Interaction of mindfulness disposition and instructional self-talk on motor performance: a laboratory exploration

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In considering that high mindfulness disposition individuals possess a unique ability to maintain attention and awareness, and attention is one of the key mechanisms of instructional self-talk, the purpose of this study was to examine the interaction of mindfulness disposition and instructional self-talk on motor performance. Forty-nine college students ($Mage$=18.96±1.08) with high/low mindfulness disposition (high n=23; low n=26) selected out of 126 college students performed a discrete motor task (standing long jump) and a continuous motor task (line tracking task) under instructional and unrelated self-talk conditions. Two separate 2 (self-talk type) X 2 (high/low mindfulness) mixed design ANOVA statistical analyses indicated that mindfulness disposition interacted with unrelated self-talk in the line tracking task. Specifically, low mindfulness participants performed poorer than high mindfulness participants in line tracking task under unrelated self-talk. Further, participants performed better in both standing long jump and line tracking under instructional self-talk than unrelated self-talk. Results not only revealed the triangular relationships among mindfulness, self-talk, and motor performance but also indirectly support the role of attention in self-talk effectiveness. Limitations, future research directions, and practical implications were discussed.

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29   **Abstract**

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31   maintain attention and awareness, and attention is one of the key mechanisms of instructional

32   self-talk, the purpose of this study was to examine the interaction of mindfulness disposition and

33   instructional self-talk on motor performance. Forty-nine college students (M_{age}=18.96±1.08)

34   with high/low mindfulness disposition (high n=23; low n=26) selected out of 126 college

35   students performed a discrete motor task (standing long jump) and a continuous motor task (line

36   tracking task) under instructional and unrelated self-talk conditions. Two separate 2 (self-talk

37   type) X 2 (high/low mindfulness) mixed design ANOVA statistical analyses indicated that

38   mindfulness disposition interacted with unrelated self-talk in the line tracking task. Specifically,

39   low mindfulness participants performed poorer than high mindfulness participants in line

40   tracking task under unrelated self-talk. Further, participants performed better in both standing

41   long jump and line tracking under instructional self-talk than unrelated self-talk. Results not only

42   revealed the triangular relationships among mindfulness, self-talk, and motor performance but

43   also indirectly support the role of attention in self-talk effectiveness. Limitations, future research

44   directions, and practical implications were discussed.

45

46   Self-talk is one of the most popular skills in psychological skills training (Gould, Tammen,

47   Murphy, & May 1991, p. 121), and one that has been widely used by performers (Weinberg &

48   Gould, 2015; Williams & Krane, 2015). Self-talk is so widely used by athletes and exercisers

49   because research shows that self-talk can effectively enhance sport and motor performance

50   (Edwards, Tod, & McGuigan, 2008; Kolovelonis, Goudas, & Dermitzaki, 2011; Dickens, Van

51   Raalte, & Hurlburt, 2018; Hardy, Comoutos, & Hatzigeorgiadis, 2018; Hatzigeorgiadis,

52   Zourbanos, Galanis, & Theodorakis, 2011; Weinberg, Miller, & Horn, 2012). Also, the benefits

53   of self-talk have been further supported by both narrative and systematic reviews (e.g., Hardy,

54   2006; Hatzigeorgiadis et al., 2011; Tod, Hardy, & Oliver, 2011). According to Hatzigeorgiadis

55   and colleagues (Hatzigeorgiadis et al., 2011), the global effect size of self-talk on motor

56   performance is positive and moderate (effect size, ES= 0.48) but ranges from 0.22 to 1.31. To

57   deepen our knowledge of the effects of self-talk on motor performance, Tod and colleagues (Tod

58   et al., 2011) suggested that researchers not only continue examining the "first-generation

59   questions", that is, the effects of self-talk on performance; but also explore the "second-

60   generation questions", that is, investigation of moderators and mediators underlying the self-talk-

61   motor performance relationship, such as self-efficacy (Chang, Ho, Lu et al., 2014), self-

62   confidence (Hatzigeorgiadis, Zourbanos, Mpoumpaki, & Theodorakis, 2009), and task

63   characteristics (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011). Hence, the aim of

64   this study was to explore the effects of instructional self-talk on motor performance, specifically,

65   the mechanism underlying self-talk-performance relationship.

66   Theoretically, self-talk is a cognitive strategy that individuals use to talk to themselves

67   either silently or aloud to interpret lived perceptions, to change evaluations and beliefs, and to

68   give instructions or reinforcements (Hardy, Gammage, & Hall, 2001; Hardy, 2006). For

69   example, a tennis player may talk to himself and say "…hit the ball to the left bottom corner…"

70   or "…forget about the last point, now focus on the next point," or "common on, you can it!" All

71   these statements, either spoken loudly or silently, are good examples of self-talk. According to

72   the extant literature, self-talk includes the thoughts that a performer expresses in language or

73   statement, and uses implicitly or explicitly before, during or after the execution of an activity or a

74   sports skill (Zetou, Nikolaos, & Evaggelos, 2014). Zetou and colleagues (Zetou et al., 2014)

75   contended that the self-talk process usually happens unconsciously; it affects not only the

76   performers' feelings but also their actions.

