were randomly assigned. After each trial, the researcher provided feedback about the speed of their imagery so the participants had a better approximation of how quickly or slowly they were imaging, allowing them to adjust the rate of imagery to ensure they were imaging 50% slower, 50% faster, or at about the same time. After practice imagery, participants were informed they would complete the task again, only with imagery before each putt. Before the posttest started, participants completed the self-efficacy measure to gauge how confident they were in performing the task a second time. Participants then completed the posttest, during which the researcher measured imagery times, performance times, and performance. The posttest was exactly the same as the pretest, only participants imaged themselves performing the task once before each putt. Following completion of the posttest, participants completed the postexperimental questionnaire, were debriefed, and thanked for participating.

Results

Statistical Design

The statistical design used to analyze the performance data were a $4 \times 2 \times 2$ (imagery condition $\times$ task difficulty $\times$ time) mixed model MANOVA with repeated measures on the second and third factors. Dependent variables used were the two measures of putting performance (average distance from hole and number of putts made).

The statistical design for the self-efficacy data were a $4 \times 2$ (imagery condition $\times$ task difficulty) mixed model MANOVA with repeated measures on the second factor. Dependent variables for this analysis were the two measures of self-efficacy (level and strength).

Descriptive Statistics

Descriptive statistics for all performance measures are provided in Table 1. Of note are the high standard deviations for all of the performance scores, indicating large variability between participants in their performance at both pre and posttest.

Preliminary Analyses

Group Differences. One-way ANOVAs were conducted to determine if the four groups (three experimental and one control) differed on any of the pretest variables. No significant differences emerged on MIQ-R scores, pretest performance measures, and pretest average performance time.

Manipulation Checks. One-way ANOVAs were used to test if the experimental groups differed on their imagery speeds. Average imagery times differed significantly across the three imagery groups, $F(2, 44) = 28.37, p < .001, \eta^2 = .56$. Tukey post hoc comparisons ($p < .05$) of the three groups indicated that the SMI group ($M = 31.92s$) was significantly different from the FMI group ($M = 12.01s$), while the RTI group ($M = 24.88s$) was also significantly different from the FMI group.

In addition, percent changes in imagery speeds (compared with average pretest performance times) differed significantly across the three imagery groups, $F(2,$
Image Speed and Self-Efficacy

44) = 82.96, \( p < .001, \eta^2 = .79. \) Tukey post hoc comparisons of the three groups indicated that the slow-motion group (\( M = 50.69\% \)), real-time group (\( M = 3.39\% \)), and fast-motion group (\( M = -45.65\% \)) were all significantly different from each other, \( p < .001. \)

Paired samples \( t \) tests between the mean scores of the 2.13m putts and the 4.27m putts (with average distance from the hole and number of putts made serving as the dependent measures) were performed. Results for average distance indicated participants performed significantly better on the 2.13m putts (\( M = 0.28m \)) compared with the 4.27m putts (\( M = 0.53m \)), \( t (61) = -10.57, p < .001. \) Results for number of putts made indicated participants performed significantly better on the 2.13m putts (\( M = 2.43 \)) compared with the 4.27m putts (\( M = 1.15 \)), \( t (61) = 6.84, p < .001. \)

To determine if an assimilation effect took place, a 4 × 2 (imagery condition × time) repeated-measures ANOVA was conducted between the average performance time of the pretest and the average performance time of the posttest. Results indicated a significant interaction effect, \( F (3, 58) = 9.27, p < .001. \) However, Tukey post hoc comparisons of the four groups were not significant. Additional one-way ANOVAs on the pretest and posttest average performance times were also not significant. These results indicate an assimilation effect did not occur in the present investigation.

**Main Analyses**

**Imagery Speed and Performance.** A 4 × 2 × 2 (imagery condition × task difficulty × time) mixed model MANOVA was conducted with repeated measures on both task difficulty and time. Dependent variables for this analysis were the two measures of golf putting performance (average distance and number of putts holed). Examination of the results from the MANOVA revealed a significant main effect for task difficulty, Wilks’s \( \lambda = .33, F (2, 57) = 58.27, p < .001, \eta^2 = .67, \) which is consistent with the results of the previously reported paired samples \( t \) test on task difficulty. No other main or interaction effects were found to be significant. Although not statistically significant, inspection of mean differences for the individual groups (Table 2) reveals the SMI and RTI groups improved their scores on all four task measures from the pretest to the posttest. In contrast, participants in the FMI and control groups showed improvement from pretest to posttest in two of the performance scores but decreases in performance in the other two scores.

