

The Influence of a Deliberate Practice Intervention on the Putting Performance and Subsequent Practice Behaviours of Aspiring Elite Adolescent Golfers

Rick Hayman^{1*}, Remco Polman², Erika Borkoles² and Jamie Taylor³

Abstract: **Objectives:** This study aimed to determine if a golf specific deliberate practice intervention would improve putting performance and influence future practice behaviours of aspiring elite adolescent golfers with no prior experience of specialised short game interventions. **Method:** Participants completed a 13 week AB single-subject multiple-baseline design study with social validation and five month follow up interviews. **Results:** The findings indicated the deliberate practice intervention to be effective in enhancing the putting performance of all participants from baseline to intervention phases. Mean performance measure scores were significantly higher in the intervention phase than the baseline phase. Social validation and follow up interviews revealed all participants enjoyed undertaking deliberate practice, experienced a range of psychological and technical improvements, adapted current training schedules to mirror deliberate practice and committed long term to activities of this nature. **Conclusions:** Deliberate practice has the potential to improve putting performance of aspiring elite adolescent golfers and was viewed by all participants as a key strategy in successfully bridging the gap to elite adolescent status. Findings provide support for practitioners, sport psychologists and policy makers who may wish to expose aspiring elite golfers to golf specific deliberate practice regimes for the first time during late adolescence.

Keywords:

deliberate practice intervention, golf, aspiring elite, single-subject design

The extant skill acquisition literature contains a range of cognitively focussed learning theories which outline and explain the progressive nature of motor learning development from novice to elite levels of performance across a range of disciplines (Ericsson, Charness, Feltovich, & Hoffman, 2006). Examples of well-established theories of motor learning include the stages of learning model (Fitts & Posner, 1967) and the power law of practice (Anderson, 1983; Newell & Rosenbloom, 1981). The research undertaken by Fitts and Posner (1967) led them to suggest that the learning process is a progressive entity and any individual will pass through specific phases of development as they acquire new motor skills. The power law of practice theory claims motor learning occurs initially at a rapid rate after the onset of practice but that this rate of learning decreases over time as skill levels improve.

A collective feature of these cognitive approaches to motor learning is the suggestion that learning is a steady process whereby learner's progress through three specific phases of skill acquisition termed cognitive, associative and autonomous stages as they practice a skill and learn to perform it independently (Anderson, 1982, 1983; Fitts & Posner, 1967; Schmidt & Lee, 2005). In the cognitive phase, learners try to understand what needs to be

¹ Northumbria University, Newcastle Upon Tyne, United Kingdom

* Corresponding author: Faculty of Health and Life Sciences, Department of Sport, Exercise and Rehabilitation, NB234 Northumberland Building, Northumbria University, Newcastle Upon Tyne, NE1 8ST, United Kingdom. Email: rick.hayman@northumbria.ac.uk

² Victoria University, Melbourne, Australia

³ University of Central Lancashire, Preston, United Kingdom

done to execute the skill. Their focus is on performing the task accurately and they benefit from specific feedback to guide their movements. This stage of learning is time demanding and characterised by large amounts of cognitive effort, conscious processing and high levels of explicit verbal instruction and augmented feedback. In the associative phase, performers adjust and gradually improve how the skill is performed until movements are more consistent and spontaneous. After an extensive acquisition phase, learners finally progress into the autonomous phase where the skill is performed automatically and greater volumes of practice are required to achieve smaller gains (Farrow, 2012; Schmidt & Lee, 2005).

It is well established how both quantity and quality of practice are crucial to the development of expertise and practitioners should carefully consider the micro-structure of practice sessions they prescribe to maximise the learning opportunities of their athletes (Deakin & Cobley, 2003; Ericsson, 2003). In emphasising this point, Farrow (2012, p.57) stated “practice should be a continual striving to lift performance to a new skill level such that plateaus in learning do not occur.” Opposing the frameworks of traditional theories of skill acquisition (e.g., Fitts & Posner, 1967), the Theory of Deliberate Practice (TDP) proposed by Ericsson, Krampe, and Tesch-Römer (1993) suggests the most critical aspects of expert performance are not fully automated and the expert performer must retain conscious control for further improvement of skill to occur. This theory proposes that the acquisition of expertise within any discipline is the result of undertaking approximately ten thousand hours (over a period of ten years) of physically and mentally demanding practice regimes whilst overcoming effort, motivational and resource constraints (Ericsson et al., 1993).

The theoretical framework of the theory is underpinned by the assumption that once performance becomes consistent, current training protocols would no longer be considered as deliberate practice and a performer would need to undertake a revised practice schedule that falls beyond the individual’s current competency levels and requires greater levels of physical and mental effort and conscious control.

Ericsson and colleagues also stated that practicing for an extensive period of time will only result in the attainment of expertise if such activities are not enjoyable to undertake, tailored towards improving performance, require optimal resources, high sustained levels of physical effort and concentration and not completed under conditions of fatigue or low motivation (Ericsson et al., 1993). They have also emphasised the importance of increasing the complexity and challenge of deliberate practice activities, so aspiring elite performers remain cognitively engaged within every prescribed training session they undertake. They state this approach to learning enables the performer to offset automaticity of performance and remain in the cognitive and associative instead of autonomous stages of learning (Fitts & Postner, 1967). This process will then allow for the continued modification of cognitive mechanisms that mediate how the brain and nervous system control motor performance (Ericsson, Roring, & Nandagopal, 2007). This form of training also places equal standing on quality and quantity of practice and encourages performers to work beyond their current level of performance and comfort zone (Ericsson et al., 1993; Ericsson, 2007).

A number of possible explanations for superior performance following long term investment with deliberate practice populate the literature. These include improved accuracy and speed of performance upon a range of cognitive, perceptual and motor tasks including visual cue utilization, pattern recall and recognition, anticipation, decision making and visual search behaviour. For example, research undertaken by Savelsbergh, Williams, van de Kamp, and Ward (2002) revealed how skilled footballers demonstrated a superior ability to pick up advance visual information from teammates or opponents postural orientation prior to a key event. Research has also confirmed how expert handball and soccer performers respectively outperformed their non-expert counterparts in sport specific pattern recognition and recall tasks (Tenenbaum, Levy-Kolker, Sade, Liebermann, & Lidor, 1996; Williams, Hodges, North, & Barton, 2006).

Support for TDP is wide ranging across several domains, including sport, with evidence reinforcing the view that long-term exposure with deliberate practice is a crucial hallmark for the attainment of elite level sporting excellence (see Williams & Ford, 2008 for a review). The first studies which examined the applicability of the theory towards developing expert sports performers were undertaken during the mid to late 1990's by Hodges and Starkes (1996), Helsen, Starkes, and Hodges (1998) and Hodge and Deakin (1998). Collectively, these studies supported the viewpoint of Ericsson and colleagues as a monotonic relationship between accumulated hours of deliberate practice and performance level was reported in figure skating (Starkes et al., 1996), soccer and field hockey (Helsen et al., 1998) and karate (Hodge & Deakin, 1998). More recent support for the theory was also reported in soccer (Helson, Hodges, Van Winckel, & Starkes, 2000; Ward, Hodges, Williams, & Starkes, 2007), rhythmic dancing (Law, Côté, & Ericsson, 2007), middle distance running (Young & Salmela, 2002) and triathlon (Hodges, Kerr, Starkes, Weir, & Nananidou, 2004).

Collectively, this body of research retrospectively examined both the accumulated hours of deliberate practice undertaken in addition to levels of enjoyment, relevance, physical effort and concentration experienced by elite senior level sports performers. The findings revealed how they were first exposed to and undertook significantly more hours of deliberate practice when compared to their intermediate and recreational level counterparts.