77   Notably, self-talk can be of different types including positive, negative, motivational, and

78   instructional self-talk. Among all types of self-talk, instructional self-talk is particularly worthy

79   of further examination because students learning a motor skill are given many verbal instructions

80   (McGill, 2003; pp.247-258). Instructional self-talk occurs when task performers have to focus on

81   technical, tactical, or kinesthetic components of motor tasks (Hardy, 2006; Hardy et al., 2001;

82   Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004). Therefore, when performers apply

83   instructional self-talk they need to emphasize the cognitive components of motor tasks. By doing

84   so, performers can direct or redirect their attention to the task-relevant cues when performing

85   (Hardy, 2006; Hatzigeorgiadis et al., 2004; Landin, 1994; Nideffer, 1993; Theodorakis,

86   Weinberg, Natsis, Douma, & Kazakas, 2000).

87   Empirical studies examining the effects of instructional self-talk on motor performance

88   yielded mixed results. For example, Theodorakis and colleagues (Theodorakis et al., 2000)

89   assigned 72 male soccer players to shoot at a goal from a distance of 15 yards. Results found the

90   instructional group performed better than the control group. Similar results were also found in

91   studies by using different motor tasks such as basketball passing accuracy and speed (Boroujeni

92   & Shahbazi, 2011), softball throwing accuracy (Chang, Ho, Lu et al., 2014), handball accuracy

93   (Zourbanos, Hatzigeorgiadis, Bardas, & Theodorakis, 2013), and basketball free throw shooting

94   accuracy (Abdoli, Hardy, Riyahi, & Farsi, 2018). In contrast, some research found instructional

95   self-talk has no effect on the motor task. For example, Zourbanos and colleagues (Zourbanos et

96   al., 2013) assigned 40 primary school students to perform handball throwing accuracy with the

97   dominant hand and found no difference between instructional self-talk and control group. Similar

98   results were also found in Theodorakis and colleagues' (Theodorakis et al., 2000) early research

99   examining the effect of instructional self-talk on a 3-min endurance sit-up task. Recently, Hardy

100   and colleagues (Hardy, Begley, Anthony, & Blanchfield, 2015) compared the effects of

101   motivational self-talk and instructional self-talk on Gaelic football shooting accuracy using the

102   non-dominant foot. Results indicated there was no difference between the two types of self-talk

103   on shooting accuracy in skilled athletes.

104   The mixed results of the effects of instructional self-talk on motor performance prompted

105   researchers to propose factors underlying the relationship between instructional self-talk and

106   motor performance. Specifically, the attentional process during instructional self-talk has been

107   suggested by researchers. Theodorakis and colleagues (Theodorakis et al., 2000, p.266)

108   explained that the use of instructional self-talk involves attentional process; performers not only

109   have to focus on the relevant cues in the environment but also have to be aware of the specific

110   technical and mechanical aspects of the skills. Zourbanos and colleagues (Zourbanos et al., 2013,

111   p. 929) proposed that when performers are young and have no experience on a motor task (e.g.,

112   novel skill) the attentional demands are very high. Zourbanos and colleagues (Zourbanos et al.,

113   2013, p. 929) explained that by using instructional self-talk performers can focus on the key

114   elements of the movement and dismiss irrelevant stimuli. Thus, it seems that attention might

115   underlie the instructional self-talk and motor performance relationship.

116   Attention is "*the behavioral and cognitive process of selectively concentrating on a discrete*

117   *aspect of information, whether deemed subjective or objective while ignoring other perceivable*

118   *information*" (Anderson, 2004; p. 519). Attention is also referred to as a state of effort and

119   arousal (Schmidt & Lee, 2011), and the cognitive ability "*to possess something in the mind*

120   *consciously or unconsciously in a clear and vivid form of one out of what seem several*

121   *simultaneous objects or trains of thought* (Anderson, 2004; p. 519)". Motor behavior scholars

122   suggest that attention allows performers to allocate limited cognitive resources and handle it

123   effectively. By doing so, they can successfully achieve behavioral goals (Schmidt & Lee, 2011;

124   97-99).

