Self-efficacy assessment hinders improvement on a deliberate cricket bowling practice task

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Abstract

Self-related thoughts such as performance worries or attention to one's own body movements during sport have been known to impact performance negatively. However, self-assessment is often encouraged during learning tasks, especially when being coached on sporting tasks. In this study we examined how attention directed towards an internal psychological aspect, self-efficacy, affected performance in a cricket bowling task. We hypothesised that cricketers who are asked to assess their own ability on a bowling task would show a deterioration in performance compared to control subjects who are asked to assess the ability of another. Participants were asked to rate their self-efficacy levels in the middle of a deliberate practice task. In the pre-test phase, participants attempted to bowl in a game-standard designated "good length" zone across twelve trials. Following this, experimental group members rated their own general and task-specific self-efficacy using Bandura's self-efficacy questionnaire, while the control group rated someone else's ability. They each then bowled for twelve more trials, and their performance was measured before and after the self-assessment based on the number of trials that were bowled within the standard "good length" zone. Paired t-tests showed that while the performance of the control group improved significantly from pre-test to post-test, $t = 2.613, p = 0.008$; the experimental group did not show a significant improvement, $t = 1.156, p = 0.131$. Results indicate that asking people to rate their confidence level may hinder their improvement on a deliberate practice task. This has implications for sport performance where athletes or coaches might be tempted to self-evaluate before performance, as well as for researchers who consider administering self-efficacy questionnaires prior to performance.

Introduction

Performance improvement has been posited as hinging on psychological frameworks of self-efficacy, goal setting, concentration, imagery, arousal regulation, etc., but some aspects of self-directed thoughts have been shown to negatively impact sports performance (Weinberg and Gould, 2014). Attentional focus emerges as one of the primary factors that distinguishes better sport performances from worse ones, with a stronger effect than other variables such as how athletes expect to perform and what they prefer to attend to (Memmert, 2009). Meta-analyses of over 80 experiments involving various kinds of projectile sport (golf, darts, basketball, football, etc.) show that directing attention towards an external focus rather than an internal focus towards one's own body provides a significant advantage across several performance measures such as accuracy, consistency, balance, muscular activity, force production and cardiovascular responses (Wulf, 2013). The locus of attention also affects outcomes, with a focus on more distal loci to the body being associated with better performances than focusing upon more proximal loci, as assessed in a variety of sports involving manipulating the body in space (Bell and Hardy, 2009).

Various theories have been proposed to explain the apparent benefits of external focus. Ideomotor theory suggests that attending to external stimuli that represent the intended and actual outcome best entrains the circuit from sensory to motor neurons whose action produces that outcome. Common coding theory suggests that perception and action could have a common neural representation (Wulf and Prinz, 2001).

The self-focus theory argues that internal skill-focused attention impairs performance and is responsible for the phenomenon of “choking” under pressure and failing to execute a skill (Wulf, 2013). These results are often surprising to sports coaches since their feedback often directs attention internally towards limb movements as part of many sports training and practice paradigms. In general, deliberate practice leads to an improvement in performance across various domains such as sports, music, typing, etc. (Ericsson, 2008; Coughlan et. al, 2014). However, in many cases, improvements are stronger when players are allowed to generate their own movements

to reach a sporting goal, compared to when components of the movement are guided by feedback from experts (Soderstrom and Bjork, 2015).

The distraction theory suggests that self-directed thoughts such as performance worries during or before high pressure performances act as a distraction from an external focus and therefore have an adverse effect on performance (Oudejans et. al., 2011). The detrimental effect of pre-performance anxiety and stress upon confidence and self-efficacy may also play a moderating role (Stanger, et al., 2018). Self-efficacy, a self-report measure, is distinguished from general self-confidence or self-esteem in referring to a specific belief in one's ability to organize and execute a particular course of action towards a goal or outcome (Short and Ross-Stewart, 2008; Feltz, 1988a). Self-efficacy beliefs can be affected by past performance, vicarious experiences, motivational experiences, physiological states, imagery and verbal persuasion, and can in turn impact future actions, choices, effort and persistence (Short and Ross-Stewart, 2008). A meta analysis of 45 studies (102 correlations) found that the average correlation between self-efficacy and sport performance was $r = 0.38$ (Moritz et al., 2000), similar to the correlation between self-efficacy and performance in other domains such as work or academia. In general, researchers have found that performance worries have a negative association with performance, whereas, self-efficacy has a positive association with performance.

Metacognition theory suggests that an athlete might have metacognitive knowledge about their levels of self-efficacy, and might use metacognitive skills to regulate their thoughts and feelings about their self-efficacy (Baker and Brown, 1984). For example, Olympic athletes who use their metacognitive abilities to self regulate outperform others who don't, and such metacognitive abilities positively correlate to sport performance and learning (Macintyre et al., 2014).

