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Examining the accuracy and in-game performance effects between pre- and post-performance routines: A mixed methods study

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Examining the accuracy and in-game performance effects between pre-
and post-performance routines: A mixed methods study

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2 *Objectives:* Researchers have identified that pre-performance routines improve performance
3 under pressure, yet have not investigated the effects of post-performance routines. Thus, the
4 purpose of the current study was to examine whether the type of performance routine training
5 could improve tenpin bowling accuracy and in-game performance.

6 *Design:* A mixed-method design was adopted, whereby the impact of a performance routine
7 intervention on performance accuracy and in-game performance was examined. This was
8 followed by participants completing semi-structured interviews which explored the perceived
9 effect of those routines.

10 *Method:* Thirty-six experienced tenpin bowlers completed 30 accuracy shots pre- and post-
11 intervention training, with league scores obtained for in-game performance comparison. Four
12 groups (i.e., pre-performance routine [PPR], post-performance routine [POST], combined pre-
13 post routine, and a control group) practiced 12 games across four weeks while listening to the
14 group specific routine instruction on an iPod.

15 *Results:* It was noted that accuracy improved (albeit non-significantly) for the PPR and combined
16 pre-post routine group, but not the other groups. Critically, all intervention groups (PPR, POST
17 & COMBO) improved in-game performance. The qualitative data indicated that both the PPR
18 and POST was perceived to influence positively performance, attentional and emotional control,
19 self-awareness, self-confidence, motivation. The PPR was also considered to enhance a state of
20 readiness, and perceived control.

21 *Conclusions:* Results indicate that the PPR training enhanced accuracy and in-game
22 performance, with the POST training acting as a supportive role for in-game performance as
23 evidenced by the qualitative and quantitative data. Future research should continue to investigate
24 the effects of POSTs.

16 engages in prior to performance of a sport skill. Moran's definition is the most widely
17 among studies investigating PPRs (see Cotterill, 2010 for a review). To date, PPRs have
18 adopted predominantly to improve the performance of closed and self-paced tasks (e.g.
19 in golf, free-throw shooting in basketball, or executing a ten-pin bowling delivery).

20 Researchers have provided equivocal results regarding the effectiveness of PPRs
21 novices appearing to benefit the most (Beauchamp, Halliwell, Fournier, & Koestner, 2001;
22 Crews & Boutcher, 1986; McCann, Lavalley, & Lavalley, 2001); while studies in
23 experienced athletes have indicated mixed results following PPR training (e.g., Boutcher
24 Crews, 1987; Cohn, Rotella, & Lloyd, 1990; Kingston & Hardy, 2001; Lobmeyer & Warr
25 1986; Marlow, Bull, Heath, & Shambrook, 1998). Cohn et al. (1990) for example, examined
26 effects of a cognitive-behavioral PPR intervention on three male collegiate golfer

16 1987), increase intrinsic motivation, reduce negative introspection (Beauchamp et al., 19
17 increase attention to task (Cohn et al., 1990; Cotterill, Sanders, & Collins, 2010).

18 A number of researchers (e.g., Anshel, 1995; Bartholomew, 2003; Dale, 2003) have
19 posited that a PPR is a suitable intervention to aid athletes in coping effectively with pressure
20 during real-world competition. Mesagno, Marchant, and Morris (2008) employed a single-case
21 design method to demonstrate improved performance under pressure of three “choking
22 susceptible” (i.e., likely to experience “choking under pressure”) ten-pin bowlers using an
23 extensive PPR. The extensive PPR included modifying or incorporating cognitive and behavioral
24 elements into their pre-existing PPR, such as a deep breath, cue word and behavioral strategy.
25 To address the limitations associated with a single-case design, Mesagno and Mullane-Grant
26 subsequently conducted a follow-up experimental study with a larger cohort, to assess the

16 (POST) as a series of behavioral or psychological strategies undertaken after per
17 execution, yet prior to the PPR of the next performance attempt. Hill, Hanton, Matth
18 Fleming (2010) were the first to identify that the use of POSTs may be a mechanism to
19 performance under pressure. Hill et al. interviewed six elite golfers who frequently exp
20 choking under pressure and five elite golfers who frequently excelled under pressure. Th
21 those golfers who excelled under pressure, performed a consistent POST after each sho
22 tended to include constructive task-related reflection, followed by a behavioral respo
23 removal of glove) that triggered attention to be directed towards the next shot. Howev
24 who experienced choking under pressure appeared to rarely or intermittently complete
25 Much of the psychological turmoil that athletes encounter during competition may st
26 maladaptive thoughts associated with unacceptable shot performance, which in turn ma

