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

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Kinematics

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Abstract

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

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

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

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

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

63 *Keywords:* Implicit overcompensation; Ironic processes; Expertise; Kinematics; Golf
64 putting

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65 **The effects of avoidant instructions on golf putting proficiency and kinematics**

66 Research on mental control (or people’s ability to implement their intentions
67 successfully) suggests that skilled athletes may be subject to performance
68 impairments when they focus on avoidant instructions during the execution of a
69 complex motor skill (e.g., Binsch, Oudejans, Bakker, Hoozemans, & Savelsbergh,
70 2010; Dugdale & Eklund, 2003). However, contradictory evidence exists regarding
71 the precise influence avoidant instructions exert on performance. Specifically,
72 consider the rival predictions emanating from the ironic processes theory (Wegner,
73 1994; 2009) and the “implicit overcompensation hypothesis” (de la Peña, Murray, &
74 Janelle, 2008). On the one hand, Wegner’s (1994) model predicts that self-instructions
75 *not* to perform in a certain manner will lead to the very behavior the individual seeks
76 to avoid – if the person is anxious or otherwise cognitively overloaded. By contrast,
77 the implicit overcompensation hypothesis (de la Peña et al., 2008) predicts that
78 avoidant instructions will produce the opposite outcome to that intended by the
79 performer – regardless of cognitive load. Surprisingly, there is a dearth of research
80 examining the role of expertise in implicit overcompensation so we do not presently
81 know whether or not skilled performers are susceptible to over-compensatory
82 behavior when focusing on avoidant instructions. Against this background, the present
83 study sought to test the predictions of the implicit overcompensation hypothesis by
84 determining the extent to which high-skilled and low-skilled golfers’ putting
85 performance and swing kinematics are influenced by focusing on avoidant self-
86 instructions.

87 Wegner (1994) postulated the theory of ironic processes of mental control to
88 explain how avoidant instructions (i.e., self-instructions not to behave in a certain
89 manner), together with mental load (e.g., anxiety, information-processing demands)

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90 can lead to an individual carrying out the very behaviour that he or she had sought to
91 avoid. In postulating an explanation for this latter phenomenon, Wegner (1994)
92 referred to two hypothesized processes that work together to maintain mental control:
93 the operating process and the monitoring process. The “operating process” searches
94 consciously and effortfully for items consistent with the desired goal or state. In
95 contrast, the “monitoring process” is usually unconscious, less cognitively demanding
96 and seeks signals of failure to achieve the desired state. Wegner (1994, 1997)
97 proposed that when mental load increases (e.g., as a result of anxiety), fewer
98 attentional resources are available to the operating process, and the latter is
99 superseded by the monitoring process. This subtle change in mental control results in
100 the contents of the monitoring process (unchecked by the operating process)
101 becoming prioritized. Herein lies the ironic effect as the monitoring process activates
102 the very thoughts or actions that the person had intended to avoid.

103 An example of such a lapse in mental control during motor skill execution is
104 provided by Wegner, Ansfield, and Pilloff, (1998). In this study, novice golfers putted
105 in two conditions, one requiring them to land the ball on a spot and one in which they
106 were instructed not to hit the ball past the spot. With the addition of cognitive load,
107 which involved keeping a six-digit number in mind and reporting it after the
108 experimental putt, the tendency to hit the ball past the target significantly increased.
109 Wegner et al. (1998) interpreted these findings as evidence of thought rebound in
110 motor actions. In short, attempting not to perform certain actions under mental load
111 may ironically lead to execution of the very action that performers had sought to
112 avoid. Empirical support for the ironic processes theory has been found in a number
113 of recent studies (Bakker, Oudejans, Binsch, & Van Der Kamp, 2006; Binsch,
114 Oudejans, Bakker, & Savelsbergh, 2009; Binsch, Oudejans, Bakker, & Savelsbergh,

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115 2010; Binsch et al., 2010; Dugdale & Eklund, 2003; Woodman & Davis, 2008). For
116 example, Bakker et al. (2006) used eye-tracking technology to show that soccer
117 players who are instructed to avoid aiming their kicks at a particular part of the goal
118 tend to direct their gaze at the very location to be avoided.