This initial sport specific deliberate practice research was also responsible in the evolution of the theory over the past 15 years. Firstly, it is important to remember how TDP emerged from research within the musical and chess disciplines which are activities that don't require the performer to undertake physically demanding movements. However, the findings by Hodges and Starkes (1996) refined the definition of deliberate practice within a sporting context because participants of different standards were required to provide insights into the intensities of both concentration (mental effort) and effort (physical effort) exerted throughout their developments instead of providing a unique rating for effort. The study further revealed how the elite wrestlers tended to enjoy undertaking all their deliberate practice activities.

Novice participants have shown rapid improvements in golf performance after short term exposure to laboratory based golf specific practice interventions (e.g., Lam, Maxwell, & Masters, 2010; Maxwell, Masters, & Eves, 2003). However, the efficacy of these studies in terms of developing training regimes for promising adolescent golfers is low because participants tend to be beginners who are situated in different stages of the learning process from more accomplished performers. To our knowledge the present study is the first to examine the influence of a golf specific deliberate practice intervention upon the performance and future practice behaviours of promising adolescent golfers who had no previous experience of undertaking specialised golf specific training regimes.

Single Subject Designs (SSD) have become a popular approach with sport psychology to assess the efficacy of mental skills interventions including goal-setting, imagery, self-talk, hypnosis and relaxation techniques upon components of athletic performance (Calmels, Berthoumieux, & d'Arripe-Longueville, 2004; Jordet, 2005; Munroe-Chandler, Hall, Fishburne, & Shannon, 2005; Thelwell & Greenlees, 2001, 2003). These studies are characterised by their small and specified sample sizes (e.g., between three and five elite or aspiring elite level performers) and reliance on the subjective assessment criteria to identify any individual differences in performance between participants (see Kinugasa, Cerin, & Hooper, 2004 for a review).

As opposed to skill acquisition studies that have adopted group designs, an AB SSD across multiple baselines approach (Martin & Pear, 1996) was considered as the most appropriate method to use in the current study. This decision was based on the fact that we wanted to detect any change in performance level of promising adolescent golfers who were situated in a phase of the learning process where improvements in performance may be difficult to discover using traditional significance group based

testing procedures. The aim of the SSD approach is to observe participant outcomes (e.g., performance measures) as a dependent variable at multiple time points prior, during and after the implementation of an intervention and to compare any changes (Kinugasa et al., 2004). SSD approaches also eliminate the need for a non-treatment control group and enable an individual's performance level to be observed over an extended period of time. Further justification for using this approach with sports performers displaying promise to achieve eventual adolescent golfing excellence was provided by Wollman (1986) who stated:

Single subject designs allow detection of successful effects for certain individual subjects who otherwise might have their success masked in a non-significant group. Single subject methodology may also be better suited than group designs in working with skilled athletes who will not improve much from pre-training level. Small but consistent changes may be seen in a single subject design but not emerge significantly in a group design. (p.136)

Another reason why a SSD was used was because they have the potential to be more effective at controlling threats to internal validity such as carry over effects than reversal designs (Kinugasa et al., 2004). Further support for the usefulness of this method in detecting changes in performance when undertaking research within a sports coaching context has been recently provided by Harwood and Steptoe (2013).

The primary aim of this study was to determine if the introduction of a deliberate practice putting intervention was associated with improvements in short game golf putting performance of skilful but non-elite adolescent golfers who had no prior experience of undertaking intensive putting specific training interventions. The second aim was to inspect the participant's experiences of the intervention and the subsequent impacts upon future practice trends and behaviours.

Method

Participants

Participants were five (age: $M = 16.50$ years, $SD = 0.76$) aspiring elite male adolescent amateur golfers with a handicap ranging between three and one ($M = 1.40$, $SD = 0.95$). The competitive playing experience of the sample ranged between two and five years ($M = 3.8$, $SD = 1.3$). Throughout the study, all participants were affiliated with their respective county's Under 18 representative teams, which comprised Lancashire, Cheshire and Yorkshire. They were also full time first year students upon a golf specific Advanced Apprenticeship in Sporting Excellence (AASE) qualification which was delivered at an academic institution located in Northern England.

The nature of previous golf participation and practice trends prior to enrolment upon the course was verified by golf coaches at the institution who retrospectively interviewed the participants and their parents at two separate stages of the selection process for the AASE programme. This revealed how all participants had encountered a diversified introduction to several sports since early childhood, which included golf, within a playful, fun, non-competitive environment that resembled key tenets of deliberate play theory (Côté, 1999). A change in emphasis towards specialising in golf occurred around the ages of 14–15 once participants had gained initial selection for county representative golf teams. Informed consent was obtained from all participants prior to any investigatory proceedings and ethical approval was granted by the local university ethics committee.

Throughout the duration of the putting study, the AASE programme did provide participants with the opportunity to partake in golf activities. However, amounts of competition and practice undertaken throughout this 13 week period were reflective of their previous day to day activities prior to enrolment upon the course due to the timing (golf off season) and time spent fulfilling the academic components of the course. The golf provision undertaken outside of the prescribed deliberate practice intervention comprised 18 hole practice rounds and long game practices at the driving range. Participants also completed off course activities strength and conditioning and

cardiovascular fitness training within this 13 week period. In an attempt to increase the likelihood that any improvements in putting performance were a result of the deliberate practice intervention and not the additive effect of any additional putting practices, the head coach instructed the sample to use the deliberate practice intervention as the only means of practicing their short game putting over the duration of the 13 week study.

Apparatus

Participants used their own putter and golf balls to perform the weekly performance measure and prescribed deliberate practice drills. The putting surface used for all 13 performance measures was a grass section of the outdoor putting green located at the academic institution. The same hole was used over the 13 week period and the surface was flat, level and maintained by professional green keepers on a daily basis to maintain the same level of putt difficulty from week to week (e.g., slope and break). This helped to ensure that any improvements in performance measure scores could be attributed to increased skill levels related to deliberate practice rather than decreased task difficulty. The performance measure was created by precisely inserting ten golf tees around the circumference of a golf hole. The distance from all ten locations to the centre of the hole was eight feet. The deliberate practice drill was created by inserting ten separate golf tees into the ground from 3, 6, 9, 12, 15, 18, 21, 24, 27 and 30 feet respectively from the hole.

Procedures

The lead author attended an AASE squad development training day at an academic institution in early September 2010. This enabled him to inform all squad members about the nature of a mixed methods study he was undertaking which would examine the effects of undertaking “effortful golf practice on short game putting performance and future practice behaviours” and to emphasise the commitment required. The lead researcher randomly selected 5 squad members to participate in the study based on the premise that if self-selection was used, then a strong motivational effect to improve performance may underlie any positive findings to emerge from the study instead of increased skill levels through exposure with deliberate practice. Quantitative and qualitative data were collated via weekly performance measures, self-report diary logs and social validation and five month follow-up interviews. The self-report diary log provided instructions including the number of times the weekly performance measure and deliberate practice intervention were to be completed by each participant. It also required participants to record subjective ratings for physical and mental effort exerted and fun encountered for every deliberate practice drill they completed on a scale of zero (*‘very very low’*) to ten (*‘very very high’*). A brief written justification for each rating and the time it took to complete the session was also recorded.

One week prior to the start of the study, all participants attended a one hour seminar delivered by the lead author at the institutions golf academy which reinforced what was expected of them over the duration of the study and allowed additional clarification to be provided for those who were unsure. A demonstration of how to complete the deliberate practice intervention and weekly performance measure was also provided by the lead researcher on the institutions outdoor putting green to all participants and all questions posed were addressed. Each participant also completed a pilot run of creating the correct measurements from the hole for each shot to be played during the intervention drill. To aid their understanding of deliberate practice, participants were also provided with the following definition within their self-report diary logs *“deliberate practice is as a highly structured activity that requires maximal physical and mental effort, is not intrinsically enjoyable to undertake, generates no immediate rewards and is performed solely for performance improvements”* (Ericsson et al., 1993).