16 From the aforementioned research, using POSTs as an intervention could improve
17 responses and minimize negative reactions to skill errors that lead to self-deprecating comments
18 and performance inconsistency, by providing athletes a central attentional focus during
19 performance execution. This could prove particularly helpful for athletes who have a tendency to
20 be highly self-critical (i.e., dysfunctional perfectionists), and who suffer from low confidence
21 and poor attentional control. Thus, it could be inferred that focusing on a routine may reduce
22 negative introspection, increase functional self-regulation and improve performance over time
23 (Singer, 2002). Further research on POSTs and their effectiveness for in-game performance (especially
24 under pressure) would be advantageous. Such information could help applied sport psychologists
25 augment their psychological skills repertoire to implement empirically tested and validated
26 interventions related to after shot psychological recovery.

16 provide a comprehensive analysis of the research problem (Creswell, 2003).

17 **Participants**

18 Thirty-six league bowlers ($M_{age} = 40.50, SD = 14.72$), with a reported bowling
19 average between 142 and 207 ($M_{average} = 179.03, SD = 17.10$) for at least 24 games, par
20 in the study. A league average of between 140 and 210 was necessary to represent inter
21 to sub-elite bowlers because novices (below 140 average) may not be able to apply th
22 procedures due to inconsistency, and elite bowlers (above 210 average) were likely
23 relatively consistent PPRs and a ceiling performance effect might occur. A dem
24 questionnaire was completed prior to testing as a screening device for bowling experie
25 league average) and sport psychology training. Participants were untrained in sport psy
26 principles with only six suggesting they had “attended group workshops with

16 because it is a self-paced closed skill that is conducive to PPRs and POSTs. Further
17 routines may have a direct influence on performance because the impending shots are
18 quickly (if a spare is attempted after the “strike” shot) and only short breaks are allowed
19 frames. Therefore bowlers are required to perform soon after errors in performance occur.

20 The accuracy task was identical to that used within the Mesagno et al. (2008) study
21 whereby participants attempted shot attempts at a target on the bowling lane. Bowlers are
22 instructed to focus attention at a target 15 feet (e.g., arrows) rather than 60 feet (i.e., pins)
23 away for easier identification of targeting and improved accuracy (Wiedman, 2006).
24 Absolute error, in centimeters (cm), from center of the target to center of the ball track
25 was examined. Mean absolute error (MAE) for all shot attempts was the dependent variable.

16 Considering each bowler's PPR was individualized and existing routines may
17 inconsistent for novice compared to experienced bowlers, PPR modifications were ta
18 each participant's individual routine with no standardized routine implemented
19 developing the behavioral steps for the routine and to ensure understanding, the rou
20 practiced to the satisfaction of both the participant and the first author, and terminated
21 participant performed five repeated "shadow shots" (i.e., shots without the ball) using the

22 The POST group used a psychological POST, whereby each participant answered
23 of questions, which related to the previously delivered strike shot. The series of quest
24 developed by elite level coaches ($n = 2$; average coaching experience = 24.5 years) and
25 author. This sequence of questions was perceived by the elite coaches (but has not
26 empirically tested) to help the bowler remain psychologically composed, accept the effe

16 The combined pre-post performance routine group (hereafter labeled simply
17 “combined”) completed both the PPR and POST training as described above. The
18 control group completed the intervention training phase without PPR or POST education.

19 **Procedures**

20 Upon receiving approval from the lead author’s University Research Ethics Co
21 participants were recruited from tenpin bowling leagues ($n = 3$) in an Australian major
22 asking league officials for their consent. Volunteer bowlers were addressed prior to
23 competition session / event, and those recruited completed an informed consent f
24 demographics questionnaire to determine eligibility (i.e., a league average below
25 Participants completed the study independently and took part in three phases: pre-int
26 test, intervention training, and post-intervention test phases.