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

134 When scrutinized heavily, it becomes evident that the theory of ironic
135 processes and the implicit overcompensation hypothesis make contradictory
136 predictions. In fact, Russell and Grealy (2010) summarized these contradictory
137 predictions by stating that ‘Wegner (1994) predicts that instructing participants to
138 avoid making specific movements should, ironically, cause them to make these
139 movements more intensely, whereas de la Peña et al. (2008) predicts that such

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140 avoidant instruction should cause participants to overcompensate by making
141 movements in the direction opposite to those that were forbidden' (p. 1673). In
142 addition, there are methodological issues that compromise the ecological validity of
143 some studies in this field that have examined these competing predictions in golf
144 settings. To explain, the Wegner et al. (1998) study required participants to land a golf
145 ball on a spot (glow spot, 4 cm in diameter) while the de la Peña et al. (2008) study
146 required the ball to be landed in a circle (10.8 centimeter chalked outlined circle).
147 Unfortunately, both of these tasks are rather contrived and unrepresentative of the
148 normal goal in golf putting, simply because golfers are trained to putt the ball over or
149 through the target, particularly for short putts. For example, it has been calculated that
150 a putt has its best chance of being holed if the ball is struck at a velocity which
151 ensures it would roll 12-18 inches past the hole (Pelz, 2000). Striking a ball at such
152 velocity ensures it has the best chance of going into the hole at all angles (i.e., left
153 edge or right edge of the hole) and minimizes the impact of putting surface variations
154 that can have a significant impact on a slowly rolling ball (Pelz, 2000). The lack of
155 ecological validity in some golf studies in this field presents a potential confound both
156 for the instructions given, and for subsequent interpretation of resulting data. This
157 issue of ecological validity is crucial for the elucidation of any expertise effects in
158 psychology. Thus Farrow and Abernethy (2003) claimed that it is central to 'any
159 attempts to determine experimentally the underlying source of the expert's advantage'
160 (p. 1127).

161 In the current study we addressed this issue concerning the ecological validity
162 of the golf putting task in two ways. First, we required participants to putt the ball into
163 a hole and recorded the final location of each task attempt (i.e., short or long/left or
164 right). Second, we focused the avoidant instructions on the lateral movement (or

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165 “break”) of a golf putt, the correct judgment of which is critical in sloping putts (Van
166 Lier, Van der Kamp, & Savelsburgh, 2010). Thus the current study enhanced the
167 ecological validity of the methodology employed by both Wegner et al. (1998) and de
168 la Peña et al. (2008) by creating a left-to-right slope on the putting green and requiring
169 participants to avoid missing putts to the left or the right of the hole.

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

186 By contrast, as the low-skilled performers in our sample started golf at a later
187 age in life and had significantly fewer years playing experience than their high-skilled
188 counterparts, we predicted that they would be *more* vulnerable to the effects of
189 avoidant instructions. Support for this latter prediction is derived from Hernandez,

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190 Mattarella-Micke, Redding, Woods, and Beilock's (2011) suggestion that the
191 'learning of a task later in life requires more overt or explicit cognitive processing' (p.
192 255). Based on such reasoning, and by contrast with their high-skilled counterparts,
193 the low-skilled golfers in the present study should have *fewer* attentional resources
194 *available* to process the cognitively complex demands of avoidant instructions.

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

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

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

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

234 **Method**

235 **Participants**

236 Participants were 14 high-skilled and 14 low-skilled male golfers. The high-
237 skilled group had a mean handicap of 5.5 ($SD = 2.6$), a mean of 28.25 years ($SD =$
238 10.22) playing experience and a mean age of 46.5 years ($SD = 12.4$). The low-skilled

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239 group had a mean handicap of 21.1 ($SD = 2.7$), a mean of 19.73 years ($SD = 11.35$)
240 playing experience and a mean age of 49 years ($SD = 13.9$).