Interventions to enhance self-efficacy of performers can enhance sport performance (Wulf and Lewthwaite, 2016) - for example providing better than average feedback; providing evidence of the performer's best performance; priming; and liberal definitions of task success (Lewthwaite and Wulf, 2017). Knowledge of results and augmented feedback (feedback from external sources) are

often considered key to improvement, not only during deliberate practice but during learning more generally (Salmoni et al., 1984; Lee 2012). However, it is unclear how reflecting on one's knowledge of results in the middle of a task may impact performance. Through this study, we wish to examine how different kinds of self-directed thoughts relate to performance. Specifically, we study how a metacognitive activation about self-efficacy and self-assessment of feedback may impact performance.

In order to explore the specific effect of realistic feedback on self-efficacy and performance, we study Indian athletes playing cricket, a sport with pauses built in after each period of play during which attentional focus might shift towards various inward factors. Much of the scientific literature on cricket has examined the physiological characteristics of differently skilled players (Barrett et al. 2017; Edwards, 1996), the biomechanics of batting (Taliep et al., 2007) and bowling (Bartlett et al., 1996; Renshaw and Davids, 2006), and the effects of various pre-performance routines (Cotterill, 2011), techniques (Wallis et al., 2002), and training methods (Ford et al., 2010; Low et al., 2013). Most psychology of cricket literature has looked at differences between players in anticipation (Ford et al., 2010), head and eye movements while batting (Sarpeshkar et al., 2017), judgement of ball length and direction (Müller et al., 2006), ability to discriminate amongst various delivery types (Renshaw and Fairweather, 2000) and stress and coping strategies (Thelwell et al., 2007).

We propose to examine performance before and after a manipulation midway through a standardized deliberate practice bowling accuracy task session, where self-related thoughts are elicited by administering a self-efficacy questionnaire where players reflect on their performance and are given knowledge of their results. Players in a control group are asked to reflect on the performance of another bowler. All participants are not given any technical instructions and are allowed to improve through self-generated movements. When we ask these athletes about their levels of self-efficacy, their metacognitive knowledge is activated. Since these athletes do not have individual or institutional access to psychological skills training, this approach specifically probes

metacognitive knowledge in the absence of taught metacognitive skills. We hypothesize that in the absence of metacognitive skills, activation of metacognitive knowledge through self assessment of one's scores in the middle of a deliberate practice task might negatively affect athlete performance.

Methods

Participants

Participants were recruited from Ashoka University and two cricket academies from the National Capital Region in India and included all participants present on those days who could bowl. Participants were between 16 and 24 years of age and included 5 female and 37 male cricketers who all varied in training experience. During recruitment, they were told that the study was about learning a specific bowling skill. Informed consent was taken from the participants, and in the case of minors, from their coaches. Some participants were told that they will be rewarded with food coupons ($N = 38$), while others were promised extra credit ($N = 4$). The research design was approved by the Institutional Review Board of Ashoka University.

Set-Up

An illustration of the set-up is shown in Figure 1. The experiment was conducted in standard cricket nets used for training. The surface of the pitch was either concrete or soil — based on availability at the cricket academy. While a change in surface may have impacted what the ball did after pitching, this did not impact their performance on the task — which was only concerned with where the ball pitches. Three stumps were placed on the closed end of the net (see Figure 1) and one stump on the bowling end. The distance between the stumps, batting crease and bowling crease was marked according to standard cricketing dimensions. Additionally, saucer cones were placed at four and six meters away from the stumps at the batting end. This distance is typically used to indicate a “good length zone” — an area where trained bowlers attempt to bowl to create difficulty for batsman (see Figure 1). This zone was two metres long and half a metre wide. It started from the right most stump (leg stump for a right hander) and ended slightly outside the left-most stump. This was to ensure that bowling accuracy is measured on both parameters: line and length which typically determine the quality of a ball. The outside vertices of this zone was marked using four saucer cones. An experimenter stood on the side of the cricket net to check for no-balls (see

“Invalid Trials”) and to determine where the ball pitched. Video cameras were placed behind the stumps to corroborate the experimenter’s observation.

Measures

Task Performance. A simple “hit or miss” paradigm was used and trials were deemed successful if the ball pitched inside the target zone and unsuccessful otherwise.

Invalid Trials. These included a) front foot no balls: trials that were bowled from in front of the bowling crease (no part of the leading foot of the player is behind the line); b) throwing no balls: trials where participants bowled with a bent arm (at an angle greater than fifteen degrees). These trials were not counted during pre-test or post-test phase. This was checked by an experimenter.

Training Experience. Training experience was measured using three questions (see Questionnaire A, Supplementary Materials A). These asked about years of formal cricket training an individual had received, how many hours of such training they received in a week and how many hours they practiced bowling in a week. Formal cricket training was defined as any training received from a coach at school, university or a cricket academy. The last two questions were answered in relation to the last three months to gauge present involvement in cricket.

Figure 1. Experimental Set-Up. The bowlers attempted to pitch the ball within the “*Good Length Zone*” area demarcated by the cones, indicated by the triangles, in a standard sized cricket pitch which was replicated in the experiment. The “*Good Length Zone*” area was between four and six metres from the stumps.