16 exception that participants in the intervention training groups implemented their perfor
17 mance during routine training during post-intervention accuracy test.

18 To investigate in-game performance changes, and therefore real-world perfor
19 mance responses, the 12 competition (i.e., league-based) games prior to the pre-intervention test
20 and 24 competition games immediately following the post-intervention test phases, respec
21 tively, were obtained from the league secretary. The 24 games post-intervention training were
22 divided into two separate 12 game sets, with the initial 12 games hereafter referred to as
23 pre-intervention training and the final 12 games called follow-up intervention training. The
24 follow-up intervention training games were obtained to determine the robustness of the routine t

16 **Individual Interviews**

17 An interview guide of open-ended questions was derived from the relevant
18 performance literature and finalized after consulting two sport psychologists. The purpose
19 of the interview was to explore the perceived emotional, cognitive, behavioral effect of the intervention
20 on performance accuracy, and perceived in-game (i.e., league average) performance
21 before and after routine training. In line with the recommendations of Teddlie and Tashakkori
22 (2009), the interviews completed within this mixed methods study were semi structured.
23 Participants were encouraged to articulate in detail, and from their own viewpoint, the perceived
24 effect of the pre- and / or post-performance routines on their performance. The questions were
25 open ended (i.e., prefaced by how? why? in what way?) and probes were used to gain
26 insights where necessary (e.g., can you tell me more about that?). The interview schedule

16 with repeated measures on the Test factor was conducted on mean league scores of the 1
17 collected in each phase. Partial eta squared (partial η^2) was used as an indicator of effect
18 ANOVA calculations (Tabachnick & Fidell, 2007) and an alpha level of .05 was used for
19 statistical tests.

20 **Homogeneity of Groups**

21 The reported league average indicated no significant Group differences, $F(3, 32) =$
22 $.10$, partial $\eta^2 = .004$, indicating that groups were equal in initial bowling ability
23 involvement in the study.

24 **Homogeneity of Possible Confounding Variables**

25 The total number of leagues bowled per week indicated no significant Group dif
26 $F(3, 32) = 2.12$, $p > .10$, partial $\eta^2 = .18$. The total number of games practiced with

16 and combined groups improved accuracy the most (see Table 1 for descriptive statistics)

17

****Insert Table 1 here****

18 **In-Game Performance**

19 Analysis of in-game performance, via league scores, indicated no significant Gro
20 effect, $F(3, 29) = .22, p > .10$, partial $\eta^2 = .02$, or significant Group \times Test interaction, F
21 $1.04, p > .10$, partial $\eta^2 = .10$. There was, however, a Test main effect, $F(2, 58) = 3.60$,
22 partial $\eta^2 = .11$. Pairwise comparisons indicated that league scores in the post-intervent
23 $184.76, SD = 17.37$) and follow-up intervention tests ($M = 184.53, SD = 16.7$
24 significantly different to performance scores in the pre-intervention test ($M = 179.5$
25 19.73), with no significant difference between the post-intervention and follow-up into

16 outcomes (see Giorgi & Giorgi, 2003). Transcripts with the emergent codes / categories
17 sent to the participants for member checking.

18 The interviews revealed seven over-arching themes regarding the perceived effects
19 and five for POST. Several themes were similar for both PPR and POST (see Table 2 and
20 3 for summaries), with the effects of the routines independent of whether they were used as
21 individual strategies or used in combination (i.e., the combined pre-post performance
22 group). The themes included: *performance, attentional and emotional control, self-awareness,*
23 *self-confidence, motivation, a state of readiness (PPR only), and perceived control (PPR only).*
24 ****Insert Table 2 and 3 here****

25 Of the 24 participants who were interviewed [$n = 7$ PPR; 8 POST; 9 combined],
26 perceived the adoption of a routine (i.e., within the PRE, POST, or combined group).

16 *measure would be okay, how well did I execute that shot*”), while the POST initiated a
17 reflection on necessary target alignment adjustment after skill execution. This in turn
18 participants to block out distractors that would have previously affected their performance
19 detrimentally (including anxiety-related thoughts and self-presentational concerns).
20 enhanced attentional control was considered particularly beneficial after a mental / performance
21 error. For example, Anna explained, “*I have the [pre-performance] routine running through my
22 head, so I turn off from everything that’s happening around me...Previously, I would be
23 about what’s going on around me...and what I’m doing wrong*”. Another participant,
24 suggested that, “*[after an error] instead of focusing on being a bad bowler whilst taking*

¹ All participant names are pseudonyms.

