Title: The Effects of Avoidant Instructions on Golf Putting Proficiency and Kinematics

Abstract

Objectives: Although the effects of avoidant or negative instructions on skilled performance in sport has received little research attention, de la Peña, Murray, and Janelle (2008) reported recently that novice golfers who were instructed not to leave a putt short of a circle, overcompensated by leaving their putts significantly longer than at baseline, and vice versa. It is unclear, however, whether athletes' propensity to engage in over-compensatory behaviour is affected by their level of expertise.

Design: To address this unresolved issue, the present study investigated the influence of avoidant instructions on golfers' putting stroke proficiency (i.e., as measured by an index of putting performance and the direction in which putts are missed) and on their putting stroke performance (as measured by motion analysis).

Method: 14 high-skilled and 14 low-skilled golfers were required to putt from a distance of 2.5 metres on a sloped surface which caused the ball to move left-to-right as it approached the hole. All participants performed in a condition in which they were given no instructions and in a condition in which they were instructed not to miss a putt in a specific direction (i.e., left or right of the hole).

Results: High-skilled golfers' overall putting proficiency was unaffected by avoidant instructions. In contrast, low-skilled golfers' performance was significantly degraded due to disruption of certain kinematic features of their putting stroke (e.g., putter path and forward-swing times).

Conclusions: Overcompensatory behaviour was more prevalent amongst low-skilled than high-skilled golfers. Theoretical and practical implications of these findings are discussed.

Keywords: Implicit overcompensation; Ironic processes; Expertise; Kinematics; Golf putting

The effects of avoidant instructions on golf putting proficiency and kinematics

Research on mental control (or people's ability to implement their intentions successfully) suggests that skilled athletes may be subject to performance impairments when they focus on avoidant instructions during the execution of a complex motor skill (e.g., Binsch, Oudejans, Bakker, Hoozemans, & Savelsbergh, 2010; Dugdale & Eklund, 2003). However, contradictory evidence exists regarding the precise influence avoidant instructions exert on performance. Specifically, consider the rival predictions emanating from the ironic processes theory (Wegner, 1994; 2009) and the "implicit overcompensation hypothesis" (de la Peña, Murray, & Janelle, 2008). On the one hand, Wegner's (1994) model predicts that self-instructions *not* to perform in a certain manner will lead to the very behavior the individual seeks to avoid – if the person is anxious or otherwise cognitively overloaded. By contrast, the implicit overcompensation hypothesis (de la Peña et al., 2008) predicts that avoidant instructions will produce the opposite outcome to that intended by the performer – regardless of cognitive load. Surprisingly, there is a dearth of research examining the role of expertise in implicit overcompensation so we do not presently know whether or not skilled performers are susceptible to over-compensatory behavior when focusing on avoidant instructions. Against this background, the present study sought to test the predictions of the implicit overcompensation hypothesis by determining the extent to which high-skilled and low-skilled golfers' putting performance and swing kinematics are influenced by focusing on avoidant self-instructions.

Wegner (1994) postulated the theory of ironic processes of mental control to explain how avoidant instructions (i.e., self-instructions not to behave in a certain manner), together with mental load (e.g., anxiety, information-processing demands) can lead to an individual carrying out the very behaviour that he or she had sought to avoid. In postulating an explanation for this latter phenomenon, Wegner (1994) referred to two hypothesized processes that work together to maintain mental control: the operating process and the monitoring process. The “operating process” searches consciously and effortfully for items consistent with the desired goal or state. In contrast, the “monitoring process” is usually unconscious, less cognitively demanding and seeks signals of failure to achieve the desired state. Wegner (1994, 1997) proposed that when mental load increases (e.g., as a result of anxiety), fewer attentional resources are available to the operating process, and the latter is superseded by the monitoring process. This subtle change in mental control results in the contents of the monitoring process (unchecked by the operating process) becoming prioritized. Herein lies the ironic effect as the monitoring process activates the very thoughts or actions that the person had intended to avoid.