**Imagery Speed and Self-Efficacy.** A 4 × 2 (imagery condition × task difficulty) mixed model MANOVA, with repeated measures on the second factor, was con-

<table>
<thead>
<tr>
<th>Performance</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( M (SD) )</td>
<td>Min</td>
</tr>
<tr>
<td>2.13m AD</td>
<td>0.27 (0.21)</td>
<td>0.00</td>
</tr>
<tr>
<td>2.13m # Hole</td>
<td>2.31 (1.73)</td>
<td>0</td>
</tr>
<tr>
<td>4.27m AD</td>
<td>0.56 (0.24)</td>
<td>0.11</td>
</tr>
<tr>
<td>4.27m # Hole</td>
<td>1.13 (1.24)</td>
<td>0</td>
</tr>
</tbody>
</table>

_Note._ AD = Average distance from hole in meters; # Hole = Number of putts holed.
ducted to test if the level and strength of participants’ self-efficacy differed across experimental groups and/or across task difficulty (Table 3). Dependent variables for this analysis were the two measures of self-efficacy (level and strength). Results of the MANOVA revealed a significant main effect for task difficulty on level and strength of self-efficacy, Wilks’s $\lambda = .36$, $F \left(2, 57\right) = 50.07$, $p < .001$, $\eta^2 = .64$. Results of follow-up univariate tests revealed participants had significantly higher levels of self-efficacy on the 2.13m putts ($M = 4.08$) compared with the 4.27m putts ($M = 2.85$), $F \left(1, 58\right) = 76.95$, $p < .001$, $\eta^2 = .57$. Participants also had significantly higher strength of self-efficacy on the 2.13m putts ($M = 67.28$) versus the 4.27m putts ($M = 56.57$), $F \left(1, 58\right) = 41.56$, $p < .001$, $\eta^2 = .42$. No other significant main or interaction effects emerged.

Because participants’ self-efficacy scores as assessed just before their post-test performance may have been affected by their pretest performance scores, a $4 \times 2$ (imagery condition \times task difficulty) mixed model MANCOVA was also conducted. Again, dependent variables were the two self-efficacy scores (level and strength), and participants’ pretest performance was used as a covariate in this analysis. Obtained results indicated the same findings as in the previously described MANOVA. Thus, even after controlling for pretest performance, no significant differences in self-efficacy level or strength were found across the four experimental groups.

Postexperimental Questionnaire Results

All participants in the experimental groups indicated they used the imagery as instructed by the researcher. Of the participants in the experimental groups, 89% found the imagery helpful and 70% found the imagery easy to use. Participants mostly reported using an internal perspective (60%), with the rest using an external perspective (15%) or both perspectives (25%). In addition, 85% indicated on an open-ended question that their imagery changed how they were feeling (viz., increased confidence and focus). Nearly one-third of participants in the imagery groups reported using other mental strategies (viz., self-talk). Finally, most participants in the control group indicated they used imagery at some point during the experiment (73%). These control participants used imagery during their routine, found it helpful, and used it to see the ball going into the hole.

Discussion

The primary purpose of this study was to explore the effects of different imagery speeds on the performance of a golf-putting task. Empirical investigations on imagery speed have been mixed (e.g., Andre & Means, 1986; Louis et al., 2008; O & Munroe-Chandler, 2008) and no prior studies compared the effects of all three speeds at once. The secondary purpose of this study was to explore the effects of different imagery speeds on self-efficacy beliefs.

Manipulation Checks

In the current investigation, quantitative methods ensured successful task manipulation. Specifically, when looking at raw times, participants in the FMI group imaged
### Table 2  Means, Standard Deviations, and Mean Differences for Performance Measures