Self-Efficacy. Self-efficacy was measured using Bandura’s 100 point scale using two items. This scale has been used for self-efficacy measurement in a sporting context (see Treasure, Monson and Lox, 1996). The scale indicates confidence levels from “not at all confident” (0) to “moderately confident” (50) to “very confident” (100). The first questions asked about participant’s confidence about their bowling. The second question asked how confident the participants were of bowling 50% of the deliveries in the target zone (see Questionnaire B, Appendix A). This item was adapted from Ong et. al, (2015) who used a similar measure as task self-efficacy indicator for dart throwing. The two questions gave an indication of participant’s general and task self-efficacy, respectively. Only two items were used to understand whether even a brief period of attention towards one’s self-efficacy may impact performance, as well as to make the self-efficacy intervention seem less obtrusive.

Control Group Questionnaire. Participants (N = 17) were asked a set of questions - they were asked first to write the name of their favourite bowler. Then, they too were given a 100 point scale and asked to rate their favourite bowler’s ability on this scale (see Questionnaire C, Supplementary Materials A). This second version of the control group questionnaire was to ensure that the question and responses of the control group are similar to the experimental group in all but one aspect — they do not prompt their attention to be directed inwards to the self.

Procedure

The experiment had a mixed design and was divided into three phases. Overall, the participants had to bowl twenty four times. Pilot studies that we conducted showed that this was an ideal number of deliveries to measure improvement while preventing fatigue — especially for fast

bowlers (see Maunder, Kilding and Cairns, 2017). After the first twelve balls (Phase 1), participants were given a five minute break and they were administered a questionnaire (Phase 2). Half the participants ($N = 21$) were administered the control group questionnaire, while the other half was administered the experimental group questionnaire. Finally, after they bowled twelve more times, they were administered another questionnaire, were thanked, rewarded and debriefed (Phase 3). The entire task was conducted on the same day and took between twenty to thirty minutes for each participant.

Phase 1. This phase constituted of warm up and 12 bowling trials. First, participants were asked to read and sign the informed consent. Then, they were told to stretch and warm up. As part of the warm up, they were asked to bowl three times without the cones in place. During these trials, the experimenter gave them feedback about invalid trials (if any) and they were required to correct this before they began. No participant required more than three warm up deliveries to correct invalid trials. After the warm up, participants were given instructions in either English or Hindi depending on their comfort: (Supplementary materials, Appendix C). Following the instructions, the participants proceeded to bowl two blocks of six trials each. They could take a thirty second break after the first six balls.

Phase 2. After the first twelve balls, participants were told how many trials were successful. This was conveyed verbally by the experimenter in a neutral tone. For example, “Four out of twelve trials pitched inside the zone.” While the results were visible in plain sight to the participants, the feedback was made explicit to ensure that knowledge of results is uniform across participants. This was important because their results may have affected their self-efficacy ratings. Then, they were given a break of five minutes. In this break they were allowed to drink water as lack of hydration has been shown to influence bowling accuracy (Devlin, Fraser, Barras and Hawley, 2001). However, they were not allowed to consume any other substances. After five minutes, both groups were administered “Questionnaire A” which asked about the duration and frequency of cricket training. Then, the experimental manipulation was introduced. While experimental group

participants ($N = 21$) were administered “Questionnaire B”, control group ($N = 21$) participants were administered “Questionnaire C”. The participants were assigned to these groups through random number generation using the software R.

Phase 3. Following phase 2, the participants bowled one warm up delivery without the cones. This was because pilot studies had shown that participants required at least one warm up delivery to start bowling accurately again. Then, they were given the same instructions to bowl for the next set of trials. Following this, the participants bowled twelve times with an optional thirty second break after six balls. The criterion to indicate the success of a trial was the same as Phase 1. At the end of these trials, all participants were told the number of successful trials in the last twelve balls. Then, participants from both groups were administered “Questionnaire B”. This was to get an after task self-efficacy measure from both groups and also to see if participants in the experimental group changed their self-efficacy scores. Finally, the participants were thanked, rewarded and debriefed regarding the study. In the debrief they were told about the aims of the study, the primary research question and the hypothesis.

Results

The effect of a self efficacy intervention upon bowling performance

The primary hypothesis was tested using a paired t-test for control and experimental groups, based on a used a 2x2 design : (Test Time: Pre-test vs Post-test x Questionnaire Administered: Control vs Experimental) design. The performance variable (DV) was the number of times the participants “hit” the good length zone in the 12 pre-test trials versus the 12 post-test trials.

Post-test bowling scores ($M = 4.14$, $SD = 1.53$) were significantly higher than the pre-test bowling scores ($M = 3.05$, $SD = 1.50$) for the control group, $t(20) = 2.61$, $p = 0.008$. However, post-test bowling scores ($M = 3.619$, $SD = 1.830$) for the experimental group were not significantly greater than the pre-test bowling scores ($M = 3.14$, $SD = 1.91$), $t(20) = 1.16$, $p = 0.131$ (Figure 2). The Shapiro-Wilk normality test showed that pre-test scores for the control group ($W = 0.92$, $p = 0.10$) and experimental group ($W = 0.95$, $p = 0.29$) were normally distributed; as were the post-test scores for the control group ($W = 0.95$, $p = 0.34$) and experimental group ($W = 0.95$, $p = 0.34$). This supported the primary hypothesis which stated that improvement would be less for the experimental group in comparison to the control group.