16 on the PPR during the routine training sessions than the POST, which may indicate that
17 was adhered to more than the POST, leading to the performance differences among groups.

18 The one participant, Simon, who perceived the PPR did not improve performance
19 admitted he had not adhered to the PPR, was sceptical about psychological skills training
20 was uncomfortable using the Ipod during training: “...*the Ipod thing, it just kept falling out of
21 my ears], so I just gave up. I just couldn't do what it said. I don't think I've learnt anything
22 honest. It's [PPR] nothing that would benefit me.*” Curiously, though, Simon improved above
23 league average considerably after the intervention training (by 28 pins).

24 Concerning *emotional control*, most participants [$n = 5$ PPR; 7 POST; 7 control] suggested
25 suggested the PPR and POST alleviated negative emotions (e.g., frustration & anxiety) and
26 encouraging positive emotional responses (e.g., relaxation). Sam, who adopted a PPR exclusively,

16 *before, I just bowled.*” Another participant, Helen, stated, “...*the routines made me aware*
17 *not concentrating before. I hadn’t realised....You then take the game more seriously...I*
18 *start to analyse yourself to look for improvement.*” Such improved self-awareness was
19 particularly evident within the POST group for it specifically encouraged increased awareness of
20 technical errors, “*Until using it [POST] I didn’t realise I was releasing it [the ball] because*
21 *[be]cause I was just throwing the ball down. It all makes sense now...and so I am now*
22 *on that with my coach*”. Similarly, Eddie explained:

23 So my [post shot] routine makes me notice if I am hitting the specific area of my
24 am now thinking about where I am throwing and how I can hit the pocket.
25 improve each shot...I now adjust really quickly...and so learning how to bowl really
26 and consistently.

16 *clear plan of action as a result*". Importantly, it was recognized that the POST
17 constructive reflection after a performance error, which minimized participants' self-
18 and so protected their self-confidence.

19 It was also reported by nine participants that the PPR and POST led to raised mo
20 With regards to the PPR, it was suggested by Helen that, "*If I had thrown a few bad ba*
21 *past, I would have given up, because I didn't have any base to go back to. Now I have th*
22 *to go to and it keeps me going*". A similar example was offered from Carl within the c
23 group, "*Thing is, I can actually do things to make it better...so by focusing on it [PC*
24 *knowing I can make it better, I'm not going to give up*".

25 Several participants [$n = 8$] also acknowledged the PPR encouraged a *state of n*
26 prior to the task. It fostered a slower and more considered / planned approach for skill e

16 Finally, the data revealed that most participants within the PPR group also adopted
17 their own POST that was predominantly an evaluation of their PPR and shot execution. In
18 participants who were assigned to the POST group often developed a PPR that attended
19 to the outcome of their POST reflection (i.e., they focused on technical adjustments). According
20 to the qualitative data indicated a blurred line between the three participant groups, though
21 the independent perceived impact of a PPR and POST on the participants and their performance.

22 **Discussion**

23 The aim of this study was to examine the effect of a pre- and post-performance reflection
24 on experienced ten-pin bowlers' accuracy and in-game performance. The findings indicated
25 a small increase (albeit non-significantly) in performance accuracy from pre- to post-intervention
26 training for groups using the PPR. Critically, all intervention groups' in-game performance

16 intervention training had improved in-game performance from pre- to post-intervention,
17 to the follow-up intervention test. Immediate in-game performance improvements were
18 the current study with further effects occurring at the four week follow-up interven
19 Cohn et al. (1990) however, found no immediate improvements in performance but
20 improvements four months later. The current research was the first to investigate the
21 effect of routines to determine the robustness of the training on in-game performance
22 larger sample, irrespective of performance measure (i.e., accuracy or in-game), rather
23 single-case design. In combination, using a PPR appears to help improve performance
24 and enhance in-game performance, as it acts as a mechanism for athletes to focus atte
25 accuracy and within competition.