Two professional golfers piloted the deliberate practice drill prior to the study commencing. This confirmed how the drill was challenging, required maximal physical

and mental effort throughout and took approximately 30 minutes to complete the 20 putts that comprised one run through of the intervention. This finding fits well with the recommendations made by Ericsson et al., (1993) who recommend the maximum amount of time spent undertaking deliberate practice regimes on a daily basis should initially be approximately 20–30 minutes for participants with no previous experience of intensive training strategies.

The study commenced with all five participants performing a baseline period (5, 6, 7, 8 or 9 weeks respectively) in addition to their normal golf participation trends discussed previously. The nature of these activities (e.g., marginal amounts of time spent undertaking short game specific putting practice) also strengthens the support for how any improvements in putting performance could be traceable to the deliberate practice intervention. During this time, once a week, each participant completed a generic weekly performance measure, which comprised ten separate eight foot putts from around the circumference of the hole. Participants were awarded one point if a putt was successfully holed. If the putt missed the hole, no point was awarded which meant that the final score obtained each week was located between zero and 10. Using the same hole and starting at the same point every week, each participant moved around the circumference of the hole in a clockwise direction to execute ten shots in total. This was repeated over the course of 13 consecutive weeks.

The deliberate practice intervention was sequentially introduced from week six of the study with all participants undertaking the specialised putting training by week ten. The lead author and head golf coach at the institution developed a short game putting drill that fitted the theoretical framework of a deliberate practice activity. Specifically, the task was intended to be challenging to complete, required sustained concentration and was designed with the sole purpose of improving performance rather than for enjoyment.

Informed by the findings of the pilot studies, each participant was projected to undertake between 90–120 minutes of golf putting specific deliberate practice per week during the intervention period. Participants individually completed one deliberate practice intervention drill on four consecutive days (Monday–Thursday). All performance measures were undertaken 24 hours later (Friday) with scores recorded by the lead author and stored in a secure place.

Participants started each drill by performing a 3 foot putt from the hole and then played one putt at the same hole from 6, 9, 12, 15, 18, 21, 24, 27 and 30 feet respectively. This process was undertaken twice resulting in the total number of putts made within each intervention practice totalling 20. Successful putts were awarded two points and a score of minus one was awarded for unsuccessful putts. The maximum and minimum scores available ranged from minus 20 to 40. Each participant undertook four drills each week during the intervention stages of the study. Therefore, participant one who undertook an eight week intervention period was scheduled to undertake 32 separate drills (totalling 640 practice putts) and participant five who undertook a four week intervention period was scheduled to undertake 16 separate drills (this totalled 320 practice putts).

Participants were instructed to use the same starting point on the drill over the course of the study and keep a record of their score. This information was not included in any stage of the data analysis process of the study. Participants were informed not to discuss the putting performance scores obtained throughout both the intervention drills and performance measures with other participants so the risk that any improvements could be attributed to motivational instead of skill acquisition changes was minimised. All intervention practice sessions and performance measure schedules were completed individually.

Self-report diary logs were maintained by all participants throughout the intervention phase of the study. Participants were instructed to complete the diary log immediately after a practice drill was completed. Manipulation checks were also undertaken by the lead author who inspected diary logs twice per week during the intervention phases to

ensure data was inserted correctly and to track adherence levels to prescribed practice schedules.

In compliance with sport psychology studies that have employed SSD in the past, (e.g., Thelwell & Greenlees, 2001, 2003) participants also undertook a social validation interview which comprised eight questions in the week after the study was completed. This allowed the lead researcher to obtain insights into the participant's experiences and perceived effectiveness of the deliberate practice intervention as a mechanism for improving their golf putting ability. All interviews took place at a location of the participants' choice which in all cases was the institutions golf academy and lasted approximately 20 minutes.

All participants were followed up five months after the completion of the study. Eleven predetermined questions were asked to establish the types, microstructures, and intensities of golf activities undertaken during these five months. All interviews took place at the golf academy at the institution and lasted approximately 30 minutes.

Data Analysis

SSD

Weekly performance data during baseline and intervention were plotted and visually examined to determine if consistent effects were established during intervention using the following guidelines proposed by Hrycaiko and Martin (1996): (1) stable baseline performance; (2) replication of effect within and across participants; (3) number of overlapping data points; (4) timing of effect following introduction of treatment; and (5) size of effect in comparison to baseline.

Self-Report Diary Logs

Mean participant ratings and standard deviations for physical effort, mental effort and fun were calculated for each participant during the intervention stage of the study. This data was then tallied and divided by five to produce grand means and standard deviations for each of the three dimensions.

Social Validation and Follow up Interviews

Both the social validation and follow up interview data were analysed using the same analysis procedure. Once all interviews were completed, they were transcribed verbatim and the text was read on several occasions over a 14 day period to increase the lead author's familiarity with the data. Once the transcribing process was complete, content analysis following the recommendations of Côté, Salmela, Baria, and Russell (1993) was used to identify repeated patterns of meaning provided by the participants in response to the questions posed. This qualitative analysis procedure involved organising and generating themes from interview data to identify recurring themes.

Firstly, each transcript was subjected to inductive line by line analysis by the lead author to identify individual meaning units and raw data themes within participant quotations. Once these initial statements were compiled, an inductive analysis of the data was undertaken throughout the early stages of the analysis process to develop higher order themes that linked similar raw data themes together in a higher order concept. Similar themes were grouped together as either positive or negative perceptions of the intervention. The next step involved the creation of profiles which reflected the major findings for each individual participant. After this point, deductive analysis was employed to refine and develop emergent themes. Finally, several steps were taken to ensure the trustworthiness and validity of the data collated. Firstly, in recognising the risk of miscoding during the data analysis process, a collaborative approach was taken to increase the validity of data which involved an independent researcher who was blind to the aims and objectives of the study scrutinising the analytic processes employed. A high

level of agreement was found for both sets of interview data and the minor disagreements concerning interpretations were all solved after a short discussion between the two researchers. Secondly, validity was checked for separate interviews using respondent validation techniques (Patton, 2002). The lead author made contact with all participants via phone to discuss the accuracy of the data analysis procedure and their satisfaction with the truthfulness of the constructs which emerged. This member checking exercise involved the participants answering a sample of verification and clarification questions which aimed to provide further depth to the data that was already created and reduce ambiguity (Lincoln & Guba, 1985).

Results Part One: Visual Inspection of Data

A reasonably stable baseline and prompt improvement in performance during the intervention stage was experienced by participant one (see figure 1a). No overlapping data points across the two phases support the effectiveness of the intervention in enhancing putting performance. A consistent improvement in putting accuracy was evident compared to baseline data across all eight weeks of the intervention. Mean scores for successful putts at baseline and intervention were 3.8 and 6.1. The increase in performance for participant one was the largest of the five participants in the study with a 61% improvement between mean baseline and intervention performance measures.