An example of such a lapse in mental control during motor skill execution is provided by Wegner, Ansfield, and Pilloff, (1998). In this study, novice golfers putted in two conditions, one requiring them to land the ball on a spot and one in which they were instructed not to hit the ball past the spot. With the addition of cognitive load, which involved keeping a six-digit number in mind and reporting it after the experimental putt, the tendency to hit the ball past the target significantly increased. Wegner et al. (1998) interpreted these findings as evidence of thought rebound in motor actions. In short, attempting not to perform certain actions under mental load may ironically lead to execution of the very action that performers had sought to avoid. Empirical support for the ironic processes theory has been found in a number of recent studies (Bakker, Oudejans, Binsch, & Van Der Kamp, 2006; Binsch, Oudejans, Bakker, & Savelsbergh, 2009; Binsch, Oudejans, Bakker, & Savelsbergh, 2010; Binsch et al., 2010; Dugdale & Eklund, 2003; Woodman & Davis, 2008). For example, Bakker et al. (2006) used eye-tracking technology to show that soccer players who are instructed to avoid aiming their kicks at a particular part of the goal tend to direct their gaze at the very location to be avoided.

Interestingly, in experimental psychology (e.g., Russell & Grealy, 2010) and sport psychology (de la Peña et al., 2008) evidence is emerging to suggest that negative or avoidant instructions may actually produce the *opposite* effect to that proposed by the ironic processes theory. For example, de la Peña et al. (2008) found that novice golfers who were instructed *not* to leave a putt short of a circle, left putts significantly *longer* than at baseline, and vice versa, irrespective of whether or not they had been burdened with mental load. In an effort to explain these findings the authors implicated implicit overcompensation processes whereby instructions *not* to leave a putt short somehow triggered an implicit message to the performer that it is better to putt firmly than to leave it short. Conversely, they suggested that instructions not to putt the ball long occasioned an implicit message that it is better to putt it short. In another study (Beilock, Afremow, Rabe, & Carr, 2001), novice golfers were instructed to imagine the ball rolling towards the target, but to be careful not to imagine leaving the ball short. Again, participants in the imagery suppression conditions tended to overcompensate and putt the ball significantly past the hole.

When scrutinized heavily, it becomes evident that the theory of ironic processes and the implicit overcompensation hypothesis make contradictory predictions. In fact, Russell and Grealy (2010) summarized these contradictory predictions by stating that ‘Wegner (1994) predicts that instructing participants to avoid making specific movements should, ironically, cause them to make these movements more intensely, whereas de la Peña et al. (2008) predicts that such avoidant instruction should cause participants to overcompensate by making movements in the direction opposite to those that were forbidden' (p. 1673). In addition, there are methodological issues that compromise the ecological validity of some studies in this field that have examined these competing predictions in golf settings. To explain, the Wegner et al. (1998) study required participants to land a golf ball on a spot (glow spot, 4 cm in diameter) while the de la Peña et al. (2008) study required the ball to be landed in a circle (10.8 centimeter chalked outlined circle). Unfortunately, both of these tasks are rather contrived and unrepresentative of the normal goal in golf putting, simply because golfers are trained to putt the ball over or through the target, particularly for short putts. For example, it has been calculated that a putt has its best chance of being holed if the ball is struck at a velocity which ensures it would roll 12-18 inches past the hole (Pelz, 2000). Striking a ball at such velocity ensures it has the best chance of going into the hole at all angles (i.e., left edge or right edge of the hole) and minimizes the impact of putting surface variations that can have a significant impact on a slowly rolling ball (Pelz, 2000). The lack of ecological validity in some golf studies in this field presents a potential confound both for the instructions given, and for subsequent interpretation of resulting data. This issue of ecologically validity is crucial for the elucidation of any expertise effects in psychology. Thus Farrow and Abernethy (2003) claimed that it is central to 'any attempts to determine experimentally the underlying source of the expert's advantage' (p. 1127).

In the current study we addressed this issue concerning the ecological validity of the golf putting task in two ways. First, we required participants to putt the ball into a hole and recorded the final location of each task attempt (i.e., short or long/left or right). Second, we focused the avoidant instructions on the lateral movement (or "break") of a golf putt, the correct judgment of which is critical in sloping putts (Van Lier, Van der Kamp, & Savelsburgh, 2010). Thus the current study enhanced the ecological validity of the methodology employed by both Wegner et al. (1998) and de la Peña et al. (2008) by creating a left-to-right slope on the putting green and requiring participants to avoid missing putts to the left or the right of the hole.