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

243 **Apparatus**

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

255 **Procedure**

256 After providing written informed consent, participants were instructed that
257 they would perform a series of putts with the goal of landing the ball in the hole under
258 different instructions. Following four practice putts, participants performed three trial
259 blocks of ten putts each (in line with de la Peña et al.'s 2008 methodology).

260 Participants were informed that they could initiate each trial in their own time. For all
261 participants, Block 1 comprised the baseline condition, in which they were instructed
262 to hole as many putts as possible. In Block 2, participants were instructed to avoid
263 missing the target on either the left or right side. Within the high-skilled and low-

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264 skilled groups, the side of the hole on which participants were instructed to avoid
265 missing was randomly assigned.

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

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

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289 performance parameters and comparing them with data recorded from European Tour
290 golfers (Science and Motion in Golf, 2005).

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

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314 towards the toe (after receiving instructions not to miss putts to the right of the hole)
315 were deemed to be consistent with instruction (evidence of ironic effects) and putts hit
316 towards the heel were deemed to be in opposition with instruction (evidence of over-
317 compensation). The opposite applied for participants instructed not to miss putts to the
318 left of the target.

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

323 **Results**

324 **Putting proficiency**

325 First, a 2 (instruction condition: baseline, instruction conditions) \times 2 (skill
326 level: high-skilled, low-skilled) mixed-model ANOVA was conducted to examine
327 how avoidant instructions influenced golfers' overall putting performance. Our
328 dependent variable, putting performance, was normally distributed for the groups as
329 assessed by the Kolmogorov-Smirnov test and a visual inspection of a Q-Q plot. In
330 addition, there was homogeneity of variance between groups as assessed by Levene's
331 test for equality of error variances. The 2 \times 2 ANOVA found a significant interaction
332 between instruction condition and skill level for overall putting performance, $F(1,26)$
333 $= 8.09, p < .05, \eta^2 = .24$. Tests of simple effects revealed that low-skilled golfers'
334 putting performance was significantly influenced by receiving avoidant instructions, p
335 $= .003, 95\% \text{ CI } [1.23, 5.20]$, whereas high-skilled golfers experienced no such change,
336 $p = 0.49, 95\% \text{ CI } [1.31, -2.67]$. A closer analysis of the results (see Table 1) revealed
337 that high-skilled golfers marginally improved their overall putting performance
338 proficiency from trial block 1 ($M = 42.42, SD = 4.14$) to trial blocks 2 and 3 ($M = 43,$

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339 $SD = 3.42$). In contrast, low-skilled golfers' putting performance was significantly
340 better in the baseline condition ($M = 38.22$, $SD = 6.31$) than when performing under
341 avoidant instructions ($M = 35$, $SD = 6.23$).

342 Second, a 2 (instruction condition: baseline, instruction conditions) \times 2 (skill
343 level: high-skilled, low-skilled golfers) mixed-model ANOVA was conducted to
344 examine how avoidant instructions influenced the direction in which putts were
345 missed (i.e., left or right of the target). Again, our dependent variable (direction of
346 misses), was normally distributed for the groups as assessed by the Kolmogorov-
347 Smirnov test and a visual inspection of a Q-Q plot. In addition, there was
348 homogeneity of variance between groups as assessed by Levene's test for equality of
349 error variances. The 2 \times 2 ANOVA revealed a non-significant interaction between
350 instruction condition and skill level for the direction (i.e., left/right) of missed putts,
351 $F(1,26) = 0.01$, $p > .05$, $\eta^2 = 0.001$. However, there was a significant main effect of
352 instructions on the direction of misses, $F(1,26) = 17.35$, $p < .05$, $\eta^2 = 0.4$. A closer
353 analysis of the results revealed that golfers missed more putts on the side opposite
354 with instruction ($M = 5.48$, $SD = 0.38$) than on the side they had been instructed to
355 avoid ($M = 2.76$, $SD = 0.49$).