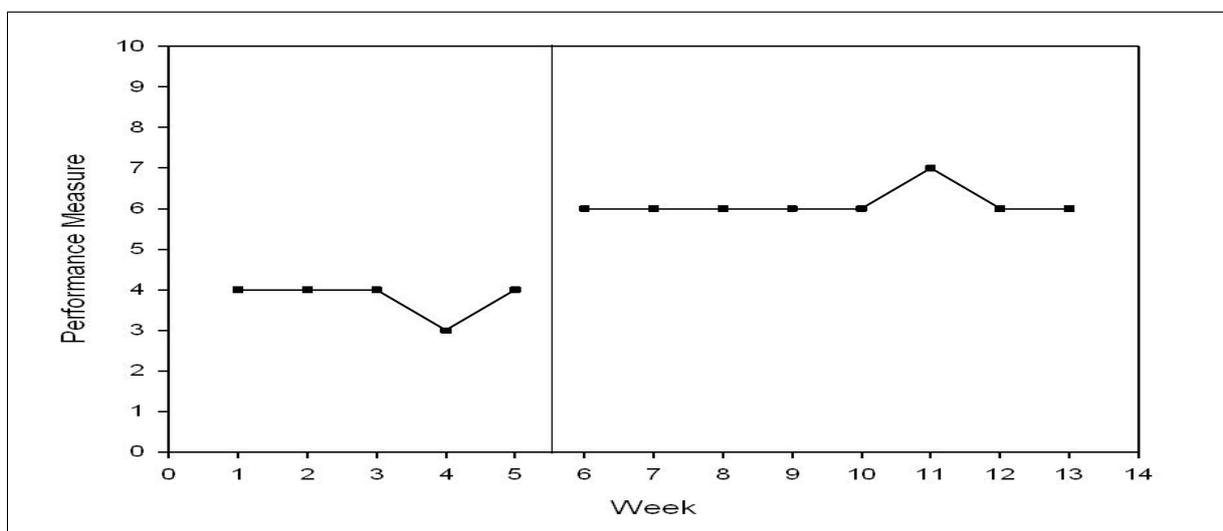


Figure 1a. Participant one weekly performance measure score.

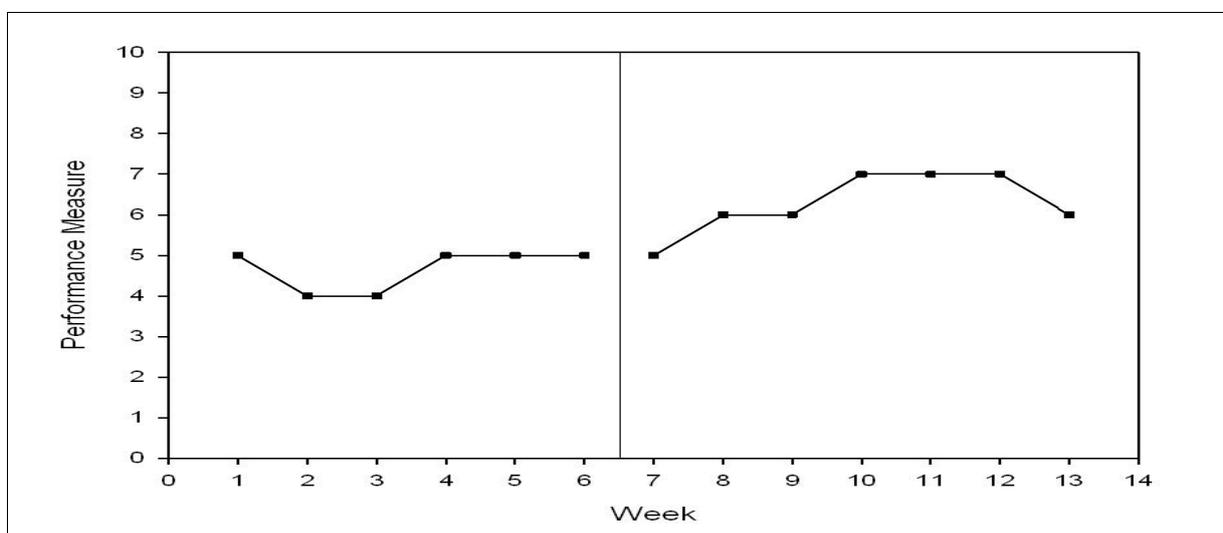


Figure 1b. Participant two weekly performance measure score.

Participant two demonstrated a relatively stable baseline and one overlapping data point during the first week of intervention (see figure 1b). Putting success increased gradually between weeks seven and ten although performance plateaued during the final four weeks of the study. Mean baseline and intervention measures were 4.7 and 6.3 and the increase in performance for participant two was reasonably large with a 34% improvement between mean baseline and intervention performance measures.

Again participant three had a stable baseline performance during week's four to seven. Similarly to participant two, only one cross-over data point was observed throughout the baseline period and intervention which provide partial support for the efficacy of the intervention (see figure 1c). A slight decrease in performance during the final two weeks of intervention was evident but no overlap with baseline data occurred. Mean baseline and intervention measures were 5.4 and 7 and the increase in performance was moderate with a 30% improvement between mean baseline and intervention performance measures.

Baseline data for participant four were initially unstable but stabilized during weeks five to eight (see figure 1d). Weekly performance measures didn't improve after exposure to the intervention and whilst performance levels became more consistent during the final

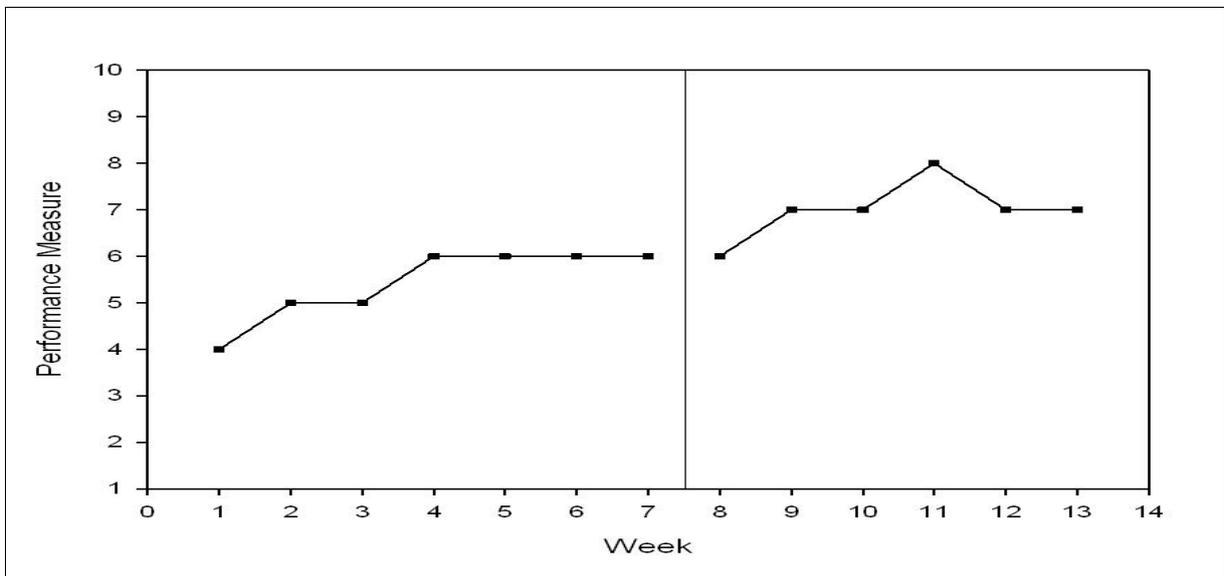


Figure 1c. Participant three weekly performance measure score.