<table>
<thead>
<tr>
<th>Group</th>
<th>2.13m AD</th>
<th></th>
<th></th>
<th></th>
<th>2.13m # Hole</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Difference&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Pre</td>
<td>Post</td>
<td>Difference&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMI</td>
<td>0.29 (0.26)</td>
<td>0.24 (0.15)</td>
<td>-0.05</td>
<td>2.53 (2.27)</td>
<td>2.71 (2.14)</td>
<td>+0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTI</td>
<td>0.30 (0.23)</td>
<td>0.29 (0.29)</td>
<td>-0.10</td>
<td>2.07 (1.75)</td>
<td>2.87 (2.00)</td>
<td>+0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMI</td>
<td>0.24 (0.14)</td>
<td>0.24 (0.16)</td>
<td>0.00</td>
<td>2.20 (1.57)</td>
<td>2.80 (1.57)</td>
<td>+0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.27 (0.21)</td>
<td>0.35 (0.23)</td>
<td>+0.08</td>
<td>2.40 (1.24)</td>
<td>1.80 (1.42)</td>
<td>-0.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.27m AD</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>4.27m # Hole</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Difference&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Pre</td>
<td>Post</td>
<td>Difference&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMI</td>
<td>0.55 (0.24)</td>
<td>0.52 (0.33)</td>
<td>-0.03</td>
<td>0.94 (1.25)</td>
<td>1.29 (1.83)</td>
<td>+0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTI</td>
<td>0.53 (0.21)</td>
<td>0.44 (0.25)</td>
<td>-0.09</td>
<td>1.00 (1.00)</td>
<td>1.20 (1.32)</td>
<td>+0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMI</td>
<td>0.49 (0.23)</td>
<td>0.47 (0.27)</td>
<td>-0.02</td>
<td>1.73 (1.49)</td>
<td>1.13 (1.25)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.66 (0.27)</td>
<td>0.56 (0.20)</td>
<td>-0.10</td>
<td>0.87 (1.24)</td>
<td>1.07 (1.16)</td>
<td>+0.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>Note.</sup> AD = Average distance from hole (meters); # Hole = Number of putts holed; SMI = Slow-motion imagery; RTI = Real-time imagery; FMI = Fast-motion imagery; C = Control, no imagery.

<sup>a</sup>Negative differences indicate improvements in performance (closer to hole).

<sup>b</sup>Positive differences indicate improvements in performance (greater number in hole).

### Table 3  Means and Standard Deviations of Self-Efficacy Measures

<table>
<thead>
<tr>
<th>Self-Efficacy</th>
<th>Slow-Motion</th>
<th>Real-Time</th>
<th>Fast-Motion</th>
<th>Control</th>
<th>Overall Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.13m Level</td>
<td>4.24 (1.68)</td>
<td>4.00 (1.41)</td>
<td>3.87 (1.25)</td>
<td>4.20 (1.37)</td>
<td>4.08 (1.42)</td>
</tr>
<tr>
<td>2.13m Strength</td>
<td>72.09 (14.33)</td>
<td>65.33 (15.30)</td>
<td>66.29 (15.04)</td>
<td>64.78 (11.89)</td>
<td>67.28 (14.18)</td>
</tr>
<tr>
<td>4.27m Level</td>
<td>3.06 (2.02)</td>
<td>2.87 (0.74)</td>
<td>2.67 (1.35)</td>
<td>2.80 (1.61)</td>
<td>2.85 (1.50)</td>
</tr>
<tr>
<td>4.27m Strength</td>
<td>62.97 (14.32)</td>
<td>49.49 (17.02)</td>
<td>55.61 (23.27)</td>
<td>57.37 (15.64)</td>
<td>56.57 (18.02)</td>
</tr>
</tbody>
</table>

<sup>Note.</sup> Level = Level of efficacy beliefs; Strength = % strength of efficacy beliefs
significantly faster than participants in the RTI or SMI groups. When looking at percent changes from average pretest performance time to average imagery time, participants in the FMI and SMI groups imaged about 50% faster and slower, respectively, while participants in the RTI group imaged at about the same speed. All participants stated they used imagery as instructed thus attesting to the imagery manipulation. It also appears that the imagery intervention did not affect the actual rate at which participants performed the task. Previous research has established that assimilation effects can occur in either direction (e.g., Boschker et al., 2000; Debarnot et al., 2011; Louis et al., 2008), but in this study, participants still performed the golf putt task at the same rate as before, suggesting the imagery speed did not affect their movement speed. In addition, participants performed better on the shorter putt, indicating the shorter putt was easier.