Figure 2. Improvement in Performance. Pre-test indicates the number of successful trials in the first set of 12 trials, whereas, Post-test indicates the number of successful trials in the second set of 12

trials. (A) Mean comparisons for pre-test and post-test in the Control Group. (B) Mean comparisons for pre-test vs post-test in Experimental Group.

A Mixed ANOVA showed that there was a significant main effect of test time, $F(1, 40) = 7.15, p < 0.05$. This means that there was an overall significant improvement for all bowlers from pre-test to post-test confirming the known effects of practice on producing improvement. However, the interaction of test time and questionnaire administered was not significant, $F(1, 40) = 1.11, p = 0.298$. This indicates that the improvement did not simplistically interact with the intervention.

We checked that there were no initial differences between the two groups, who were randomly drawn from the test population. An independent samples t-test indicated that there was no significant difference in the pre-test scores for experimental vs control group, $t(40) = -0.180, p = 0.858$. Similarly, there was no significant difference in post-test scores for experimental vs control group, $t(40) = 1.01, p = 0.160$. Additionally, there was no significant difference between overall scores for the experimental group ($M = 7.19, SD = 2.34$) and the control group ($M = 6.76, SD = 3.22$), $t(40) = 0.493, p = 0.625$. This meant that either before or after the intervention, there were no differences in average performance scores of individuals across the two groups. Further, absolute change in scores were not significantly lower for the experimental group ($M = 0.476, SD = 1.89$) compared to the control group ($M = 1.10, SD = 1.92$), $t(40) = 1.05, p = 0.149$. This indicated that when change in scores is used as the dependent variable, the difference between the two groups was not significant.

Smaller improvements in scores for higher pre-test bowling scores

Perhaps most interesting is the finding of a negative correlation between pre-test bowling scores and the absolute change in bowling scores for both the control ($r(19) = -0.627, p = 0.002$) and experimental ($r(19) = -0.534, p = 0.013$) groups (Figure 3), as well as when the two groups were pooled ($r(40) = -0.53, p = 0.013$). However, as might be expected, post test bowling scores are significantly positively correlated with the absolute change in scores for both the experimental

($r(19) = 0.475, p = 0.03$) and control groups ($r(19) = 0.643, p = 0.002$). Individuals who scored higher on the pre-test scores in bowling therefore showed less improvement in scores over time.

Figure 3. The correlation between the change in bowling performance between the first pre-test set of 12 trials, and the post-test set of 12 trials, relative to pre-test scores in the (A) Control Group ($r = -0.627, p = 0.002$) and (B) Experimental Group ($r = -0.534, p = 0.013$).

Self-Efficacy. There were two measures of self-efficacy. One measured general self-efficacy as a bowler, whereas the other measured task-specific self-efficacy. For the experimental group, these measures were taken twice: once after the pre-test and again after the post-test. However, for the control group these were only taken after the post-test. Separate analyses were conducted for the two groups since there was a difference in when self-efficacy scores were measured.

Firstly, we found a generally robust correlation between all measures of self-efficacy. Specifically for the experimental group, the first measure of self-efficacy — general self-efficacy measured after the pre-test bowling ($M = 65.95, SD = 26.25$) — was significantly positively related to all subsequent measures of self-efficacy: task self-efficacy measured next after the pre-test bowling, ($M = 60.69, SD = 29.35$), $r(19) = 0.90, p < .001$ (Figure 4A); general self-efficacy measured after post-test bowling ($M = 66.02, SD = 27.91$), $r(19) = 0.96, p < .001$ (Figure 4C); and

task self-efficacy measured after that ($M = 64.71$; $SD = 30.70$), $r(19) = 0.66$, $p = 0.001$. General and task-specific self-efficacy both measured post-test were also positively correlated ($r(19) = 0.63$, $p = 0.002$) (Figure 4B). Task-specific self-efficacy measured after pre-test and post-test bowling were also positively correlated ($r(19) = 0.75$, $p < 0.001$).

For the control group, general self-efficacy ($M = 68.05$, $SD = 20.42$) and task self-efficacy ($M = 65.83$, $SD = 22.55$) were positively correlated, $r(19) = 0.74$, $p < .001$) (Figure 4D). So individuals who reported higher self-efficacy scores as bowlers also reported higher self-efficacy scores on the task.

(A)

(B)

(C)

(D)

Figure 4. (A) The correlation between general efficacy and task-specific efficacy, both measured after the pre-test set of 12 trials ($r = 0.90$, $p < 0.001$) and (B) after the post-test set of 12 trials ($r = 0.63$, $p = 0.002$), in the experimental group. (C) The correlation between general self-efficacy

measured after the pre-test (1) versus measured after post-test trials (2) for the experimental group ($r = 0.96, p < .001$). (D) The correlation between general and task specific efficacy in the control group ($r = 0.74, p < 0.001$).