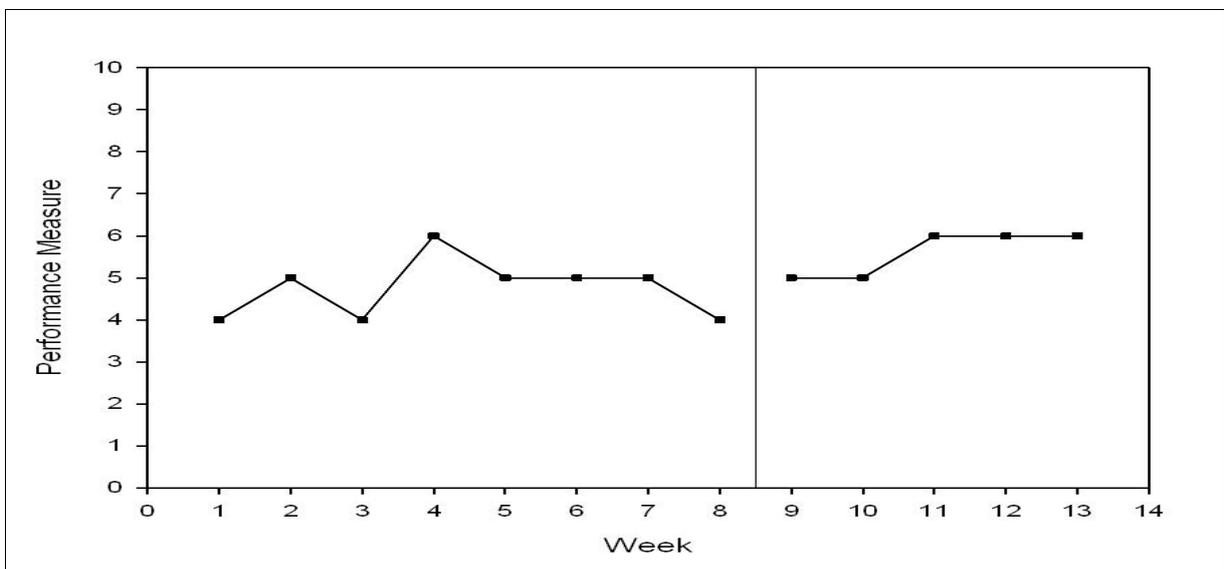


Figure 1d. Participant four weekly performance measure score.

three weeks of the intervention, there was a crossover of data points between baseline and intervention data on five occasions. Mean baseline and intervention measures were 4.7 and 5.6 and the increase in performance for participant four was relatively weak with a 19% improvement identified between mean baseline and intervention performance measures.

Baseline data for participant five was relatively stable but showed gradual decline in putting performance during weeks four to eight in comparison to weeks one, two and three (see figure 1e). Performance during the intervention stage was consistent although no improvements in putting scores were evident when compared to baseline. Participant five encountered four overlapping data points which suggests the impact of the intervention upon performance was low. Mean baseline and intervention measures were 5.2 and 6 and a 15% improvement between mean baseline and intervention performance measures was observed.

Performance data during the final four weeks of baseline were reasonably stable for all five participants. Participant three obtained a score of six on all four occasions, whilst the other four participants obtained the same score on three out of four occasions with the other measure being one less each time. Replication of the treatment effect occurred for three of the five participants. Clear performance improvements during intervention were evident for participants one, two and three which ranged in size from large (participant one) to relatively large (participants two and three). Participants four and five provide partial support for a replication effect and highlight how improvements in consistency of performance occurred during the intervention phase of the study (see table 1).

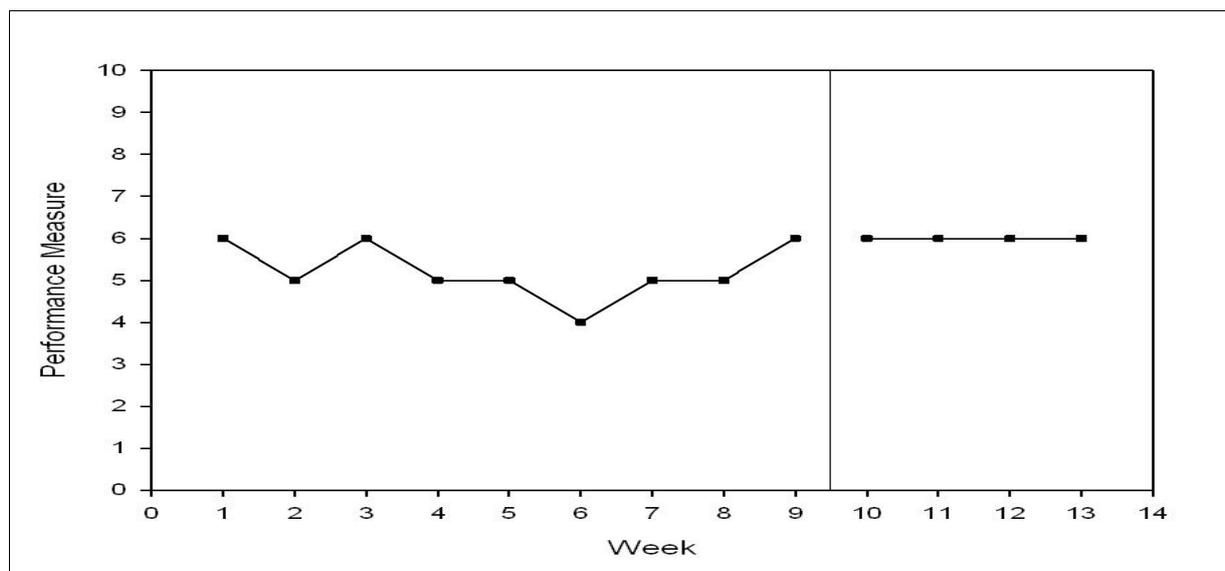


Figure 1e. Participant five weekly performance measure score.

Table 1. Mean (*SD*) Baseline and Intervention Performance Measure Scores (0–10) and Percentage Differences

Participant	Baseline score	Intervention score	% Difference (+ or -)
1	3.8 (0.45)	6.1 (0.35)	61%+
2	4.7 (0.52)	6.3 (0.76)	34%+
3	5.4 (0.79)	7 (0.63)	30%+
4	4.7 (0.71)	5.6 (0.55)	19%+
5	5.2 (0.67)	6 (0)	15%+
Grand mean	4.8 (0.56)	6.2 (0.46)	31.8 (18.08)

Results Part Two: Self-Report Diary Log Measures

Analysis of self-report diary log data revealed adherence levels to prescribed training protocols were extremely high with 116 out of the 120 (97%) prescribed deliberate practice drills completed. Participant four was unable to complete any of the four prescribed practice drills during week 12 of the study due to illness although he was able to complete the weekly performance measure. The grand mean subjective ratings for physical and mental effort and fun were 9.1 ($SD = 1.04$), 9.1 ($SD = 0.98$) and 9.3 ($SD = 0.85$) respectively, which implies how participants enjoyed undertaking the drills yet also invested considerable amounts of physical and mental effort into every prescribed practice drill.

Results Part Three: Qualitative Analysis

Social Validation Interviews

The results of the data analysis yielded six sub-ordinate themes that were subsequently grouped into the following two super-ordinate themes: Psychological Benefits of Intervention and Technical Benefits of Intervention. For the purpose of this paper we have only included one quotation per theme.

Psychological Benefits of Intervention

Motives to Practice. Participants discussed how they enjoyed the intervention and that it increased their motivation to practice which had generally been low throughout the past year as they preferred to play competitive rounds with peers:

This was something really different but useful for me to get better and it was so much harder doing that than playing nine holes with my mates. This is the best block of training I have ever done and I actually really liked doing it and it has sort of made me realise I can be really good at this game if I work hard enough. (P2)

Increased Self-Efficacy. The intervention appears to have increased the short game specific self-efficacy levels of participants; Participant three stated:

I liked the drills as they made me realise I'm actually a good short game player although I never believed it and what my dad used to say that I'm good is right really.

Increased usage of Mental Skills. The intervention appears to have increased usage of mental skills such as concentration and goal-setting within prescribed practice drills. For example, participant two said:

We learn these mental things in class about psychology and John (lecturer) always says to use them but I never used them really but I did in the drills as they were hard and I thought they would help and I took my time and went through my routines that I have and it seemed to have been good for my performance.