The primary aim of the current study was to examine how avoidant instructions influence high-skilled and low-skilled golfers' putting performance – specifically the direction in which they strike the ball when instructed not to miss on one side of the hole. We predicted that highly-skilled performers would be relatively immune to the effects of avoidant instructions because they have *more conscious attentional resources available* to enable them to process the demonstrably complex demands of this type of instruction (Janelle, 1999). Interestingly, recent cognitive research (e.g., Panizza, 2012) shows that the comprehension of negative sentences or instructions requires more attentional resources than does that of positive equivalents. A likely explanation for this effect comes from the fact that the meaning of negated instructions can be understood only *after* a cognitive representation of the positive equivalent has been created. As Panizza (2012) put it, "the meaning of a negated sentence is fully understood in a subsequent stage, after the representation of the positive version of the negative sentence is built and evaluated" (p. 477). In the light of such findings, it seems plausible that highly-skilled golfers will have sufficient spare attentional capacity to successfully process avoidant instructions.

By contrast, as the low-skilled performers in our sample started golf at a later age in life and had significantly fewer years playing experience than their high-skilled counterparts, we predicted that they would be *more* vulnerable to the effects of avoidant instructions. Support for this latter prediction is derived from Hernandez, Mattarella-Micke, Redding, Woods, and Beilock's (2011) suggestion that the 'learning of a task later in life requires more overt or explicit cognitive processing' (p. 255). Based on such reasoning, and by contrast with their high-skilled counterparts, the low-skilled golfers in the present study should have *fewer* attentional resources *available* to process the cognitively complex demands of avoidant instructions.

In summary, based on the preceding rationale, we suggest that avoidant instructions are more difficult to process than are standard (or permissive) instructions. Furthermore, because high-skilled athletes have more spare attentional resources available for cognitive processing, we propose that these performers will not be as troubled by avoidant instructions as will be their less skilled counterparts. Support for this idea comes from Janelle (1999) who suggested that "increased automaticity will free attentional resources to be used for cue utilization and strategy formation, and *resources would also be made available to deal with excessive cognitive loads and potential ironic processes*" (p.215; italics added for emphasis).

Following de la Peña et al.'s (2008) work, we predicted this disruption to performance would take the form of over-compensatory effects. While acknowledging that ironic effects may occur, de la Peña et al. postulated that 'negatively worded instructions are the primary stimulus driving outcome directionality, which is likely overcompensation rather than ironic effects' (p. 1324). The authors suggested that the implicit overcompensation process begins first and takes prominence over the impact of other cognitive loads (e.g. auditory or visual distracters, anxiety) and 'is independent of any rebound of thought' (p. 1325). Accordingly, instructing low-skilled performers to avoid missing a putt to the left of the hole should occasion an implicit message that putts missed left are unsuccessful.

This process should culminate in an implicit command programming movement execution to putt to the right of the hole.

The second aim of the present study arose from de la Peña et al.'s (2008) suggestion that the provision of negatively worded instructions would lead to performers "augmenting the movement to counteract the explicit instructions" (p.1324). We postulated that if negatively worded instructions led to golfers augmenting their movement, this process would likely involve the adoption of an internal focus of attention (see Wulf, in press). According to Wulf's 'constrained action hypothesis' (Wulf, McNevin, & Shea, 2001; Wulf, Shea, & Park, 2001), an internal focus (e.g., focusing on body movements) induces a conscious mode of control which is likely to constrain the motor system and interfere with the smooth and fluid execution of skilled movement (see also Masters & Maxwell, 2008). More specifically, this process is likely to result in disruption to timing and increased variability of movement (Gray, 2004; Mullen & Hardy, 2000; Toner & Moran, 2011). Therefore, we predicted that over-compensation would be accompanied by disruption to the timing and variability of putting stroke kinematics. To assess this, we examined how avoidant instructions influenced several key movement parameters that have been shown to affect the direction of a golf putt (Karlsen et al., 2008) and aspects of timing (e.g., forward-swing) and variability that are affected when experienced performers revert to a more conscious mode of control (Mullen & Hardy, 2000).