356 **Kinematic measures of the putting stroke**

357 Two separate mixed factor MANOVAs were conducted. First, a 2 (instruction
358 condition: baseline, avoidant instructions) \times 2 (skill level: high-skilled, low-skilled)
359 MANOVA was conducted on the four dependent variables related to the timing and
360 consistency of participants' putting strokes. Preliminary assumption testing was
361 conducted to check for normality, linearity, univariate and multivariate outliers,
362 homogeneity of variance-covariance matrices, and multicollinearity. No significant
363 violations of these assumptions were evident. Using Pillai's trace, a significant effect

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364 of instruction condition was found, $V = .52$, $F(4,23) = 6.27$, $p < .05$, $\eta^2 = 0.52$. The
365 univariate output revealed that avoidant instructions had a significant effect on
366 golfers' backswing times, $F(1,26) = 14.38$, $p < .01$, $\eta^2 = 0.2$, and on their forward-
367 swing times, $F(1,26) = 15.12$, $p < .01$, $\eta^2 = 0.4$, but not on putting stroke consistency,
368 $F(1,26) = .79$, $p > .01$, $\eta^2 = 0.08$, or impact timing, $F(1,26) = .93$, $p > .01$, $\eta^2 = 0.08$.
369 Tests of simple effects indicated that high-skilled golfers experienced no change in
370 backswing times across conditions $F(1,26) = 0.83$, $p > .05$, whereas less-skilled
371 golfers experienced a significant change $F(1,26) = 21.04$, $p < .05$. Specifically,
372 although high-skilled golfers' backswing times remained similar in trial block 1 ($M =$
373 659.32ms , $SD = 107.4$) and trial blocks 2 and 3 ($M = 654.46\text{ms}$, $SD = 110.6$) low
374 skilled golfers experienced a decrease in their backswing times from trial block 1 (M
375 $= 695.28\text{ms}$, $SD = 136.2$) to trial blocks 2 and 3 ($M = 718.14\text{ms}$, $SD = 132.6$). Tests of
376 simple effects were also carried out to examine how avoidant instructions influenced
377 forward-swing times as a function of skill level. Results showed (see Table 3) that
378 high-skilled golfers experienced no change in forward-swing times across conditions
379 $F(1,26) = 0.004$, $p > .05$, whereas less-skilled golfers experienced a significant change
380 $F(1,26) = 31.73$, $p < .05$. A closer look at the mean scores indicates that high-skilled
381 golfers' forward-swing times were similar in trial block 1 ($M = 801.63\text{ms}$, $SD = 129.4$)
382 and trial blocks 2 and 3 ($M = 803.8\text{ms}$, $SD = 146.9$). In contrast, avoidant instructions
383 appear to have slowed low-skilled golfers' forward-swing times from trial block 1 (M
384 $= 718.84\text{ms}$, $SD = 118.7$) to trial block 2 and 3 ($M = 762.32\text{ms}$, $SD = 109.9$).

385 As noted earlier, we also used motion analysis to examine how avoidant
386 instructions influenced a number of the key movement parameters that influence a
387 putt's direction. To assess this, a 2 (instruction condition: baseline, avoidant
388 instruction) \times 2 (skill level: high-skilled, low-skilled) mixed-factor MANOVA was

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389 conducted with putter path, impact point, putter face change, putter face alignment
390 entered as dependent variables. Again, preliminary assumption testing was conducted
391 and no significant violations of these assumptions were evident. Using Pillai's trace, a
392 significant effect of instruction condition was found, $V = .54$, $F(4,23) = 6.98$, $p < .05$,
393 $\eta^2 = 0.55$. The univariate analysis revealed that avoidant instructions influenced
394 golfers' putter paths, $F(1,26) = 13.76$, $p < .01$, $\eta^2 = 0.35$, and their putter face impact
395 points, $F(1,26) = 6.33$, $p < .01$, $\eta^2 = 0.2$, but had no effect on putter face change,
396 $F(1,26) = .1$, $p > .01$, $\eta^2 = 0.004$, or putter face alignment, $F(1,26) = 5.32$, $p > .01$, η^2
397 $= 0.17$. Tests of simple effects revealed that avoidant instructions had no significant
398 influence on high-skilled golfers' putter paths $F(1,26) = 0.24$, $p > .05$ but did
399 significantly influence less-skilled golfers' putter path, $F(1,26) = 6.71$, $p < .05$. Tests
400 of simple effects also revealed that avoidant instructions had no significant influence
401 on high-skilled golfers' impact point $F(1,26) = 1.22$, $p > .05$ but did influence impact
402 spots of less-skilled golfers $F(1,26) = 5.96$, $p < .05$. The significance of each of these
403 findings will be discussed in greater detail in the following section.