Self-Efficacy and bowling scores.

For the experimental group, general self-efficacy scores measured after the pre-test were significantly positively related to pre-test bowling scores, $r(19) = 0.58, p = 0.006$, (Figure 5A); but were not significantly related to post-test bowling scores, $r(19) = 0.08, p = 0.745$. Task self-efficacy measured after pre-test bowling was also positively correlated with pre-test scores, ($r(19) = 0.56, p = 0.009$), (Figure 5B), but not with post-test scores ($r(19) = 0.12, p = 0.607$). Likewise, general self-efficacy scores measured after post-test bowling had a significant positive correlation with pre-test bowling scores ($r(19) = 0.56, p = 0.008$), (Figure 5C), but not with post-test bowling scores ($r(19) = 0.18, p = 0.44$; task-specific self-efficacy scores measured after post-test bowling also had a significant positive correlation with pre-test bowling scores ($r(19) = 0.45, p = 0.041$), (Figure 5D), but not with post-test bowling scores ($r(19) = 0.24, p = 0.3$). These measures of self efficacy taken post-test in the experimental group are comparable in timing to the measures taken for the control group. In the control group as well, task self-efficacy was significantly moderately positively correlated with pre-test bowling scores, ($r(19) = 0.53, p = 0.013$) (Figure 5F) but not with post-test scores ($r(19) = 0.20, p = 0.39$). Thus, higher the individual scored on the pre-test or overall, the higher they rated their confidence on the task. However general efficacy was not significantly correlated either with pre-test ($r(19) = 0.36, p = 0.11$) (Figure 5E) or post-test bowling scores ($r(19) = 0.21, p = 0.37$).

Across groups, therefore, any significant correlation of general or task-specific efficacy with pre-test bowling scores did not hold with post-test bowling scores.

(A)

(B)

(C)

(D)

(E)

(F)

Figure 5. The correlation between pre-test bowling scores, with (A) general efficacy ($r = 0.58$, $p = 0.006$) and (B) task-specific efficacy ($r = 0.56$, $p = 0.009$), both measured after the pre-test set of 12

trials and (C) general efficacy ($r = 0.56, p = 0.008$) and (D) task-specific efficacy ($r = 0.450, p = 0.041$), both measured after the post-test set of 12 trials ($r = 0.63, p = 0.002$), in the experimental group; with (E) general self-efficacy ($r = 0.36, p = 0.11$) and (F) task-specific efficacy ($r = 0.53, p = 0.013$) in the control group.

Interestingly, for the experimental group, the absolute change in bowling scores was negatively correlated to both the general self efficacy scores ($r(19) = -0.51, p = 0.017$) (Figure 6A) and to task-specific self-efficacy ($r(19) = -0.45, p = 0.043$) (Figure 6B) measured immediately after pre-test bowling. The correlation between the absolute change in bowling scores with general and task specific efficacy measured after post-test bowling, in both the experimental and control groups, was negative but not significant.

Figure 6. The correlation between the absolute change in bowling performance scores between the first pre-test set of 12 trials and the post-test set of 12 trials, relative to (A) general ($r = -0.51, p = 0.017$) and (B) task-specific self efficacy in the experimental group ($r = -0.45, p = 0.043$).

Training experience and test scores. There were three different measures of training experience: number of years of cricket training one has received; number of hours one receives such

training in a week (for the last three months); and the number of hours one practices bowling in a week (for the last three months) (See Questionnaire A, Appendix A). Based on participant ratings, the scores for all items about training experience were normalized to a number from 1 to 5.

Correlation analyses were run to see how training experience interacts with other variables.

A weak positive correlation emerged between various measures of training experience and performance on the task. Years of training an individual received (*Mean normalized score* = 2.79, *SD* = 1.14) was positively correlated with their pre-test scores $r(40) = 0.33, p = 0.034$, when participants were pooled across the experimental and control groups. Similarly, pre-test scores were also positively correlated with hours of cricket training in a week (*Mean normalized score* = 3.36, *SD* = 1.51), $r(40) = 0.47, p = 0.002$; and number of hours one practiced bowling in a week (*Mean normalized score* = 2.69; *SD* = 1.41), $r(40) = 0.41, p = 0.007$. However, this correlation was not significant for post-test scores, either when disaggregated for control and experimental groups, or when pooled together.

(A)

(B)

(C)

Figure 7. The correlation between bowling scores from the first pre-test set of 12 trials, pooled together across both experimental and control groups ($n = 42$) with various measures of training experience, such as (A) number of years of training ($r = 0.33, p = 0.034$), (B) number of hours of general cricket training per week ($r = 0.47, p = 0.002$) and (C) number of hours of bowling practice per week ($r = 0.41, p = 0.007$).