Method

Participants

Participants were 14 high-skilled and 14 low-skilled male golfers. The high-skilled group had a mean handicap of 5.5 (*SD* = 2.6), a mean of 28.25 years (*SD* = 10.22) playing experience and a mean age of 46.5 years (*SD* = 12.4). The low-skilled group had a mean handicap of 21.1 (*SD* = 2.7), a mean of 19.73 years (*SD* = 11.35) playing experience and a mean age of 49 years (*SD* = 13.9).

Ethical approval for the study was granted by the University Ethics Committee and all participants provided informed consent before taking part in the study.

Apparatus

The experiment was conducted on an indoor putting green (4×10 feet, Huxley golf green). A slope was incorporated into the putting green which presented participants with a 2.5 metre putt that sloped from left to right (angle of the surface was 1.8 degrees and the slope started two metres from the target). All participants were right handed and used their own putters. Golf balls were supplied by the experimenter. The participants' putting actions were recorded using a 3D kinematic ultrasound system (SAM PuttLab; www.scienceandmotion.com). This is a bespoke system that records putting stroke positional, velocity and acceleration data for several kinematics variables. The system records more than 210 Hz, to determine the position of the club with a precision of one tenth of a millimeter for position and one tenth of a millimeter for alignment (Science and Motion in Golf, 2005).

Procedure

After providing written informed consent, participants were instructed that they would perform a series of putts with the goal of landing the ball in the hole under different instructions. Following four practice putts, participants performed three trial blocks of ten putts each (in line with de la Peña et al.'s 2008 methodology). Participants were informed that they could initiate each trial in their own time. For all participants, Block 1 comprised the baseline condition, in which they were instructed to hole as many putts as possible. In Block 2, participants were instructed to avoid missing the target on either the left or right side. Within the high-skilled and low-skilled groups, the side of the hole on which participants were instructed to avoid missing was randomly assigned.

Thus, participants in the high-skilled group were given the following instructions “One of the most common mistakes an expert golfer can make when attempting a left-to-right putt is to miss the putt to the [left/right] of the hole. Your goal is to putt the ball and try and make it land in the hole, but be careful not to miss the putt to the [left/right]; don’t miss the putt to the [left/right]”. The instruction for the low-skilled golfers was the same except that the word “expert” was replaced with “high-handicap”. In Block 3 participants were simply reminded of the instructions they received in Block 2 with the addition of the word “remember” (i.e., “Remember, your goal is to putt the ball and try and make it land in the hole, but be careful...”).

Two measures of putting accuracy and seven measures of the putter motion were recorded. For putting accuracy, a scoring system based on the one adopted by Smith and Holmes (2004) was used as an index of overall putting proficiency: 5 points for putts finishing in the hole; 4 points for putts that ‘lipped out’ (i.e., caught the edge of the hole but did not finish in it); 3 points for putts that went past the hole on the “high” side (i.e., left) or on the “low” side (i.e., right); and 1 point for putts that finished short of the hole. In addition, we recorded the side the ball missed for all putts that were not holed and whether or not this was consistent with the avoidant instructions given. With respect to swing kinematics, we measured participants’ impact timing (time taken from the initiation of the downswing to the point of contact with the ball), backswing and forward-swing times, putter face alignment, putter face change (difference between the angle of the putter face at address and at impact), putter swing path and point of impact. SAM PuttLab system also generates a consistency index for these measures by measuring the variability of these performance parameters and comparing them with data recorded from European Tour golfers (Science and Motion in Golf, 2005).