16 Irrespective of group allocation, participants perceived the PPR and POST enhanced
17 game performance as a result of improved consistency. That is, fluctuations in performance
18 levels were minimized, and there appeared to be less ‘catastrophic’ performances. This
19 although the study does support the claim that performance routines are effective in improving
20 performance under perceived pressure, it identifies this may be achieved principally through
21 maintenance of expected performance standards *throughout* the game / competition.

22 The qualitative data revealed that for the most part, performance effects were perceived
23 to be due to enhanced attentional control. That is, the PPR and POST enabled the athletes to focus
24 on the task at hand, re-focus in between shots / games, and block distractors (e.g., organizational
25 and competitive stressors). Such positive performance effects for the current study support
26 previous researchers (e.g., Cohn et al., 1990; Cotterill et al., 2010) findings regarding attentional control.

16 routines were perceived to influence performance detrimentally. This was particularly
17 for the combined group because the information being learned was twice that of other
18 Accordingly, having to learn both routines simultaneously might have been overwhel
19 the athletes. This is similar to Hill et al. (2011), whose participants took approxima
20 weeks to implement fully a pre- and post-performance routine, along with several other s
21 (e.g., imagery). In contrast, however, Mesagno and colleagues (Mesagno et al., 2008;
22 & Mullane-Grant, 2010) found immediate performance accuracy under pressure for par
23 who were only provided a short (i.e., less than 30 minutes) performance routine training
24 It is possible that in the current study, the use of a recorded message on an Ipod (to
25 completion of the performance routine), may have been distracting initially, and c
26 delayed learning response. Practitioners should therefore, remain mindful of this respon

16 through perceptions of enhanced self-confidence, which supports other researcher's
17 (e.g., Cohen et al., 1990). The PPR and POST both led to raised expectations of
18 performance as participants began to trust the routines would facilitate effective
19 performance. Subsequently, it appeared that participants became more focused on executing
20 routines during performance, and less concerned with the performance outcome. I
21 inferred therefore, that the PPR and POST may have afforded higher levels of confidence
22 result of the sense of control gained over their performance, through achieving a more
23 rather than outcome focus (see Kingston & Wilson, 2009). In addition, similarly to H
24 (2010), this study found the POST protected the participants' self-confidence, by ensuring
25 reflection of errors was constructive, and so self-criticism was minimized.

16 problem-focused, and more likely to achieve their goals as a result. Thus, whilst the PC
17 designed initially to encourage reflection (only) within the current study, it would appear
18 stimulated participants to engage with the forethought and performance phase, and
19 encourage effective self-regulation and the development of sporting expertise (see Kit
20 Zimmerman, 2002).

21 As an aside, while it may be suggested that raised self-awareness can induce
22 through explicit monitoring, it was not found to be the case within this study (indirectly
23 interviews). As summarized by Carr (in press), post-performance reflection may
24 performance of an established (i.e., automatic) skill, if it is aimed specifically at
25 technical and / or performance errors. Moreover, and critically, the post-performance
26 adopted within the current study was designed to encourage focus on target a

16 that the control group also contained individuals who possessed their own PPR and
17 Therefore, it remains challenging to establish objectively and with certainty, the extent
18 effect that each discrete routine had on performance. However, in this study, the qualitative
19 identified a distinctive perceived effect the PPR and POST had on performance, reinforcing
20 advantages of the mixed method approach adopted.

21 Future research should continue to investigate PPR, but also expand the POST
22 For example, a clearer understanding of whether POST are used (and their function)
23 generally to differentiate their benefits. Furthermore, it is not possible to generalize the
24 findings, and to assume the same routine can impact athletic performance within other
25 considering this was a bowling specific POST. Thus, future research could differentiate
26 the effectiveness of other POSTs such as those using behaviours, other cognitions, or e

16 can be of considerable value to practitioners working with athletes who perform

17 competitive pressure.

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Motivation

Increased persistence and effort

Perceived Control

Over self, emotions and performance

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- All training groups improved in-game performance from pre- and post-intervention.
- All training groups maintained performance levels at a follow-up intervention.
- Qualitative themes were similar for the pre- and post-performance routine groups.
- Readiness and control were also themes for the pre-performance routine groups.

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