Gender. There were only five female participants compared to 37 male participants. Due to the large variation in sample sizes, it is difficult to draw any meaningful conclusions from this aspect of the data. Data for pre-test and post-test scores pooled together, and pooled across experimental and control groups and disaggregated by gender showed that the mean self-efficacy scores on the task were lower for women ($M = 51; SD = 23.02$) than for men ($M = 67.20; SD = 26.74$). This is despite the fact that women participants had higher mean overall bowling scores ($M = 9, SD = 2.12$) than male participants ($M = 6.70, SD = 2.778$). Similarly, the absolute change in scores was higher for women ($M = 2.2, SD = 1.64$) than men ($M = 0.595, SD = 1.88$). However, an ANOVA indicated that neither the difference in bowling scores ($F(1, 40) = 3.144, p = 0.084$) (Table 1) nor self-efficacy ($F(1, 40) = 1.66, p = 0.205$) (Table 2) between men and women was statistically significant. Pre test scores pooled across experimental and control groups did not lend themselves to

statistical tests requiring normal distributions, since they did not show normality when disaggregated by gender and checked with a Shapiro-Wilk test.

Table 1. ANOVA for the difference in bowling scores pooled across pre-test and post-test bowling, relative to participant gender.

ANOVA – Gender Differences in Overall Scores

Cases	Sum of Squares	df	Mean Square	F	p
Gender	23.246	1	23.246	3.144	0.084
Residual	295.730	40	7.393		

Note. Type III Sum of Squares

Table 2. ANOVA for the difference in task self-efficacy scores pooled for both experimental and control groups measured after the post-test, relative to participant gender.

ANOVA – Gender Differences in Task Self-Efficacy

Cases	Sum of Squares	df	Mean Square	F	p
Gender	1156.371	1	1156.371	1.660	0.205
Residual	27869.730	40	696.743		

Note. Type III Sum of Squares

Discussion

This study showed that cricket bowlers who were asked to rate their self-efficacy scores in the middle of a deliberate practice task, showed no significant improvement in performance, compared to a control group which showed a significant improvement, across two sets of trials in a bowling accuracy task. These results support the hypothesis that a self efficacy intervention might affect sports performance. However, a comparison using the difference of scores was not significant. These findings require further examination with more participants to make substantial claims.

These results can be understood relative to the context of theories around metacognitive processes. The manipulation in the present experiment activated a metacognitive process involving self-directed thoughts, mid-way through a deliberate practice task. Since none of these bowlers had worked with sport psychologists before, they had not consciously learned metacognitive regulation. In the absence of metacognitive regulation, the activation of a metacognitive process could have interfered with expected improvements. Specifically, athletes who were asked to rate their self-efficacy ratings may have become more conscious about their ability as bowlers and about their performance on the task. Since these ratings were given immediately before the next set of trials, this may have led them to attend to conscious control of their skill execution. As Wulf (2013) has found, such internal focused attention in the experimental group may have led to interference with their performance and reduced the improvement seen in the control group.

The two items in the self-efficacy questionnaire that were introduced as a manipulation, were particularly important. The first item asked about individual's self-efficacy levels as a bowler, while the second rating asked how confident they were of bowling 50% of the balls in the target zone. Both these questions require athletes to make estimates about their own ability and performance. Thus, they are likely to prompt inward metacognitive regulation internally and inwards i.e. paying attention to their skill levels and performance. This means that they would either

think would be about their own body movements (internal) or about their performance (inward). This, in turn, could have negatively impacted their performance.

These findings have implications for sport performance. The primary implication is that mid-performance self-evaluation might be detrimental to sport performance. An athlete may be tempted to think about internal psychological factors such as their confidence, their abilities, etc. or may be prompted to do so by a coach, an opponent, etc. Alternatively, an opponent may point out that the athlete looks nervous. Either way, the results of this experiment indicate that activating a metacognitive process in the absence of metacognitive regulation may be detrimental to sport performance.

This study also has implications for research in sport psychology. As discussed earlier, self-efficacy is measured using questions similar to those used in this experiment. Results showed that simply asking such questions may impact an athlete's performance on the consequent task. Thus, researchers may want to account for the effects of these questionnaires on performance. This is particularly important when athletes are asked to answer these questions in the middle of the task i.e. after receiving feedback.

An alternate explanation for the results is that the control group improved more because of the questions administered to them. They were asked to think of their favourite bowler and subsequently, rate them. Simply thinking about their favourite bowler could have enhanced their performance on the post-test. Previous research has looked at related occurrences. For instance, in a study with golfers it was found that participants who were told that their equipment belonged to a pro-golfer previously, performed better than a control group (Lee et al., 2011). However, a key aspect of the participants performance — the equipment — was linked to the pro-golfer. Such a link was missing in the present experiment. Another possible experimental design might have involved asking the experimental group to also think of their favourite bowler, but only to rate the self. On the other hand, since the direction of how self efficacy might impact performance is still unclear, self-rating while imagining a favourite bowler might activate feelings of inadequacy.