The challenging nature of the deliberate practice drills stimulated an upsurge in the levels of mental effort the participants placed into their normal practice routines:

The drill was hard and needed really focussing on which I liked as I don't really do this at all normally in practice or in my matches. (P1)

Long Term Commitment to Deliberate Practice. The majority of participants revealed how they would commit long term to golf specific deliberate practice in the future with a particular emphasis on improving their short game performance levels. For example, participant two said:

This is so different to what I normally do but I'm sticking with it because it will get me to where I want to be in a few more years' time once I have finished college.

Technical Benefits of Intervention

Stroke Play. There was evidence to suggest how participants thought the intervention was beneficial for their technical putting skills. Participant one for example stated.

My stroke play is better but I just think how many times I have played that drill and similar shots since the start of term. It is a lot but it really has made it better.

Shot Shaping. Participant three explained how the intervention improved his shot shaping:

My shape has become so much better with all the time spent doing your drills and even my dad said so when I played on Sunday with him and my uncle.

Five Month Follow up Interviews

Analysis of follow up interview data generated two super-ordinate and six sub-ordinate themes. The results of the data analysis yielded six sub-ordinate themes that were subsequently grouped into the following two super-ordinate themes: Strategic Approach to Practice and Improved Psychological Approach to Golf. Exemplar quotations are also presented to illustrate particular concepts that emerged from the study.

Strategic Approach to Practice

Allegiance to Short Game Deliberate Practice. Prior to the intervention, participants were typically prescribed generic practice sessions of 60–90 minutes in duration by parents and institutional coaches that focussed on more than one facet of the game, involved predominantly a lot of course play and didn't require a great deal of effort to complete. For example, participant one said:

My golf routine was just practicing on the course really, nine holes in the morning and nine in the afternoon during the holidays and summer and hardly anything in the winter except for the games for my club.

After completing the intervention, participant three reported undertaking larger volumes of practice each week than ever before:

I have spent much more time recently on the greens instead of travelling around and playing on the college tours and if you would have asked me that at the start of the year I would have laughed as I was just play all the time thinking this was the only way to improve.

Exposure to challenging, high quality short game practice also coincided with increased short game skill development and self-initiated behaviours. Participants started to become receptive of the new deliberate practice regimes and positive in their outlook as they had started to see benefits in relation to short game skill improvement. The following quote emphasise the nature of their new training environments.

I now use lots of putting practices instead of just moping around the putting green and hitting random shots. (P1)

Long Term Commitment to Deliberate Practice. The modified approach to practicing has initiated a change in the golfers' attitude to golf and they reported to be more focused on achieving golfing excellence and scaled down their involvement in various extracurricular activities and leisure pursuits that were commonplace prior to the intervention. For example, participant one said:

I have started to live a bit like a golfer who wants to become a professional should be doing. I've started to put the work in on the greens now when I wouldn't have done so in the past but this really matters and I don't want to think what if in a few years.

The majority of the participants reported a greater confidence in their golf ability, especially their short game. They discussed how they are striving more than ever to successfully bridge the transition from aspirant to elite adolescent then senior level golfer through long term engagement with deliberate practice. The narrative below emphasise how participant four views long term commitment to deliberate practice as central in their quest for excellence.

I have concentrated much more just on golf this last few months than ever before and I have realised I am a better golfer than I thought I was and I have surprised myself just how much more work I have started to now put into my game.

After short term exposure to deliberate practice, participants started to enjoy the nature of the practice more and observable improvements in weekly testing protocols were

evident. The following quote illustrates the realisation that deliberate practice can aid expert performance.

The pro at my club has been telling me I need to do this hard practice for months now and even showed me some drills to do but I wasn't so bothered as my handicap was coming down anyway but if I do this as well then it might come down more in the future. (P2)

Significance of Deliberate Practice in Pursuit of Excellence. Undertaking deliberate practice activities was found to guarantee an intensity and focus that was never previously evident in the daily practice regimes of participants.

Whenever I do my practice now I always set myself hard tasks that make me work hard and focus as I do not see the point anymore of going onto a putting green for example and just putting holes. (P3)

All participants discussed their allegiance to long term deliberate practice and the realisation that such provision has a key role to play in both fulfilling their potential and facilitating their pursuit of golfing excellence. A number of participants were also initially wary of the new practice regime and found it to be tedious, but they soon realised its long-term significance once the intervention commenced. Participant three's narrative illustrates this point.

I was a bit like what is this all about at the start but I gave it a go and it's really grown on me and I even do it sometimes in the morning on my own now before classes start.

Improved Psychological Approach to Golf

Promotion of Critical Self-Reflection. Participant three discussed how undertaking regular deliberate practice helped him to improve his golfing skills:

If you want to identify your weaknesses and strengthen them then the best way to do this is through using these types of practices.

Participant four stated how undertaking deliberate practice has helped him to identify the strengths and weaknesses in his game:

Deliberate practice tells you the truth and you can't hide from it. If you are playing badly it will show up but I think this is good because it makes you aware of what you are doing well and also where you need to spend time working.

Post practice reflections over the course of the past five months helped these golfers to evaluate the standard of their practice. Involvement in the intervention has also fostered self-reliance, autonomy and heightened awareness of the antecedents believed integral for achieving and maintaining golfing excellence. To illustrate, participant one stated:

I have grown up as a golfer and a student really since I came here (Institution) and I now act like I should have done two years ago. I think this new approach to golf (undertaking regular deliberate practice) has helped this and even my mum has noticed it when I go home some weekends and I'm always out of the house practicing my golf or doing my reflection portfolio for class.

Psychological Benefits of Deliberate Practice. After five months it was still evident that there was an increase in participants self-discipline and dedication towards their golf development. The following narrative by participant three highlights the significance of doing deliberate practice:

What I have learned through training this way is that you must have patience with golf and it is not about looking a couple of months into the future but six or seven years into your career.

There is no doubt that exposure to a complex, demanding and challenging learning environment was advantageous for the refinement of numerous mental skills including goal setting and imagery. For example, participant one stated:

I use all the psychology that the coaches tell us about in my practice and games now which I never did but I have given it a good go and use the goal setting and imagery stuff all the time now.

All participants discussed how both their attitudes and time dedicated towards the psychological aspects of golf have altered as a result of undertaking deliberate practice. Participant five's narrative highlights how his mental attitude to training and practice has changed compared to five months ago:

I have been really working on the mental side of the game and how I deal and manage myself on the course and trying to stop thinking about other things whilst playing.

Participant three discussed how dedicating time for setting goals proved beneficial in facilitating both enjoyment of practice and confidence in ability.

As long as you set yourself goals on all the different tasks it can't not be enjoyable because you just want to beat your score from last time and this is great for confidence.

These quotes demonstrate how participants increased their ability to use psychological skills including imagery and pre-shot routines.

Discussion

In agreement with TDP (Ericsson et al., 1993), the findings of this study lend support to the role of deliberate practice as an effective strategy for increasing short game putting ability of aspiring elite adolescent golfers. All participants achieved improvements in performance (15%–61%) with the largest and most consistent increases observed in participants one, two and three who's performance measures during the intervention remained above the levels obtained at baseline. The largest performance improvement within the sample was achieved by participant one who spent the longest amount of time undertaking the deliberate practice intervention and conforms to the power law of practice which suggests skilled performers who undertake the largest amounts of deliberate practice will encounter the greatest improvements in performance.

During the intervention participants four and five's performance measures also stabilised, which is important for consistent scoring and has implications for total tournament outcomes in elite golf (Alexander & Kern, 2005). Long-term sport specific deliberate practice from early childhood is common within physically demanding sports like rhythmic gymnastics and this early specialisation approach has been shown to aid the ability to compete at the world class level at younger ages (Law, Côté, & Ericsson, 2007). However, the present study highlights how aspiring elite adolescent golfers who encountered diversified sporting backgrounds during their early childhood and adolescence can benefit their performance levels from exposure with specific deliberate golf practice relatively late in their talent development pathway.