125   In considering the importance of attention in motor performance, we propose that

126   performers' mindfulness disposition- a behavioral tendency to be attentive- might influence the

127   relationship between instructional self-talk and motor performance. According to Brown and

128   Ryan (2003, p.822-823) mindfulness disposition refers to "*...tendency for having an open or*

129   *receptive awareness and attention which is reflected in a more regular or sustained*

130   *consciousness of ongoing events and experiences*." Many studies support that high mindfulness

131   individuals have high attention ability and perform better on motor tasks than low mindfulness

132   performers (Djikic, Langer, & Stapleton, 2008; Kee, Chatzisarantis, Kong, Chow, & Chen, 2012;

133   Kee & Liu, 2011; Mills & Allen, 2000). Thus, when examining the effects of instructional self-

134   talk on motor performance it is imperative to examine participants' mindfulness disposition

135   because their attention tendency might be a key variable affecting the instructional self-talk and

136   motor performance relationship.

137   In addition, the triangular relationship among instructional self-talk, mindfulness

138   disposition, and motor performance suggests several theoretical questions that previous research

139   has never explored. First, is the role of mindfulness disposition on motor performance. Past

140   research examining the effects mindfulness on motor performance can be classified as (a) does

141   mindfulness training influence motor performance (e.g., Kee et al., 2012; 2013; Mills & Allen,

142   2000; Zhang et al., 2016), or (b) how does mindfulness disposition influence motor performance

143   (e.g., Kee & Liu, 2012). Generally, research has found mindfulness induction enhances motor

144   performance (e.g., Kee et al., 2012; 2013; Mills & Allen, 2000; Zhang et al., 2016), or high

145   mindful disposition participants performed better than low mindful individuals (e.g., Kee & Liu,

146   2012). Despite these efforts, research examining the effects of self-talk on motor performance

147   has not examined how mindfulness disposition influences different types of motor tasks.

148   According to Schmidt and Lee (2011), motor tasks can be classified as discrete, continuous,

149   or serial; and, each type of motor task requires a different attentional process. A discrete task,

150   such as basketball free throw or soccer kicking, which is characterized by a recognizable

151   beginning and end, requires performers to pay attention to external stimuli (e.g., target or goal),

152   and then to act. Generally, the movement time for discrete motor tasks is relatively short. For a

153   continuous task, such as swimming, steering a car, or tracking, which is characterized by having

154   no recognizable beginning and end, performers must pay and maintain attention over a certain

155   period until the task is completed. By doing so, performers can complete the motor task

156   correctly. A serial motor task is neither discrete nor continuous, but usually comprised of a series

157   of individual movements tied together in time to make some discrete tasks "whole" such as

158   playing the piano or performing a gymnastics routine. It requires performers to pay and maintain

159   attention to both individual movement and the whole routine of the motor task. Thus, will those

160   with different mindful dispositions perform differently on different types of motor tasks during

161   self-talk needs further examined. Past research on the effects of instructional self-talk on motor

162   performance generally focused on one type of motor task, such as softball throwing (e.g., Chang

163   et al., 2014), soccer shooting (e.g.,Thodorakis et al., 2000) or basketball passing (e.g., Boroujeni

164   & Shahbazi, 2011), without comparing how self-talk influences different types of motor tasks.

165   Thus, will instructional self-talk has the same effects on different motor tasks is another question

166   to be examined.

167   Moreover, past research examining the self-talk and motor performance relationship

168   generally designed a control group such as "unrelated self-talk" (e.g., Chang et al., 2014) or

169   summary feedback (e.g., Theodorakis et al., 2000), to prevent participants from automatically

170   using another type of self-talk (e.g., motivational, positive, or negative) that might contaminate

171   the experimental effects. Under such experimental control, will unrelated self-talk interact with

172   mindful disposition on different motor tasks is worthy of investigation.

173   Further, Lewin (1935) proposed an interactionist approach of personality suggests that

174   human behavior is the function of person and environment. $B= f(P, E)$.Thus, when researchers

175   examining the effects of self-talk on motor performance, they must consider that mindfulness

176   disposition might interact with self-talks on different type of motor tasks. Using the

177   aforementioned triangular relationships among mindfulness disposition, self-talk and motor tasks

178   as an example. For high mindful individuals, they may perform well on motor task that requires

179   the high ability of attention (e.g., continuous motor task) even under unrelated self-talk. In

180   contrast, for low mindfulness individuals, they might perform poorly in the motor task that

181   requires high attention under unrelated self-talk but remains unaffected for motor task that

182   requires a short time of attention (e.g., discrete motor task). Therefore, to examine the interaction

183   of mindfulness disposition and self-talk on different motor tasks can be a starting point to solve

184   the puzzle of why instructional self-talk cannot lead to positive effects for motor performance.

185   Built on the above rationale, the purpose of the present study was to examine the interactive

186   effects of mindfulness disposition and self-talk on motor performance. We proposed the

187   following hypotheses: (i) Mindfulness disposition would interact with self-talk in standing long

188   jump. (ii) Mindfulness disposition would interact with self-talk in line tracking.