**Imagery and Performance Results**

Analyses of the four performance variables yielded no significant differences, indicating the three imagery groups did not perform better than the control group. This result conflicts with most imagery research, which finds imagery use leads to significant performance gains (e.g., Feltz & Landers, 1983; Weinberg, 2008), but is consistent with some imagery speed research. For example, Andre & Means (1986) found that different imagery speeds did not lead to significant differences in performance. It is possible that requesting participants to image at particular speeds undermined imagery’s effectiveness, although future research is necessary to test this hypothesis.

In the current study, however, participants in the SMI and RTI groups improved their scores from the pretest to the posttest on all four performance measures, while participants in the FMI and control groups only improved their scores on two measures (Table 2). The amount of improvement was also higher for the SMI and RTI groups. Although not statistically significant, these findings have some limited relevance due to the exploratory nature of the study and seem to be in line with recent research using soccer dribbling tasks (O & Munroe-Chandler, 2008). It appears that participants using SMI and RTI performed more consistently because they exhibited improvement on all four of the performance measures, while participants in the FMI and control groups performed more inconsistently by not improving or worsening their scores on half the measures. Further empirical research is needed to investigate these potential differences in performance improvement as a function of different imagery speeds.

Previous researchers in the sport psychology literature have also encountered this dilemma of statistical significance versus practical significance. For example, in a goal-setting study on lacrosse players, Weinberg, Stitcher, and Richardson (1994) found no significant goal-setting differences, although the goal-setting group had higher mean scores on all four performance measures. It was reported that the coaching staff felt the goal setting program was highly effective in improving performance, giving the results applied significance despite the lack of statistical significance. Similarly, in this study 89% of participants in the imagery groups found the imagery helpful. Other writers (e.g., Andersen, McCullagh, & Wilson, 2007; Hagger & Chatzisarantis, 2009) have also noted the importance of considering not only statistical significance but also practical or applied significance when interpreting the results of sport psychology intervention studies.
Self-Efficacy Results

Analysis of the self-efficacy belief measures revealed no significant differences between the three imagery and control groups. This conflicts with past research that has found imagery use to be linked with higher self-efficacy beliefs (Short et al., 2002). Furthermore, the lack of significant group differences indicates that different imagery speeds did not lead to different self-efficacy beliefs. This may have occurred due to limitations with the study (see below).

Although efficacy was not significantly different across groups, neither were performance results. Self-efficacy beliefs have been linked with improved performance (e.g., Short et al., 2002), so it would follow that a lack of changes in self-efficacy beliefs would be linked with no significant differences in performance. Therefore, these results appear consistent with self-efficacy theory, although in an unusual manner. In addition, consistent with self-efficacy theory, participants had significantly better scores and higher self-efficacy beliefs on the less difficult putts compared with the harder putts.

Practical Implications

While the performance improvements found in the current study may not have been statistically significant, an intervention that results in putting the ball closer to the hole and making more putts could have some applied value. Small improvements can often make a large difference in golf. For example, during the 2012 season, the best putter on the PGA Tour had a putting average of 1.72 putts per hole, while the 100th best putter had a putting average of 1.78, a difference of only 0.06 (PGA Tour Statistics). On the LPGA Tour for the 2012 season, the best putter had a putting average of 1.73, while the 100th best putter had an average of 1.86, a difference of only 0.13 (LPGA Tour Statistics).

Based on those numbers, one can see how small improvements may ultimately make a large difference. In the present investigation, participants in the SMI and RTI groups made more putts from 2.13m away (0.18 and 0.80, respectively) and from 4.27m away (0.35 and 0.20, respectively) on the posttest. While seemingly small, those improvements could be the difference between being an excellent putter versus an average one and are quite large compared with differences of 0.06 and 0.13 on the PGA and LPGA Tours (though it should be noted these putts were relatively easy compared with the types of putts and putting conditions found on real golf courses).

While the results are large compared with PGA and LPGA Tour putting averages, due to the lack of statistical significance, it is difficult to make a strong endorsement for manipulating imagery speeds to improve golf putting performance. Some small, consistent improvements were observed for RTI and SMI, but the improvements observed for participants using FMI were inconsistent. These inconsistencies suggest that FMI may be hurtful to performance compared with RTI and SMI, though clearly more research is needed.