A key component of the experimental design was that athletes got feedback regarding how they had performed on their task. While this knowledge of results was important for their improvement on the task, it may have also impacted their self-efficacy ratings and subsequent attentional focus. Our results indicate that the general and task self-efficacy ratings in the experimental group were positively correlated to pre-test scores. This suggests that task performance may have been a consideration for the self-efficacy ratings given immediately after. While the alternative could also be true — that athletes who were more confident performed better on the pre-test — this seems less likely given the finding that self-efficacy ratings were not positively correlated to their performance in the post-test. This finding also provides support to previous research in the realm of self-efficacy which finds a correlation between sport performance and self-efficacy. Further, it supports the finding that this effect is stronger when self-efficacy measures are taken after the performance task (Moritz et. al, 2000).

Perhaps most interestingly, the absolute change in scores showed a significant negative correlation with pre-test scores, and with self efficacy as reported after pre-test bowling. Non significant negative correlations were also found between absolute change in bowling scores with general and task specific efficacy measured after post-test bowling, in both the experimental and control groups. Since pre-test scores are also negatively correlated with the absolute change in scores, and positively with almost all measures of efficacy, it is hard to tell what is signified by the smaller change in scores for those who score highly during pre-test bowling and report high self-efficacy.

While the findings of this experiment add to previous research, it has several limitations. First, there are methodological limitations. The experiment uses a hit or miss paradigm to measure successful vs unsuccessful trials. This provided a binary performance measure and simplistic feedback to participants. However, this also meant that a ball that may have landed two centimeters outside the target zone would be in the same category as a ball that landed twenty centimeters outside the target zone.

The intervention only included two questions as a measure of self-efficacy. Thus, this may have prevented us from gaining a holistic understanding of the participant's self-efficacy. The only difference between the two groups was in the form of these two questions administered to them. A minimal number of questions were used in order to replicate competitive sport situations and to reduce the obviousness of the intervention. Self-reflective thoughts may be fleeting in sporting contexts where attention is captured by a variety of stimuli. The use of two items indicates that even a slightly prolonged attention to these thoughts may be detrimental one's performance. It is likely that if there were more number of questions that made participants reflect in greater detail, the results would have been different. Future studies that measure performance and self-efficacy in a more continuous way, or along a wider spectrum, may lead to a more nuanced and comprehensive understanding of the relationship between bowling accuracy and self-efficacy.

Another limitation is that there was no initial screening of participants to recruit an equal number of novices and experts, or male and female participants. While there are exceptions (see Feltz, 1988b), gender differences in self-efficacy and sport performance are relatively unexplored. While the experiment intended to recruit a higher number of female participants it could only recruit five. While this study finds some interesting initial findings on lower self efficacy despite higher performance in women cricketers, no definitive conclusions could be drawn about these sections of sports participants in this experiment due to these small sample sizes. Future researchers can explore these differences with larger sample sizes and in various sports.

There are also other statistical limitations. First, the sample size was merely 42 (21 in each group). This was below the intended number and thus, impacted the statistical power of the study. The second limitation is regarding the results for the between group comparisons. The hypothesis was supported in separate within group comparisons — paired t-tests — which showed that the improvement was significant for the control group but not for the experimental group. However, other statistical tests that compared the change in scores in the two groups did not show significant differences. One explanation for this might be the small sample size, relative to the observed effect

size - the manipulation may not have been strong enough to produce conclusive differences between treatments. Future research should ideally attempt to study this phenomenon with larger populations and in different sporting contexts. This would help determine whether the effect of self efficacy upon performance is replicable in other sport and performance tasks. The implications of finding that self-directed thoughts can impact performance negatively, even if those thoughts are not explicitly directed at either performance worries or consciousness of one's movements, but at assessments of self-efficacy and feedback that are generally considered helpful interventions, would be substantially impactful in the application of sports psychology to coaching protocol.

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Supplementary material:

Appendix A

Questionnaire (A).

i. Name _____

ii. Age _____

iii. Experience of playing the sport

i. How many years of formal training have you received in cricket?

- i. Less than 1
- ii. Between 1 and 3
- iii. Between 3 and 5
- iv. More than 5

ii. How many hours in a week do you receive formal cricket training? (Write in relation to the last 3 months)

- i. Less than 2 hours
- ii. 2 to 4 hours
- iii. 4 to 6 hours
- iv. 6 to 8 hours
- v. More than 8 hours

iii. How many hours do you spend practicing bowling in a week? (Write in relation to the last 3 months)

- i. Less than 2 hours
- ii. 2 to 4 hours
- iii. 4 to 6 hours
- iv. 6 to 8 hours
- v. More than 8 hours

Questionnaire (B).

- i. Please rate your degree of confidence by recording a number from 0 to 100 using the scale below.

0	10	20	30	40	50	60	70	80	90	100
not at all			moderately confident					very confident		

- a. How confident are you of your ability of your ability as a bowler?

Confidence (0 - 100) _____

- b. How confident are you of your ability of bowling 50% balls in the given target zone?

Confidence (0 - 100) _____

Questionnaire (C).