189   **Method**

Phase 1: Selection of Participants

190

191   First, we recruited participants in PE classes at a university. We informed participants that

192   the purpose of the study was to explore college students' general psychological disposition and

193   motor skills. Participants who were interested in this study signed a consent form and completed

194   a demographic questionnaire and a Chinese version of the mindful attention awareness scale

195   (MAAS). The MAAS (Brown & Ryan, 2003) consists of 15 items for assessing mindfulness

196   disposition. The items are comprised of statements about everyday experiences for gauging

197   frequency of receptive awareness of and attention to present-moment events and experiences. A

198   sample question is "... I rush through activities without being really attentive to them." The 6-

199   point scale, ranging from 1 (almost always) to 6 (almost never), was used. Higher mean scores

200   derived from all 15 items correspond to a high mindfulness disposition. Previous work suggests

201   that MAAS is a single factor scale and has acceptable validity and reliability (alpha coefficients

202   above .80, Brown & Ryan, 2003). The alpha coefficient of the scale for the current sample was

203   .90. It took about 15 minutes to complete a consent form, demographic questionnaire, and

204   MMAS.

205   A total of 126 participants voluntarily completed the questionnaire package. Based on their

206   MAAS scores, we identified 31 participants as high mindfulness (top 25% of all the participants)

207   and 31 participants as low mindfulness (bottom 25% of all the participants). Later, 23

208   participants in the high mindfulness group and 26 in the low mindfulness group agreed to

209   participate in the experiment (*M*age=18.96 yrs, SD=1.08; females=23, males=26). Before

210   participating in the formal experiment, those 49 participants signed a consent form and

211   participated in the formal experiment. We used G*Power to estimate the experiment sample size.

212   With 2 by 2 mixed design and set alpha=0.05, the estimated sample size was 48. Descriptive data

213   for participants are presented in Table 1.

214   Insert table 1 about here

215   **Phase 2: Formal Experiments**

216   **Nature of self-talk.**

217   To allow participants to learn self-talk skills, we developed a self-talk script with a

218   professor of sports psychology and an expert familiar with psychological skill training. Then, we

219   displayed this self-talk script on an instruction sheet before performing the assigned motor task.

220   Two types of self-talk (i.e., instructional and unrelated self-talk) were applied to perform two

221   motor tasks - standing long jump and a line tracking test. To apply instructional self-talk for the

222   line tracking test, participants had to talk to themselves the words like "focus on the center of the

223   groove of the panel and move it as fast as possible!" To apply unrelated self-talk for the line

224   tracking test, we refer to Chang and colleagues' (2014, p.141) method by asking participants to

225   talk to themselves with words like " the weather today, my clothes' colors, or my pets' names."

226   To apply instructional self-talk for the standing long jump, participants had to talk to themselves

227   with words like "look at the front landing spot, swing the arms, relax, and jump forward as far as

228   possible!" To apply unrelated self-talk for the standing long jump, participants had to talk to

229   themselves with words like " the weather today, my clothes' colors, or my pets' names."

230   **Self-talk manipulation check.**

231   We adopted Kolovelonis and colleagues' suggestion (Kolovelonis et al., 2011) to check whether

232   participants followed our design in performing motor tasks under different self-talk

233   interventions. We used a self-talk check question for participants after each performance attempt.

234   The question was "during standing long jump/line tracking tasks did you use the self-talk from

235   self-talk sheet as is instructed?" The response options ranged from " *1* " absolutely not to "*5*"

236   completely so.

237   **Motor performance measure.**

238   ***Standing long jump task.***

239   We adopted Westphal and Porter's (2013) suggestion by using the standing long jump to

240   test participants' discrete motor skill performance. The standing long jump was used to assess

241   participants' muscular power and strength. The task was conducted in a regular standard-sized

242   plastic pad with two lines indicating the distance in centimeters. During the test, the participants

243   were instructed to perform warm-up until ready to act (about 3-4 min). To begin with the

244   experiment, participants had two warm-up attempts with 30% and 60% intensity of jumping.

245   Then, the participants were asked to execute six maximal attempts for official testing and asked

246   to jump as far as possible. The longest distance was recorded for further analysis.