Themes which emerged from the social validation and follow up interviews emphasise how the intervention was generally well received by participants, clearly enhanced intrinsic motivation and had an influential impact on their long-term approach towards developing as a golfer. In line with the predictions of self-determination theory (Deci & Ryan, 1985), the high task focus post intervention appears to have fostered higher levels of intrinsic motivation towards golf. Indeed, since undertaking the study, participants have become gradually more ambitious in terms of their golf career aspirations.

Participants also demonstrated a long-term commitment to golf specific deliberate practice regimes as they recognised its value in acquiring greater golfing skills. This conforms to previous research that highlights how sports performers become increasingly committed and self-determined in their quest for excellence as they grow older (Côté, 1999; Schoon, 2000; Treasure, 2001). These findings also fit well with perceived competency motivational theory which suggests how individuals are more likely to strive for excellence and dedicate the time needed to undertake the required training regimes in areas where they can demonstrate proficiency (Harter, 1981). In agreement with previous research (e.g., Ryan & Deci, 2000), our findings further imply that when participants develop higher levels of competence they are more likely to remain engaged and adhere to those activities.

Replicating previous findings from the extant sport specific deliberate practice literature (e.g., Hodges & Starkes, 1996), participants also enjoyed undertaking deliberate practice drills and the challenge of participating in the study which is contrary to the findings of Ericsson et al., (1993) who conceptualised deliberate practice as an activity that should not be inherently enjoyable or fun to undertake. This aligns with the findings of Nicholls, Polman, and Levy (2012) who showed how challenge appraisal in competitive athletes is

associated with positive emotions which resulted in the usage of more problem focussed coping strategies that is related to self-regulated learning (Zimmerman, 2002, 2006). Participants were also willing to devote time to undertaking the deliberate practice and reported high levels of fun throughout.

The interview data also emphasised how the participants had come to realise the importance of engaging in regular deliberate golf practice if they were to make progress towards accomplishing their long term goal of becoming an elite senior level golfer. Therefore, one of the key practical implications of this study is that deliberate golf practice can stimulate self-determined critical reflection (e.g., the capability to individually recognize and work on weaker aspects of their game), self-monitoring and independence of learning that are essential for success at the elite levels of sport (Jonker, Elferink-Gemser, & Visscher, 2010; Jonker, Elferink-Gemser, Toering, Lyons, & Visscher, 2010). In this regard, those involved in golf development systems and high performance coaching may wish to create increasingly autonomy supportive learning environments that encourage aspiring elites to take greater control over their thoughts, feelings and actions from a young age (Baumeister & Vohs, 2007). Participants also reported how they placed more mental and physical effort into their daily golf activities and demonstrated greater responsibility for their own development since undertaking the intervention. Indeed, we observed a shift in reliance on significant others (e.g., parents, coaches) for providing performance related practice and competition guidance to self-initiated and autonomous decision making behaviours post intervention. The follow up interview data also resonate with achievement goal theory (Nicholls 1984, 1989) as exposure with deliberate golf practice encouraged participants to evaluate their golf performance from an increasingly task instead of ego orientated perspective. Specifically, increasing focus was now placed on self-referenced rather than normative judgements of competence and mastery.

Limitations

A criticism of this study relates to the lack of ecological validity as intervention effects were judged in a non-competitive instead of a competitive golf environment. The objectivation of successful and unsuccessful putts was assured by an encoding system differentiating successful and unsuccessful putts. Future studies however may wish to use a more precise instrument (e.g., distance of ball from rim of hole) which may lead to a better understanding of changes in performance. Also, the intervention drill data could have been analysed as it may have supported the premise that sustainable learning was induced by exposure with the deliberate practice drills. Also, some of the themes that emerged from the interviews may have had a mediating effect on putting performance. For example, the fact that mental skills were used more frequently as a function of deliberate practice may have influenced the results. Finally, the study did not quantitatively measure any attitudinal or behavioural changes pre and post intervention. Therefore, in addition to follow-up interviews with participants, the completion of inventories such as The Mental Skills Questionnaire (Bull, Albinson, & Shambrook, 1996) on a frequent basis over the duration of future studies is encouraged

Conclusion

In conclusion, this study demonstrates the usefulness of a late golf specific deliberate practice intervention for improving short game putting performance and altering the adolescent golfers' long-term attitude and behaviour towards the microstructure of future practice trends. All participants demonstrated at least a stable improvement in test performance and made a commitment to embed deliberate practice into on-going golf training schedules. These findings provide important practical implications to golf practitioners, applied sport psychologists and policy makers who are responsible for the design of future golf development systems.

Note

A template of the self report diary and interview schedules for the social validation and follow up interviews are available on request from the first author.

References

- Alexander, D., & Kern, W. (2005). Drive for show and putt for dough: An analysis of the earnings of PGA tour golfers. *Journal of Sports Economics*, 6, 46–60.
- Anderson, J. (1982). Acquisition of cognitive skill. *Psychological Review*, 89, 369–406.
- Anderson, J. (1983). *The architecture of cognition*. London: Harvard University Press.
- Baumeister, R., & Vohs, D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass*, 1, 1–14.
- Bull, S., Albinson, J., & Shambrook, C. (1996). *The mental game plan: Getting psyched for sport*. Brighton, UK: Sports Dynamics.
- Calmels, C., Berthoumieux, C., & d'Arripe-Longueville, F. (2004). Effects of an imagery training program on selective attention of national softball players. *The Sport Psychologist*, 18, 272–296.
- Côté, J., Salmela, J., Baria, A., & Russell, S. (1993). Organizing and interpreting unstructured qualitative data. *The Sport Psychologist*, 7, 127–137.
- Côté, J., Salmela, J., Baria, A., & Russell, S. (1993). Organizing and interpreting unstructured qualitative data. *The Sport Psychologist*, 7, 127–137.
- Côté, J. (1999). The influence of the family in the development of sport. *The Sport Psychologist*, 13, 395–416.
- Côté, J., & Fraser-Thomas, J. (2007). Youth involvement in sport. In P. Crocker (Ed.), *Sport psychology: A Canadian perspective* (pp. 266–294). Toronto: Pearson Prentice Hall.
- Deakin, J., & Copley, S. (2003). A search for deliberate practice: An examination of the practice environments in figure skating and volleyball. In J. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 115–135). Champaign, IL: Human Kinetics.
- Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.
- Deci, E., & Ryan, R. (2000). "The what and why of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry*, 11, 227–268.
- Ericsson, K. A., Krampe, R., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, 363–406.
- Ericsson, K. A. (2003). Development of elite performance and deliberate practice: An update from the perspective of the expert performance approach. In J. Starke & K. A. Ericsson (Eds.), *Expert performance in sports* (pp. 49–84). Champaign, IL: Human Kinetics.
- Ericsson, K. A., Charness, N., Feltovich, P., & Hoffman, R. (Eds.) (2006). *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.
- Ericsson, K. A. (2007). Deliberate practice and the modifiability of body and mind: Toward a science of the structure and acquisition of expert and elite performance. *International Journal of Sport Psychology*, 38, 4–43.
- Ericsson, K. A., Roring, R., & Nandagopal, K. (2007). Giftedness and evidence for reproducibly superior performance: An account based on the expert performance approach. *High Ability Studies*, 18, 3–56.
- Farrow, D. (2012). Identifying and developing skill expertise: Understanding current limits and exploring future possibilities. In J. Baker, S. Copley, & J. Schorer (Eds.), *Talent identification and development in sport: International perspectives* (pp. 51–63). Routledge, London.
- Fitts, P., & Posner, M. (1967). *Human performance*. Belmont, CA: Brooke/Cole.
- Harter, S. (1981). A model of intrinsic mastery motivation in children: Individual differences and developmental change. In A. Collins (Ed.), *Minnesota symposia on child psychology* (vol. 14, 214–256). Hillsdale, NJ.
- Harwood, C., & Steptoe, K. (2013). The integration of single case designs in coaching contexts: A commentary for applied sport psychologists. *Journal of Applied Sport Psychology*, 25, 167–174.
- Helsen, W., Starkes, J., & Hodges, N. (1998). Team sports and the theory of deliberate practice. *Journal of Sport & Exercise Psychology*, 20, 12–34.
- Helsen, W., Hodges, N., Van Winckel, J., & Starkes, J. (2000). The roles of talent, physical precocity and practice in the development of soccer expertise. *Journal of Sports Sciences*, 18, 727–736.
- Hodge, T., & Deakin, J. (1998). Deliberate practice and expertise in martial arts: The role of context in motor recall. *Journal of Sport and Exercise Psychology*, 20, 260–279.
- Hodges, N., & Starkes, J. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe and Tesch-Römers (1993) theory of deliberate practice. *International Journal of Sport Psychology*, 27, 400–424.
- Hodges, N., Kerr, T., Starkes, J., Weir, P., & Nananidou, A. (2004). Predicting performance from deliberate practice hours for tri-athletes and swimmers: What, when and where is practice important? *Journal of Experimental Psychology: Applied*, 10, 219–237.