Because the instructions in the current study involved requesting participants *not* to putt the ball in a specific direction, we predicted the movement parameters that affect a putt's direction (see Karlsen, Smith, & Nilsson, 2008) would be most influenced by the instructional sets. Accordingly, we were most interested in the influence of avoidant instructions on putter face change, putter swing path, putter face impact point and putter face alignment prior to initiating the swing. To investigate the influence of avoidant instructions on these four movement parameters, we examined whether participants' putting strokes changed in accordance with or in opposition to the instructions administered. If participants were instructed not to miss a putt to the left of the hole and their putter face moved to the left (in comparison to the control condition), this was deemed to be evidence of ironic effects. In contrast, if participants were instructed not to miss a putt to the left of the hole and their putter face change was found to move to the right, then that participant was deemed to have altered their putting stroke in opposition with instructions (thus performing in an over-compensatory manner). The same criterion was applied to putter swing path (i.e., the direction – either left or right – the club-head was moving at the point of impact) and alignment at address (i.e., whether the putter face is aiming to the left or right of the target). Regarding putter face impact point, we examined whether avoidance instructions resulted in participants hitting the ball more towards the 'toe' or the 'heel' of the putter face. For a right-handed putter, putts hit towards the 'toe' of the putter face tend to 'open' the clubface at impact, thereby sending the ball to the right of the target. Conversely, putts hit towards the 'heel' close the putter face at impact, thereby sending the ball to the left of the target (Pelz, 2000). As a result, putts hit more towards the toe (after receiving instructions not to miss putts to the right of the hole) were deemed to be consistent with instruction (evidence of ironic effects) and putts hit towards the heel were deemed to be in opposition with instruction (evidence of over-compensation). The opposite applied for participants instructed not to miss putts to the left of the target.

Mean scores for all collected kinematic measures were calculated for all 28 participants in each of the three blocks of putts. Data from the baseline condition (Block 1) were then compared with data averaged across blocks 2 and 3 (after these latter blocks had been compared for similarity).

Results

Putting proficiency

First, a 2 (instruction condition: baseline, instruction conditions) × 2 (skill level: high-skilled, low-skilled) mixed-model ANOVA was conducted to examine how avoidant instructions influenced golfers' overall putting performance. Our dependent variable, putting performance, was normally distributed for the groups as assessed by the Kolmogorov-Smirnov test and a visual inspection of a Q-Q plot. In addition, there was homogeneity of variance between groups as assessed by Levene's test for equality of error variances. The 2 × 2 ANOVA found a significant interaction between instruction condition and skill level for overall putting performance, $F(1,26) = 8.09$, $p < .05$, $\eta^2 = .24$. Tests of simple effects revealed that low-skilled golfers' putting performance was significantly influenced by receiving avoidant instructions, $p = .003$, 95% CI [1.23, 5.20], whereas high-skilled golfers experienced no such change, $p = 0.49$, 95% CI [1.31, -2.67]. A closer analysis of the results (see Table 1) revealed that high-skilled golfers marginally improved their overall putting performance proficiency from trial block 1 ($M = 42.42$, $SD = 4.14$) to trial blocks 2 and 3 ($M = 43$, *SD* = 3.42). In contrast, low-skilled golfers' putting performance was significantly better in the baseline condition (*M* = 38.22, *SD* = 6.31) than when performing under avoidant instructions (*M* = 35, *SD* = 6.23).

Second, a 2 (instruction condition: baseline, instruction conditions) × 2 (skill level: high-skilled, low-skilled golfers) mixed-model ANOVA was conducted to examine how avoidant instructions influenced the direction in which putts were missed (i.e., left or right of the target). Again, our dependent variable (direction of misses), was normally distributed for the groups as assessed by the Kolmogorov-Smirnov test and a visual inspection of a Q-Q plot. In addition, there was homogeneity of variance between groups as assessed by Levene's test for equality of error variances. The 2 × 2 ANOVA revealed a non-significant interaction between instruction condition and skill level for the direction (i.e., left/right) of missed putts, $F(1,26) = 0.01$, $p > .05$, $\eta^2 = 0.001$. However, there was a significant main effect of instructions on the direction of misses, $F(1,26) = 17.35$, $p < .05$, $\eta^2 = 0.4$. A closer analysis of the results revealed that golfers missed more putts on the side opposite with instruction (*M* = 5.48, *SD* = 0.38) than on the side they had been instructed to avoid (*M* = 2.76, *SD* = 0.49).