247   ***Hand-eye coordination of fine line tracking test.***

248   We used the Austrian made "Visual Pursuit Test of the Vienna Test System (VTS,

249   Schuhfried GmbH) for the experiment. The VTS is a computerized psychological assessment

250   tool for perceptual-motor skill testing (Schmid, Sauter, Stepansky, Lobentanz, & Zeitlhofer,

251   2005). We used Motor Performance Series Workboard (MLS), one of the devices of VTS to

252   measure participants' continuous motor skill performance. According to Fleishman's (1954)

253   conceptualization of perceptual-motor skill tests, MLS is a very reliable and valid test for

254   continuous motor skills. The MLS requires dynamic and static ability in coordinating finger-

255   hand-arm movement. There is a path-way in the MLS task with several geometric figures that

256   requires participants to perform a single hand line tracking. The size of the work board is 300 X

257   300 X 15 mm, and there are several holes, grooves, and contact surfaces. There are two pens on

258   the work board, one is black on the right and one is red on the left. In this study, participants

259   used their preferred hand in sitting position to perform the motor task, but their bodies cannot

260   touch any part of the work board. To begin with the test, participants pick up the electronic pen

261   and touch the starting point, then move along with the path of the groove until touching the finish

262   point. While performing the task, the electronic pen cannot leave the upper edge of the work

263   board nor touch the side or bottom. If the pen hits the edge of the groove, it is recorded as a

264   mistake. More errors represent poorer performance in the line tracking motor skill task. We used

265   frequencies of mistakes for further analysis.

266   **Experimental procedures.**

267   Prior to data collection, we gained approval from the local institutional review board

268   (TSMH IRB No.18/ Protocol No.108-B). Before formal experiments, all participants were given

269   a short lecture to introduce the purpose of our study, the content of self-talk, and the procedures

270   to perform motor tasks. To avoid Hawthorne effects (Thomas, Nelson, & Silverman, 2015), we

271   just told the participants that this is an experiment to examine the relationship between language

272   use and motor performance. What they need to do was just try their best during the experiment.

273   For formal experiments, participants experienced two self-talk conditions with counterbalanced

274   order. The participants were asked to select the self-talk condition by drawing lots. Then

275   participants completed 6 trials of standing long jump and 4 trials of line tracking test. To avoid

276   fatigue effects, we gave participants a 5-minute break after standing long jump. Also, during

277   each trial of line tracking, we gave 3 minutes of break. As stated earlier, the longest standing

278   long jump and the best line tracking performance (i.e., the fewest mistakes) were used for further

279   analysis. Before they performed the official attempt, the experimenters displayed the self-talk

280   scripts. Participants selected one self-talk item from the script and then verbally and loudly spoke

281   the script to make sure they understand the words. After this step, the participants started to

282   perform a formal test. Before each trial, they had to speak these self-talk scripts either loudly or

283   silently before performing the motor tasks. The self-talk manipulation check was then

284   administrated to confirm the appropriate use of specific self-talk following each official attempt.

285   All these experiments were conducted in a quiet room of a sport psychology lab. When

286   experiments were conducted, no other person was present in order to reduce social facilitation

287   effects. Further, to avoid other unnecessary effects on experiments, we did not provide any

288   feedback on the performance. It took about 40 minutes for each participant to complete the

289   whole experiment.

290   **Statistical analyses**.

291   Two separate 2 × 2 (self-talk × high vs. low mindfulness disposition) mixed design

292   ANOVA were used to compare the effects of self-talk and high vs low mindfulness disposition

293   on standing long jump and line tracking task. Significant effects were followed-up with multiple

294   comparisons with Bonferroni correction and Greenhouse Geisser correction in order to meet the

295   sphericity assumption. The significance level was set at alpha level of .05 prior to Bonferroni

296   correction.

297

...

298 **Results**

299   Regarding the self-talk manipulation check, participants were able to use the self-talk

300   requested for the specific condition during both motor tasks (M=4.88~4.94, SD=0.24~0.33).

301   Because the highest possible score is 5, the scores indicated that participants followed the

302   experimental design to use different types of self-talk. The descriptive data on motor task

303   performance as well as a mindfulness group for the two self-talk conditions are presented in

304   Table 2.

305   Insert table 2 about here

306   **Interaction effects of mindfulness and self-talk in standing long jump**

307   The 2 by 2 mixed design ANOVA showed no significant self-talk × mindfulness group

308   interaction in standing long jump, $F(1,47) = 0.001$, $p = .97$. However, the analysis revealed a

309   main effect of self-talk on standing long jump, $F(1, 47) = 6.22$, $p = .02$, $\eta^2 = .12$, indicating that

310   participants performed better under instructional self-talk than unrelated self-talk. Further, there

311   was no main effect of mindfulness group for standing long jump, $F(1,47) = 0.01$, $p = .92$.

312   **Interaction effects of mindfulness and self-talk in line tracking**

313   Regarding line tracking, the 2 by 2 mixed design ANOVA showed a significant self-talk ×

314   mindfulness group interaction, $F (1, 47) = 6.12$, $p = .02$, $\eta^2 = .12$ (see figure 1). Further, we

315   utilized both independent t-test and paired t-test to compare this simple main effect of line

316   tracking between mindfulness and self-talk. Under instructional self-talk, there was no difference

317   between high vs. low mindfulness participants in line tracking performance. However, under

318   unrelated self-talk, the independent t-test showed that high mindfulness performed better than

319   low mindfulness in line tracking, $t(47) = 2.31, p = .01$, Cohen's $d= 0.66$. Further, the paired t-test

320   showed that low mindfulness participants performed better under instructional self-talk than

321   unrelated self-talk, $t(22) = 3.38, p = .00$, Cohen's $d = 0.70$. However, for high mindfulness

322   participants, there was no difference in line tracking between instructional self-talk and unrelated

323   self-talk.