- Hrycaiko, D., & Martin, G. (1996). Applied research studies with single subject designs: Why so few? *Journal of Applied Sport Psychology, 8*, 183–199.
- Jonker L., Elferink-Gemser, M., & Visscher, C. (2010). Differences in self-regulatory skills among talented athletes: The significance of competitive level and type of sport. *Journal of Sports Sciences, 28*, 901–908.
- Jonker, L., Elferink-Gemser, M., Toering, T., Lyons, J., & Visscher, C. (2010). Academic performance and self-regulatory skills in elite youth soccer players. *Journal of Sports Sciences, 28*, 1605–1614.
- Jordet, G. (2005). Perceptual training in soccer: An imagery intervention study with elite players. *Journal of Applied Sport Psychology, 17*, 140–156.
- Kinugasa, T., Cerin, E., & Hooper, S. (2004). Single-subject research designs and data analysis for assessing elite athletes conditioning. *Sports Medicine, 34*, 1035–1050.
- Lam, W., Maxwell, J., & Masters, R. (2010). Probing the allocation of attention in implicit motor learning. *Journal of Sports Sciences, 28*, 1543–1554.
- Law, M., Côté, J., & Ericsson, K. A. (2007). Characteristics of expert development in rhythmic gymnastics: A retrospective study. *International Journal of Sport and Exercise Psychology, 5*, 82–103.
- Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.
- Martin, G., & Pear, J. (1996). *Behaviour modification: What's it all about?* (5th ed.). Englewood Cliffs, NJ: Prentice Hall Inc.
- Maxwell, J., Masters, R., & Eves, F. (2003). The role of working memory in motor learning and performance. *Consciousness and Cognition, 12*, 376–402.
- Munroe-Chandler, K., Hall, C., Fishburne, G., & Shannon, V. (2005). Using cognitive general imagery to improve soccer strategies. *European Journal of Sports Sciences, 5*, 41–49.
- Newell, A., & Rosenbloom, P. (1981) Mechanisms of skill acquisition and the law of practice. In J. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 1–55). Hillsdale, NJ: Erlbaum.
- Nicholls, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*, 328–346.
- Nicholls, J. (1989). *The competitive ethos and democratic education*. Cambridge, MA: Harvard University Press.
- Nicholls, A., Polman, R., & Levy, A. (2012). A path analysis of stress appraisals, emotions, coping, and performance satisfaction among athletes. *Psychology of Sport and Exercise, 13*, 263–270.
- Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousands Oaks, CA: Sage Publications.
- Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.
- Savelsbergh, G., Williams, M., van der Kamp, J., & Ward, P. (2002). Visual search, anticipation and expertise in soccer goalkeepers. *Journal of Sports Sciences, 20*, 279–287.
- Schmidt, R., & Lee, T. (2005). *Motor control and learning: A behavioural analysis* (5th ed.). Champaign, IL: Human Kinetics
- Schoon, I. (2000). Towards a dynamic-interactive model of talent development: A life-span perspective. In K. Heller, F. Mönks, R. Sternberg, & R. Subotink (Eds.), *International Handbook of Giftedness and Talent* (pp. 213–225). Oxford: Pergamon Press.
- Tenenbaum, G., Levy-Kolker, N., Sade, S., Liebermann, D., & Lidor, R. (1996). Anticipation and confidence of decisions related to skilled performance. *International Journal of Sport Psychology, 27*, 293–307.
- Thelwell, R., & Greenlees, I. (2001). The effect of a mental skills training package on gymnasium triathlon performance. *The Sport Psychologist, 15*, 127–141.
- Thelwell, R., & Greenlees, I. (2003). Developing competitive endurance performance using mental skills training. *The Sport Psychologist, 17*, 318–337.
- Treasure, D. (2001). Enhancing young people's motivation in youth sport: An achievement goal approach. In G. Roberts (Ed.), *Advances in motivation in sport and exercise* (pp. 79–100). Champaign, IL: Human Kinetics.
- Ward, P., Hodges, N., Williams, M., & Starkes, J. (2007). The road to excellence: deliberate practice and the development of expertise. *High Ability Studies, 18*, 119–153.
- Williams, M., Hodges, N. J., North, J. S., & Barton, G. (2006). Perceiving patterns of play in dynamic sport tasks: Identifying the essential information underlying skilled performance. *Perception, 35*, 317–332.
- Williams, M., & Ford, P. (2008). Expertise and expert performance in sport. *International Review of Sport and Exercise Psychology, 1*, 4–18.
- Wollman, N. (1986). Research on imagery and motor performance: Three methodological suggestions. *Journal of Sport Psychology, 8*, 135–138.
- Young, B., & Salmela, J. (2002). Perceptions of training and deliberate practice of middle distance runners. *International Journal of Sports Psychology, 33*, 167–181
- Zimmerman, B. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice, 41*, 64–70.
- Zimmerman, B. (2006). Development and adaptation of expertise: The role of self-regulatory processes and beliefs. In K. Ericsson, N. Charness, P. Feltovich, & R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 705–722). New York: Cambridge University Press.

The Authors



Dr Rick Hayman is a Senior Lecturer in Sports Coaching at Northumbria University, United Kingdom. His research and teaching interests are in the area of talent development in sport. Current research projects focus on psychosocial factors involved in the development of sporting excellence as well as the role of deliberate practice on long term progression and participation in sport and physical activity.



Remco Polman is a research professor and research leader for active living at Victoria University, Institute of Sport Exercise and Active Living, Melbourne, Australia. He has published widely and has a particular interest in stress, coping and emotions and in behavioural change. He is also involved in the 'Sporting Success' study, a longitudinal examination of factors influencing sport participation in adolescents.



Dr Erika Borkoles is an Exercise and Health Psychologist at the College of Sport & Exercise Science, Victoria University, Melbourne, Australia. She is a Health Professional Council registered sport & exercise psychologist. Current research interests include self-regulation, personality (Type D) and health behaviour change across the lifespan in the context of exercise adoption and maintenance. She is the chief investigator of Sporting Success, which investigates the role of fundamental movement skills in long-term sport participation and academic achievement of adolescents, as well as role strain in adolescent elite athletes.



Dr Jamie Taylor is a Senior Lecturer with the School of Psychology at the University of Central Lancashire, United Kingdom. He is a Chartered Psychologist with the British Psychological Society and a registered Sport and Exercise Psychologist with the Health & Care Professions Council. His research and teaching interests are in the area of sport and exercise psychology. Current research focuses on the development of expertise in sport, the relation between athlete development and wellbeing, and psychological factors related to sport performance.