Kinematic measures of the putting stroke

Two separate mixed factor MANOVAs were conducted. First, a 2 (instruction condition: baseline, avoidant instructions) × 2 (skill level: high-skilled, low-skilled) MANOVA was conducted on the four dependent variables related to the timing and consistency of participants' putting strokes. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity. No significant violations of these assumptions were evident. Using Pillai's trace, a significant effect of instruction condition was found, V = .52, $F(4,23) = 6.27$, $p < .05$, $\eta^2 = 0.52$. The univariate output revealed that avoidant instructions had a significant effect on golfers' backswing times, $F(1,26) = 14.38$, $p < .01$, $\eta^2 = 0.2$, and on their forward-swing times, $F(1,26) = 15.12$, $p < .01$, $\eta^2 = 0.4$, but not on putting stroke consistency, $F(1,26) = .79$, $p > .01$, $\eta^2 = 0.08$, or impact timing, $F(1,26) = .93$, $p > .01$, $\eta^2 = 0.08$. Tests of simple effects indicated that high-skilled golfers experienced no change in backswing times across conditions $F(1,26) = 0.83$, $p > .05$, whereas less-skilled golfers experienced a significant change $F(1,26) = 21.04$, $p <.05$. Specifically, although high-skilled golfers' backswing times remained similar in trial block 1(M = 659.32ms, SD = 107.4) and trial blocks 2 and 3 (M = 654.46ms, SD = 110.6) low skilled golfers experienced a decrease in their backswing times from trial block 1 (M = 695.28ms, SD = 136.2) to trial blocks 2 and 3 (M = 718.14ms, SD = 132.6). Tests of simple effects were also carried out to examine how avoidant instructions influenced forward-swing times as a function of skill level. Results showed (see Table 3) that high-skilled golfers experienced no change in forward-swing times across conditions $F(1,26) = 0.004$, $p > .05$, whereas less-skilled golfers experienced a significant change $F(1,26) = 31.73$, $p <.05$. A closer look at the mean scores indicates that high-skilled golfers' forward-swing times were similar in trial block 1 (M = 801.63ms, SD = 129.4) and trial blocks 2 and 3 (M = 803.8ms, SD = 146.9). In contrast, avoidant instructions appear to have slowed low-skilled golfers' forward-swing times from trial block 1 (M = 718.84ms, SD = 118.7) to trial block 2 and 3 (M = 762.32ms, SD = 109.9).

As noted earlier, we also used motion analysis to examine how avoidant instructions influenced a number of the key movement parameters that influence a putt's direction. To assess this, a 2 (instruction condition: baseline, avoidant instruction) × 2 (skill level: high-skilled, low-skilled) mixed-factor MANOVA was conducted with putter path, impact point, putter face change, putter face alignment entered as dependent variables. Again, preliminary assumption testing was conducted and no significant violations of these assumptions were evident. Using Pillai's trace, a significant effect of instruction condition was found, V = .54, $F(4,23) = 6.98$, $p < .05$, $\eta^2 = 0.55$**.** The univariate analysis revealed that avoidant instructions influenced golfers' putter paths, $F(1,26) = 13.76$, $p < .01$, $\eta^2 = 0.35$, and their putter face impact points, $F(1,26) = 6.33$, $p < .01$, $\eta^2 = 0.2$, but had no effect on putter face change, $F(1,26) = .1$, $p > .01$, $\eta^2 = 0.004$, or putter face alignment, $F(1,26) = 5.32$, $p > .01$, $\eta^2 = 0.17$. Tests of simple effects revealed that avoidant instructions had no significant influence on high-skilled golfers' putter paths $F(1,26) = 0.24$, $p > .05$ but did significantly influence less-skilled golfers' putter path, $F(1,26) = 6.71$, $p < .05$. Tests of simple effects also revealed that avoidant instructions had no significant influence on high-skilled golfers' impact point $F(1,26) = 1.22$, $p > .05$ but did influence impact spots of less-skilled golfers $F(1,26) = 5.96$, $p < .05$. The significance of each of these findings will be discussed in greater detail in the following section.