324   Insert figure 1 about here

325   **Discussion**

326   **Theoretical Implications**

327   In considering that mindfulness disposition might moderate the effects of self-talk on motor

328   task performance, the present study recruited participants with high vs. low mindfulness to

329   perform standing long jump and line tracking under instructional self-talk and unrelated self-talk

330   conditions. Results found several novel findings. First, an interaction effect was found between

331   mindfulness and self-talk in line tracking. Specifically, low mindfulness participants performed

332   poorer than high mindfulness participants in line tracking task under unrelated self-talk. Further

333   two main effects indicated that participants performed better in standing long jump and line

334 tracking under instructional self-talk. However, high vs low mindfulness participants did not

335 differ in standing long jump and line tracking. The results provide several implications for

336 researchers.

337 First, our results confirmed that self-talk is beneficial to motor performance (e.g., Dickens,

338 Van Raalte, & Hurlburt, 2018; Hardy, Comoutos, & Hatzigeorgiadis, 2018; Weinberg, Miller, &

339 Horn, 2012). Specifically, we found that all participants performed better both in standing long

340 jump and line tracking under the instructional self-talk condition. The effects of instructional

341 self-talk on motor performance may be due to performers focusing on relevant cues in the

342 environment and specific technical /mechanical aspects of the skills compared to those who did

343 not receive instructions (Abdoli et al., 2018; Boroujeni & Shahbazi, 2011; Chang, et al., 2014;

344 Theodorakis et al., 2000).

345 The interaction of mindfulness disposition and self-talk in line tracking is very insightful for

346 researchers. To the best of our knowledge, this is the first study that includes mindfulness

347 disposition in examining the effects of self-talk on motor performance. Although past researchers

348 (e.g., Theodorakis et al., 2000; Zourbanos et al., 2013) suggested that attention might explain the

349 mixed results of the effects of the instructional self-talk on motor performance, no study has

350 examined the role of mindfulness disposition in self-talk-motor performance relationship. Our

351 study used mindfulness disposition as a moderator, and indirectly supported the moderating role

352   of attention between instructional self-talk and motor performance relationship. Future study

353   may use a direct measure of attention, such as EEG and other neuro-physiological index, to

354   examine the moderation effect of attention on the self-talk- motor performance relationship (e.g.,

355   Martel, Dahne, & Blankertz, 2014).

356   The interaction effect of mindfulness and self-talk on continuous motor task also outlines

357   the importance of instructional self-talk for low mindfulness participants. Especially, we found

358   low mindfulness participants performed better in line tracking only under instructional self-talk.

359   The results can be explained that instructional self-talk providing task-relevant cues or

360   information so they can perform well even with low ability to sustain their attention (Hardy,

361   2006; Hardy et al., 2001; Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004). However, the

362   results also found those participants with high mindfulness disposition did not differ under

363   instructional self-talk or unrelated self-talk in two motor tasks. This can be explained in that their

364   high ability to sustain attention from moment to moment helped them perform better with

365   different tasks either under instructional or unrelated self-talk conditions. Kee and Liu (2011)

366   suggested that high mindfulness participants performed better in different motor tasks because

367   they are kinesthetically aware and become responsive to motor tasks required. Thus, even under

368   unrelated self-talk condition, their performance was not impaired.

369   Further, under unrelated self-talk, high vs low mindfulness participants had no difference in

370   standing long jump but had a significant difference in line tracking is worthy of discussion. This

371   unique result can be explained in that a discrete motor task such as standing long jump, is a rapid

372   and ballistic movement that requires a generalized motor program (GMP, Schmidt, 1975) to

373   perform the task. It requires a short time to sustain attention so it does not interfere low

374   mindfulness participants' performance under unrelated self-talk. In contrast, a continuous motor

375   task such as line tracking requires performers to sustain their attention to accomplish the task. If

376   during a continuous task a competing attention appeared (e.g., unrelated self-talk), it would

377   impair participants' performance, especially for those with low mindfulness disposition (Schmidt

378   & Lee, 2011, pp. 103-105). The unrelated self-talk can be a source of distraction for line tracking

379   that distracts low mindfulness performers' attention and makes errors. The central-resource

380   capacity theories of attention (McGill, 2002; pp. 143-145) proposed that there is motor

381   performance deficit when performing multiple activities at the same time for novel tasks or

382   unexperienced performers. Because there is limited capacity to receive and handle information, if

383   performers are beginners or unexperienced, they have difficulty receiving correct information to

384   react correctly. For our study, because low mindfulness participants tend to be less able to

385   sustain their attention, talking to themselves with unrelated words would distract their attention

386   during line tracking. In contrast, high mindfulness participants are characterized by an ability to

387   maintain attention from moment to moment. They were less distracted when speaking unrelated

388 words. Therefore, further studies are needed to examine the performers' mindfulness disposition,

389 the role of attention allocation, type of self-talk, and motor task.