404

Discussion

405 The present study sought to examine whether or not performers' propensity for
406 engaging in over-compensatory behaviour is affected by their level of expertise. To
407 test the 'implicit overcompensation hypothesis' (de la Peña et al., 2008) we examined
408 the influence of avoidance instructions on putting performance and putting stroke
409 proficiency in experienced golfers. In accordance with our hypothesis, results showed
410 that avoidance instructions had a less deleterious effect on the putting performance
411 and putting stroke proficiency of high-skilled golfers than on that of low-skilled
412 golfers. Specifically, low-skilled golfers adjusted their swing path and impact point in
413 accordance with and in opposition to the avoidant instructions, respectively. With

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414 respect to the direction of the missed putts, there was further evidence for over-
415 compensation; however, this was not moderated by expertise as both high-skilled and
416 low-skilled golfers missed more putts on the side that was consistent with the
417 avoidance instruction.

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

435 Analysis also revealed that low-skilled golfers changed their swing paths and
436 impact points when attending to avoidance instructions. Interestingly, swing paths
437 moved more *towards* the direction they were instructed to avoid (an ironic effect) yet
438 impact point moved away from the direction they were instructed to avoid (indicative

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439 of over-compensation). The presence of both ironic and over-compensatory effects
440 may reflect the breakdown of normal compensatory variability that characterises
441 functional coupling between limb segments (Hossner & Ehrenspiel, 2010; Muller &
442 Loosch, 1999). There are two plausible ways in which this might occur. First,
443 reinvestment of conscious control might significantly perturb the functional unit to the
444 extent that “off line” compensation is no longer effective. Second, the process of
445 compensating for changes in one movement component by making changes to another
446 might come under conscious control. In both cases, the normal functional role of
447 motor variability that allows for maintenance of performance proficiency may break
448 down. In fact, the results from the current study are in line with Lohse, Sherwood, and
449 Healy’s (2010) suggestion that attempts to consciously control automated movements
450 may disrupt compensatory variability and, ultimately, movement outcome itself.

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

461 Accordingly, skilled participants in the present study may have fought an
462 internal battle between their desire “not to miss” to the left or right of the target and
463 their overall goal to maintain putting proficiency. On the one hand, high-skilled

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464 golfers may have exerted a subtle degree of explicit control (e.g., altering club face
465 alignment at address) to reduce the likelihood that they would miss putts in the
466 direction instructed to be avoided. On the other hand, their overall performance may
467 have been maintained by the implicit message that it is preferable ‘not to miss’ at all –
468 thereby ensuring that explicit control was sufficiently moderated to prevent
469 overcompensation. This finding points to better maintenance of compensatory
470 processes in high-skilled golfers.

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

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

498 **Conclusions**

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

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EFFECTS OF AVOIDANT INSTRUCTIONS

639 Table 1

640 *Influence of avoidant instructions on overall putting performance*

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

641 *Note.* Maximum putting score = 50.

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EFFECTS OF AVOIDANT INSTRUCTIONS

657 Table 2

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

659 *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)

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EFFECTS OF AVOIDANT INSTRUCTIONS

676 Table 3

677 *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	659ms	654.4ms	695.2ms	718.1ms
times	(107.4)	(100.6)	(136.2)	(132.6)
Forwardswing	801.6ms	803.8ms	718.8ms	762.2ms
times	(129.4)	(146.9)	(118.7)	(109.9)
Impact timing	318.5ms	313ms	305.7ms	304.4ms
	(952.2)	(54)	(67.4)	(66.7)

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

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691 Table 4

692 *Effect of avoidant instructions on key movement parameters influencing a putt's*

693 *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)

694 *Note.* ° = degrees.