Discussion

The present study sought to examine whether or not performers' propensity for engaging in over-compensatory behaviour is affected by their level of expertise. To test the 'implicit overcompensation hypothesis' (de la Peña et al., 2008) we examined the influence of avoidance instructions on putting performance and putting stroke proficiency in experienced golfers. In accordance with our hypothesis, results showed that avoidance instructions had a less deleterious effect on the putting performance and putting stroke proficiency of high-skilled golfers than on that of low-skilled golfers. Specifically, low-skilled golfers adjusted their swing path and impact point in accordance with and in opposition to the avoidant instructions, respectively. With respect to the direction of the missed putts, there was further evidence for over-compensation; however, this was not moderated by expertise as both high-skilled and low-skilled golfers missed more putts on the side that was consistent with the avoidance instruction.

High-skilled golfers maintained putting stroke proficiency and did not adjust their putting strokes after being told to avoid missing on one side of the hole. These results support Janelle's (1999) contention that the increased automaticity associated with expert performance may help athletes deal with potential errors of mental control; however, the direction of misses in the high-skilled group was indicative of over-compensation. In contrast, low-skilled golfers performed more poorly when given the avoidance instruction and this was accompanied by clear differences in the putting stroke kinematics. First, avoidant instructions led to significantly slower backswing and fore-swing times for the low-skilled golfers. According to the progression-regression hypothesis (see Masters & Maxwell, 2008 for a review) disruption to timing may occur when a performer devotes conscious attention to a proceduralized motor skill. Our data are consistent with Mullen and Hardy's (2000) finding that putting strokes in high-handicap (i.e., low-skilled) golfers became significantly slower when they were instructed to consciously attend to an aspect of their putting stroke. Accordingly, the slower backswings and forward-swings exhibited by low-skilled golfers in the present study may reflect attempts to reinvest conscious control in their putting action as they seek to adhere to the avoidance instructions.

Analysis also revealed that low-skilled golfers changed their swing paths and impact points when attending to avoidance instructions. Interestingly, swing paths moved more *towards* the direction they were instructed to avoid (an ironic effect) yet impact point moved away from the direction they were instructed to avoid (indicative of over-compensation). The presence of both ironic and over-compensatory effects may reflect the breakdown of normal compensatory variability that characterises functional coupling between limb segments (Hossner & Ehrenspiel, 2010; Muller & Loosch, 1999). There are two plausible ways in which this might occur. First, reinvestment of conscious control might significantly perturb the functional unit to the extent that “off line” compensation is no longer effective. Second, the process of compensating for changes in one movement component by making changes to another might come under conscious control. In both cases, the normal functional role of motor variability that allows for maintenance of performance proficiency may break down. In fact, the results from the current study are in line with Lohse, Sherwood, and Healy’s (2010) suggestion that attempts to consciously control automated movements may disrupt compensatory variability and, ultimately, movement outcome itself.

Overall, avoidance instructions resulted in low-skilled golfers making a number of alterations to various aspects of their putting strokes that degraded their putting performance. Over-compensation was also observed in the high-skilled group; yet these participants managed to maintain their overall putting proficiency. Findings from a recent study by Mazzoni and Wexler (2009) may provide a potential explanation for this latter outcome. These authors found that implicit and explicit motor control can guide movements independently (during a dual-control reaching task), and without interference. Mazzoni and Wexler concluded that the flexibility of the motor system may allow participants to vary the amount of explicit and implicit motor control based on task requirements.

Accordingly, skilled participants in the present study may have fought an internal battle between their desire “not to miss” to the left or right of the target and their overall goal to maintain putting proficiency. On the one hand, high-skilled golfers may have exerted a subtle degree of explicit control (e.g., altering club face alignment at address) to reduce the likelihood that they would miss putts in the direction instructed to be avoided. On the other hand, their overall performance may have been maintained by the implicit message that it is preferable ‘not to miss’ at all – thereby ensuring that explicit control was sufficiently moderated to prevent overcompensation. This finding points to better maintenance of compensatory processes in high-skilled golfers.