390 **Limitations and Future Suggestions**

391   Despite these significant and unique findings, several limitations should be considered when

392 interpreting the results of the present study. First, the operational and conceptual equating of

393 mindfulness disposition and attention ability may be a limitation, although related literature

394 suggests that high mindfulness disposition indicates high attention (Brown & Ryan, 2002). Also,

395 empirical research supports that mindfulness induction can enhance attention through the

396 evidence of left dorsomedial prefrontal cortex activities (Doll et al., 2016), but we did not

397 measure left dorsomedial prefrontal cortex activities. Therefore, whether attention moderates the

398 effects of instructional self-talk on motor performance needs to be further examined. We suggest

399 future study may examine the effects of instructional self-talk on motor performance and

400 simultaneously measure EEG activities. By so doing, the role of attention in the instructional

401 self-talk - motor performance relationship can be further understood.

402   In addition, our study was conducted in a laboratory setting where participants were asked

403 to perform motor tasks under different self-talk conditions. Whether the results are applicable to

404 real athletic settings needs to be further examined. Specifically, a recent meta-analysis found

405 male expert athletes performed better on cognitive-motor tasks which require attentional abilities

406   (Voss et al., 2010). Thus, future research needs to examine the effects of instructional self-talk

407   on motor tasks when participants are expert athletes or have sporting experience.

408   Further, because the duration of our self-talk intervention in the present study was adopted from

409   previous research (e.g., Chang et al., 2014; Boroujeni & Shahbazi, 2011; Theodorakis et al.,

410   2000), whether a long-term intervention produces similar results needs to be further examined.

411   Specifically, some studies have conducted relatively long-term self-talk programs (4 to 10

412   weeks) and support their effectiveness for sports performance (Hamilton et al., 2007;

413   Hatzigeorgiadis, Galanis, Zourbanos, & Theodorakis, 2013; Zetou et al., 2012). Moreover, we

414   suggest future studies examine the effects of instructional self-talk in varied settings. Martin,

415   Vause, and Schwartzman (2005) indicated that most self-talk research is conducted in laboratory

416   settings. Therefore, future studies may examine how instructional self-talk in competitive sports

417   settings, academic settings, fitness centers, military, sports injury, and rehabilitation. Moreover,

418   we found no difference in discrete and continuous tasks for high vs low mindfulness participants.

419   The true reasons for this finding are unknown. We suggest future studies to examine how

420   mindfulness disposition interacts with external stimuli on different motor tasks under different

421   self-talk conditions.

422   **Applications**

423   Practitioners, such as PE teachers, coaches, and sport psychology consultants can apply our

424   results in various settings. To facilitate students or athletes' motor learning and control

425   practitioners should provide positive and task-relevant information to performers (Edwards,

426   2011; pp. 362-401). Specifically, practitioners should provide both the general and specific

427   aspects of the skills so performers can understand the key components of the skills and direct

428   their attention to those parts when performing the motor skills. Also, practitioners should avoid

429   giving unrelated information to prevent distracting attention. In addition, because there is limited

430   information processing ability for beginners or unexperienced students, it is suggested that PE

431   teachers, coaches, and sports psychology consultants should give each key instruction each time

432   when learning a new skill. Also, the instructors should give precise information about the skill

433   requirements and avoid jargon (Edwards, 2011, pp. 366-367). For those students with high

434   mindfulness, it is suggested that PE teachers and coaches could provide a different level of

435   assignments and materials, and foster independent learning (Laine & Tirri, 2015).

436

437   **Conclusion**

438   Self-talk is a very useful psychological skill to enhance performers' motor skill learning and

439   control. Our study provides evidence that instructional self-talk is beneficial to both discrete and

440   continuous motor skills. Additionally, we found participants' mindfulness disposition interacts

441   with self-talk on the motor task. Future research may extend our research by directly examining

442   performers' mindfulness disposition, the role of attention allocation, type of self-talk, and motor

443   task to unveil the interweaving relationships of instructional self-talk, attention, and motor

444   performance. Moreover, when applying instructional self-talk with athletes and PE students,

445   practitioners should provide positive and task-related instruction in order to facilitate performers'

446   motor task performance.