Limitations

Limitations exist that may diminish the ability to generalize these findings. One limitation in this study regarding the lack of significance in the comparison of the
mental imagery conditions was large standard deviations exhibited by individuals within each experimental group. Such large interindividual variability in performance within the groups makes it considerably more difficult to detect differences between the treatment conditions (Tabachnick & Fidell, 2007). The large standard deviations seen within groups in this study were most likely a result of the wide range of prior golf experience reported by participants in the sample. Although most study participants had either no golf experience or only had a small to moderate amount of experience, there were some participants who had more extensive golf experience. Given this relatively wide range in prior experience, it is not surprising that participants’ performance levels did vary. Thus, future researchers might consider ways to reduce such interindividual variability. This could be done, for example, by establishing an a priori criterion for the amount of golf experience or skill that potential study participants would need. Such a selection procedure would likely result in a reduction of variability in performance within the experimental groups.

In addition, the use of outside strategies by participants in the experimental and control groups may have prevented the treatment from being as strong as possible. Specifically, one-third of participants in the imagery groups reported using other mental strategies. This may have contaminated the experimental groups’ performances because some participants were employing strategies other than imagery (although they did confirm the imagery speed manipulation). Furthermore, most participants in the control group reported using imagery at some point during the experiment, with many of them indicating the imagery was helpful and used on every shot. One reason for this may be due to the rise in popularity of sport psychology techniques in the past several years. Indeed, 71% of the sample reported having prior experiences with imagery, usually from use in other sports. Thus, it is plausible that because they had exposure to imagery, participants felt comfortable using it in a new setting. The finding of the spontaneous use of imagery by control participants is similar to the spontaneous use of goal setting for control groups in goal setting studies (Weinberg & Weigand, 1993). Thus, instead of trying to prevent participants from using goals or imagery (because they use these in applied settings anyway), the effectiveness of different strategies should be investigated.

Another way to increase the strength of the treatment would be to have a more experienced sample. As one learns new skills, the blueprint for those skills becomes increasingly refined as they are practiced. Novices, however, are still trying to figure out their mental blueprint. Therefore, when asked to manipulate their mental blueprint by imaging at different speeds, experts may have a better quality manipulation compared with novices. By eliminating people with no prior golf experience, the strength of the treatment would increase because that would mean that only people with strong blueprints are left. In essence, eliminating less experienced golfers should increase the strength of imagery manipulations.

**Future Research Directions**

There are many possible questions that future researchers can address. First, given the variability of prior golf experience in the sample, it may be beneficial to compare the effects of different imagery speeds based on level of expertise. For example, novices may benefit from SMI more than experts because they are trying to create a mental blueprint and need to see how the process unfolds (Syer & Connolly, 1984).
The findings of a related study also suggest imagery speed may interact with skill level (Beilock & Gonso, 2008). In this study, experts performed better when told to image or perform a task as fast as possible while still being accurate compared with when they were given unlimited time. Novices, meanwhile, performed better when given no time constraints. However, this study did not quite explore imagery speed as it focused on instructional time constraints, not the speed at which participants imaged.

Researchers should also attempt to use a variety of different tasks. Previous imagery speed studies that measured sport skill performance used disc golf and soccer dribbling (i.e., Andre & Means, 1986; O & Munroe-Chandler, 2008), while this study used golf putting. Future studies may want to use other tasks from different sports to see if the effects are specific to one type of task or useful on many tasks. For example, SMI may work better for golf putting, a slower movement, while FMI may be best for a softball pitch, which is a fast, explosive movement.

More attempts should be made to understand if imagery speeds alter psychological states. This study found no significant differences on self-efficacy, but previous research has indicated that athletes used fast-motion imagery to increase their arousal levels (Fournier et al., 2008, O & Hall, 2013). Future experimental studies may want to include measures of psychological states to determine if and to what extent these changes occur.

Lastly, it may be useful to determine how fast is fast and how slow is slow because imagery speed instructions have varied from study to study (e.g., Andre & Means, 1986; Boschker et al., 2000; Louis et al., 2008; O & Munroe-Chandler, 2008). From an applied perspective, it would be useful to know at what rate participants should image to achieve the maximum benefit (e.g., 50% slower versus 25% slower), which is a question research can address. This goes along with Calmels and colleagues (2006) finding that when gymnasts image themselves performing a specific type of vault, their imagery is at different speeds throughout the imagined movement. Certain imagery speeds may be more useful for certain stages of a movement compared with other speeds, and thus it would be beneficial to determine the appropriate spots at which to increase or decrease the rate of imagery. These are applied questions that need empirical research.

References