Q. Who is your favourite bowler? _____

Please rate their ability by recording a number from 0 to 100 using the scale below.

0	10	20	30	40	50	60	70	80	90	100
not at all			moderately good					very good		

Q. How would you rate the ability of your favourite bowler?

Ability (0 - 100) _____

Appendix B

Table 1.

Repeated Measures ANOVA. Within Subjects Effects.

Cases	Sum of Squares	df	Mean Square	F	p
Test Time	12.964	1	12.964	7.131	0.011
Test Time*Condition	2.012	1	2.012	1.110	0.298
Residual	72.524	40	1.813		

Note. Type III Sum of Squares

Table 2.

Repeated Measures ANOVA. Between Subjects Effects.

Cases	Sum of Squares	df	Mean Square	F	p
Condition	0.964	1	0.964	0.243	0.625
Residual	158.524	40	3.963		

Note. Type III Sum of Squares

Table 3.

Correlation Matrix (Overall: Experimental and Control Group Scores Combined)

	Years of Training (Normalized)	Hours in a week (Normalized)	Bowling in a week (Normalized)	General Self-Efficacy (O)	Task Self-Efficacy (O)	Overall Score (O)	Absolute Change (O)	Pre-test (O)
Hours in a week (Normalized)	0.244	—						
Bowling in a week (Normalized)	0.119	—						
General Self-Efficacy (O)	0.217	0.742	—					
Task Self-Efficacy (O)	0.168	< .001	—					
Overall Score (O)	0.494	0.598	0.647	—				
Absolute Change (O)	< .001	< .001	< .001	—				
Pre-test (O)	0.305	0.549	0.595	0.668	—			
Post-test (O)	0.050	< .001	< .001	< .001	—			
Years of Training (Normalized)	0.214	0.372	0.390	0.413	0.425	—		
Hours in a week (Normalized)	0.174	0.015	0.011	0.007	0.005	—		
Bowling in a week (Normalized)	-0.269	-0.294	-0.162	-0.262	-0.228	-0.006	—	
General Self-Efficacy (O)	0.085	0.058	0.306	0.094	0.147	0.972	—	
Task Self-Efficacy (O)	0.327	0.472	0.412	0.488	0.478	0.827	-0.567	—
Overall Score (O)	0.034	0.002	0.007	0.001	0.001	< .001	< .001	—
Absolute Change (O)	0.025	0.142	0.231	0.194	0.223	0.825	0.561	0.363
Pre-test (O)	0.877	0.371	0.141	0.219	0.155	< .001	< .001	0.018

Table 4. Correlation Matrix (Experimental Group)

Variable	Pre-test (E)	Post-test (E)
Pre-test (E)	Pearson's r	
	p-value	
Post-test (E)	Pearson's r	0.490*
	p-value	0.024
Task Self-efficacy (1)	Pearson's r	0.119
	p-value	0.607
General Self-Efficacy (1)	Pearson's r	0.582**
		0.076

General Self-Efficacy (2)	p-value	0.006	0.745
	Pearson's r	0.563	0.180
Task Self-Efficacy (2)	p-value	0.008	0.435
	Pearson's r	0.450*	0.237
	p-value	0.041	0.300

Table 5. Correlation Matrix (Control Group)

Variable		Pre-test (C)	Post-test (C)
Pre-test (C)	Pearson's r		
	p-value		
Post-test (C)	Pearson's r	0.194	
	p-value	0.400	
General Self-Efficacy	Pearson's r	0.362	0.207
	p-value	0.107	0.369
Task Self-Efficacy	Pearson's r	0.531*	0.200
	p-value	0.013	0.385

Table 6. Descriptive statistics for bowling scores pooled across pre-test and post-test bowling, relative to participant gender.

	Overall Score	
	Female	Male
Valid	5	37
Missing	0	0
Mean	9.00	6.70
Std. Deviation	2.12	2.78
Shapiro-Wilk	0.910	0.954
P-value of Shapiro Wilk	0.468	0.126
Minimum	6	2
Maximum	11	14

Table 7. Descriptive statistics for task self-efficacy measured after the pre-test and post-test bowling, relative to participant gender.

	Task Self-Efficacy	
	Female	Male
Valid	5	37
Missing	0	0
Mean	9.00	6.70
Std. Deviation	2.12	2.78
Shapiro-Wilk	0.910	0.954
P-value of Shapiro Wilk	0.468	0.126
Minimum	6	2
Maximum	11	14

Appendix C: Instructions to bowlers

“We want to study how a task can be learned. You will bowl four overs in total. After one over, you may take a break for thirty seconds. After two overs you will get a break for five minutes and will be asked to answer some questions. Then, you will bowl one warm up delivery. Finally, you will be asked to bowl the third and fourth over with an optional thirty second break in between.

Your task is to pitch the ball in the area demarcated by the cones. Every time you pitch the ball in the area demarcated by the cones, it will be considered a successful trial. If you bowl a front foot no ball or bend your arm while bowling, the trial will not be counted. Do you have any questions?”