447

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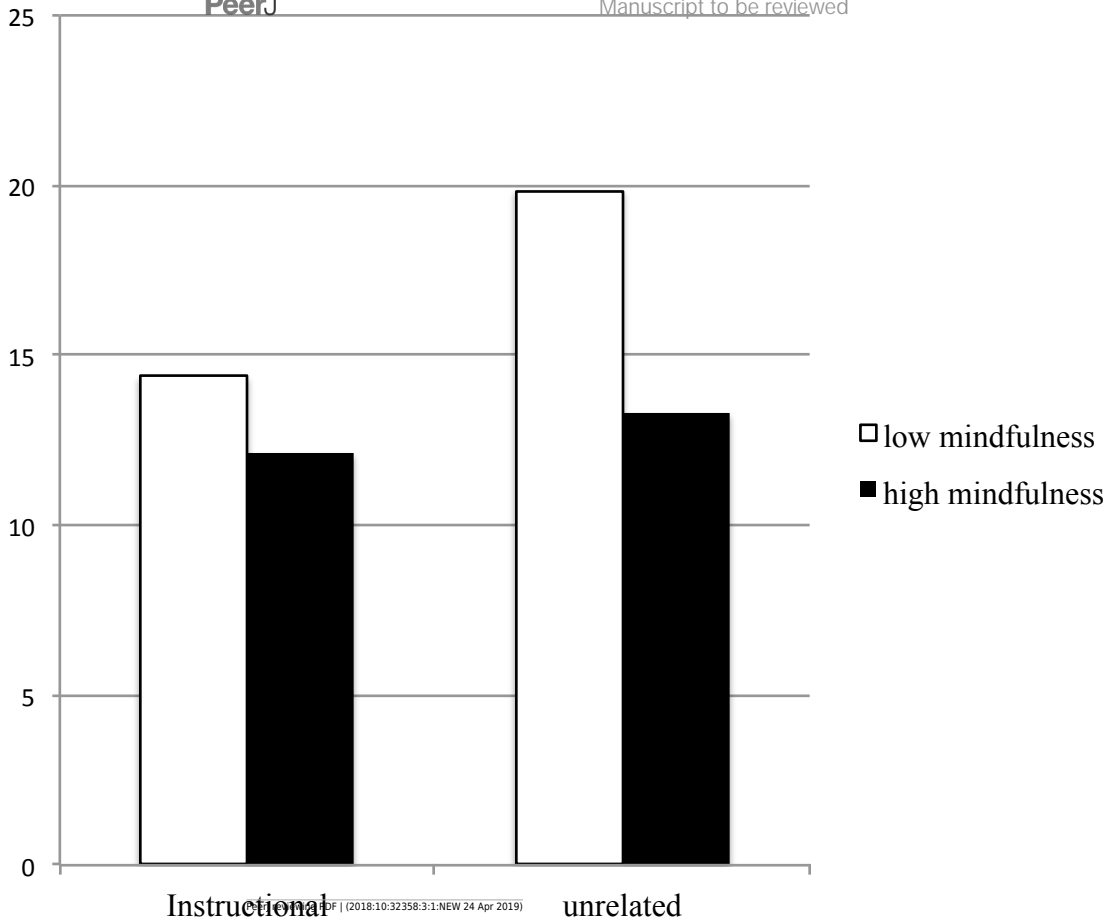
Interaction of mindfulness and two types of self-talk on line tracking

This figure illustrates how high vs low mindfulness disposition performed differently on line tracking under different self-talks

Demographic characteristics of participants

Demographic Characteristics of Participants (N=49).

1   Table 1. Demographic Characteristics of Participants (N=49).

Measures	Male	Female	High mindful group	Low mindful group	Total
n	26	23	26	23	49
Age	19.08±1.32	18.83±0.72	18.69±0.62	19.26±1.39	18.96±1.08
Height	174.58±6.00	160.78±5.41	168.69±10.	167.43±6.5	168.10±8.96
Weight	69.31±14.20	51.43±6.76	61.62±17.0	60.13±11.0	60.92±14.39
BMI	22.78±4.74	19.87±2.15	21.38±4.26	21.44±3.77	21.41±4.00

Note. BMI= body mass index.

Descriptive Statistics for All Participants on Two Motor Tasks Under Different Self-Talks

This table illustrates all the statistics of all participants' performance on two types of motor tasks under different self-talk

1   Table 2. Descriptive Statistics for All Participants on Two Motor Tasks Under Different Self-
2   Talks.

Variable	Instructional	Unrelated
Standing Long Jump (N=49)	171.82±40.21	166.88±37.15
low mindfulness (n=23)	171.17±38.20	166.30±35.07
high mindfulness (n=26)	172.38±42.65	167.38±39.59
Line Tracking Test (N=49)	13.18±7.16	16.36±10.31
low mindfulness (n=23)	14.39±6.95	19.83±12.05
high mindfulness (n=26)	12.12±7.31	13.29±7.47

4