If the movement proficiency and putting performance of low-skilled golfers is susceptible to performance degradation owing to self-instructions *not* to perform in a certain manner, then what practical methods may be employed to prevent performers focusing on these avoidant instructions? Janelle (1999) suggested that one means of dealing with ironic processes is to manage thoughts and feelings through metacognitive awareness. Metacognition refers to a higher-order process of thinking about or reflecting on thought processes in order to make appropriate responses and adjustments (Dunlosky & Metcalfe, 2009). Janelle proposed that the training of metacognitive skills will lead to a higher level of automaticity in handling ironic processes as they occur. As previously noted, this increased automaticity should free attentional resources which can be used for cue utilization (e.g., global cue words) and strategy formation (e.g., reading the slope of a golf green) and provide additional resources to deal with lapses in mental control. Janelle also suggested that if performers are aware of such lapses they may be more prepared to deal with them. In contrast, if performers are unfamiliar with these processes they may become discouraged and confused when faced with them. As such, future research may wish to examine how metacognitive training can influence skilled performance and athletes’ susceptibility to over-compensation.

In fact, an optimal method to prevent performers from focusing on unwanted thoughts might include the use of metacognitive training alongside a quiet eye training program that promotes the adoption of an external focus of attention (Vine & Wilson, 2010; Wulf, 2007). Wulf proposed that an external focus of attention would not merely distract performers from focusing on the to-be-avoided thought, but would help ensure they focused on a task-related thought which will improve the automaticity of the skill. Similarly, Dugdale and Eklund (2002) found that ironic effects could be suppressed when individuals where given a task-relevant cue word to focus on during a thought suppression task.

Conclusions

In conclusion, the present study provided evidence of over-compensation in both high-skilled and low-skilled golfers who were instructed to avoid missing a putt in a specific direction. This effect was moderated by expertise insofar as skilled golfers were better able to maintain performance proficiency under avoidance instruction conditions. By contrast, over-compensation in low-skilled golfers was accompanied by disruption to the kinematics of their putting stroke in a manner consistent with conscious control of their action. Alongside the practical implication that it is better to focus on what to do than what not to do (Binsch et al., 2009), the data reveal that high-skilled performers are better able to retain the automatic, fluent nature of their putting stroke in the face of negatively worded instructions.

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Table 1

Influence of avoidant instructions on overall putting performance

	High-skilled		Low-skilled	
	Baseline	Avoidant	Baseline	Avoidant
Overall putting score	42.4 (4.1)	43 (3.4)	38.2 (6.3)	35 (6.2)

Note. Maximum putting score = 50.

Table 2

Influence of avoidant instructions on direction of putts missed (per block) in avoidant conditions

	High-skilled	Low-skilled
Missed in the same direction	1.9 (2.46)	3.6 (1.47)
Missed in the opposite direction	4.6 (2.9)	6.4 (2.29)

Table 3

Skilled and less-skilled golfers' consistency and timing across conditions

	High-skilled		Low-skilled	
	Baseline	Avoidant	Baseline	Avoidant
Consistency	75.7 (6.1)	76.9 (6.1)	56.5 (10.5)	61.1 (10)
Backswing times	659ms (107.4)	654.4ms (100.6)	695.2ms (136.2)	718.1ms (132.6)
Forwardswing times	801.6ms (129.4)	803.8ms (146.9)	718.8ms (118.7)	762.2ms (109.9)
Impact timing	318.5ms (952.2)	313ms (54)	305.7ms (67.4)	304.4ms (66.7)

Note. ms = milliseconds. Maximum consistency score = 100.

Table 4

Effect of avoidant instructions on key movement parameters influencing a putt's directional outcome

	High-skilled		Low-skilled	
	Baseline	Avoidant	Baseline	Avoidant
Putter path	.23° (.45)	.41° (.42)	1.8° (1.66)	.1° (.15)
Impact spot	.9° (1.73)	1.8° (2)	2.2° (2.3)	.3° (.68)
Alignment at address	.14° (.33)	.36° (.54)	.61° (.74)	.12° (.34)
Face change	.28° (.44)	.13° (.21)	.22° (.27)	.14° (.19)

Note. ° = degrees.