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GATE START IN BMX, PERFORMANCE AND ANXIETY

The Influence of Gate Start Position on Physical Performance and Anxiety Perception in Expert BMX Athletes

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20

Abstract

21 The critical importance of the start phase in BMX racing is increasingly
22 acknowledged. Past experiments underlined that the internal lane of the starting gate provides
23 a strong positional advantage. However, how lane position affects start performance and
24 cognitive and somatic state anxiety remains unexplored. We examined the start performance
25 and anxiety responses of youth national-level BMX riders in both experimental and ecological
26 contexts. We used contextualization motor imagery routines to evaluate start performance and
27 state anxiety from the internal and external lanes. Cycle ergometer measures revealed a better
28 start performance from the external lane, but we did not record any lane effect on actual gate
29 start times. Both somatic and cognitive anxiety scores were higher before racing from the
30 internal compared to the external lane. Finally, state anxiety (i.e., somatic anxiety, worry and
31 concentration disruptions) negatively predicted the start performance. Present findings
32 provide original insights on psychological factors involved in BMX start performance, and
33 might contribute to fruitful coping interventions and training programs in sports overlapping
34 the framework of “handicap races” taking the specific form of positional
35 advantages/disadvantages at the start (e.g., ski/snowboard cross, athletics, swimming,
36 motorsports, etc.).

37

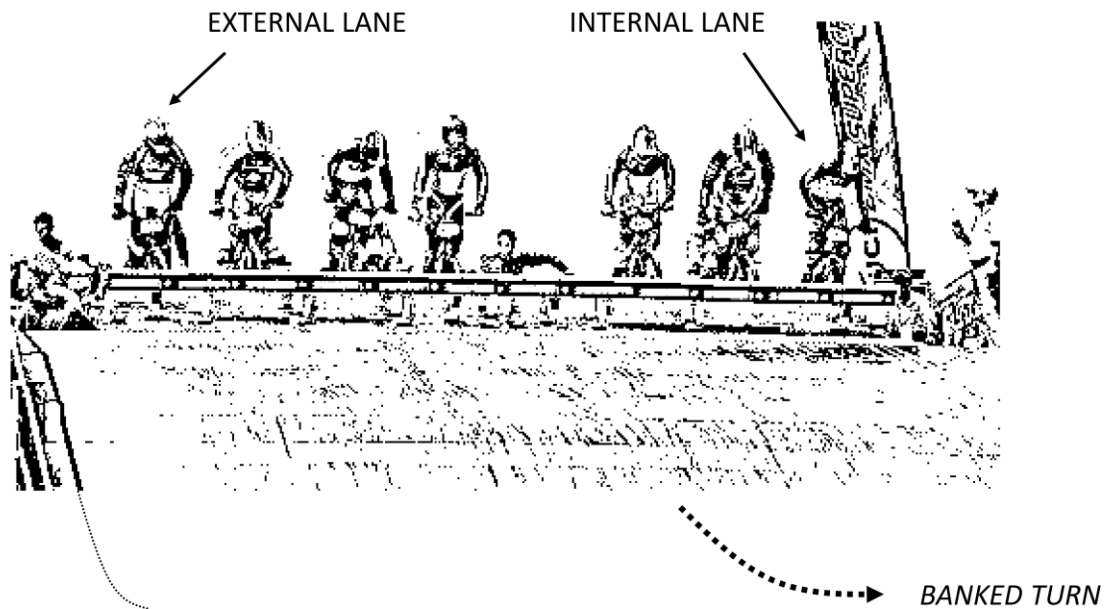
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38 1. Introduction

39 Bicycle motocross (BMX) is an Olympic cycling discipline since Beijing (2008). In
40 this event, eight riders complete one lap on narrow off-road tracks of about 400 m long. BMX
41 races require explosive efforts lasting 30 to 45 s (Zabala, Sánchez-Muñoz, & Mateo, 2009).
42 An electrical starting gate, positioned at the top of an 8 m hill, is expected to provide the
43 necessary run-up to reach the maximal starting speed. Riders are positioned next to each other
44 (Figure 1). Hence, the first banked turn yields to a first hierarchized ranking between the
45 riders. Recent findings underlined that rider's position on the starting gate (i.e., in an
46 internal/external continuum according to the curve of the first banked turn) has a strong
47 predictive power on their final ranking (Rylands & Roberts, 2014). It is noteworthy that
48 qualifying heats determine riders' position on the starting gate. Riders racing from the internal
49 lane can hug the bend more rapidly than their opponents, and are thus provided an opportunity
50 to lead the race up to the finishing line. By contrast, riders racing from the external lane have
51 the most unfavorable start position with regards to first ranking yielded by the banked turn
52 (Figure 1). Comparable challenges are present in several sports, including closed/semi-closed
53 motor skills. For instance, the relative positions on the lane at the start of the race are similar
54 in ski cross and snowboard cross, i.e., two disciplines of the Winter Olympic Games. To a
55 lesser extent, lanes 3, 4 and 5 are preferred by most athletes in sprint events of athletics.
56 Racing from lanes 1-2 requires additional energy expenditure to counterbalance centrifugal
57 forces, while lanes 6 to 8 prevent the athletes to control their opponent on the race progress
58 due to the absence of visual control. In swimming, lanes 1 and 8 confront swimmers with
59 increased energy expenditure due to additional waves resulting from the close presence of the
60 wall – and less visual control on their opponents and event from the central lanes. Obviously,
61 comparable situations are present in motorsports, where the start position greatly influences
62 the race outcome and the risks associated to confrontations with other competitors. Overall,

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63 these examples overlap the framework of handicap races under the specific form of positional
64 advantages/disadvantages on the starting line.



65
66 *Figure 1.* Sketch picture of a BMX start, with a specific emphasis on the external and internal
67 lanes of the starting gate according to the first banked turn.

68 The BMX start is one of the most determinant factors of high-level performance.
69 According to Rylands and Roberts (2014), it involves two main phases: i) a series of
70 standardized auditory commands, and ii) the drop of the electrical gate allowing riders to start.
71 A more exhaustive description of the preparatory/executive phases of the BMX start was
72 provided by Zabala et al. (2009). This skill currently receives increased attention from both
73 coaches and researchers (e.g., Debraux & Bertucci, 2011). As underlined by Rylands and
74 Roberts (2014), applied research on BMX racing remains limited. Past studies sought to
75 delineate the factors involved in high-level performance with a specific emphasis on
76 biomechanics (Cowell, Cronin, & McGuigan, 2011; Herman, McGregor, Allen, & Bollt,
77 2009; Hodgkins, Slyter, Adams, Berning, & Warner, 2001; Slyter et al., 2001). Only few
78 experiments examined the psychological factors required during the start phase. This is

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79 somewhat surprising considering the importance of psychological factors in sprint events
80 (e.g., Englert & Bertrams, 2014; Ille, Selin, Do, & Thon, 2013). Zabala et al. (2009) first
81 investigated the effect of providing audiovisual feedback on BMX start performance to six
82 national riders. The authors conducted an intervention based on the qualitative analysis of
83 individual start performance, yielding individualized feedback. The intervention resulted in
84 immediate improvements in start velocity, which remained effective after one week. This
85 research highlights the relevance of psychological interventions grounded in the systematic
86 analysis of experts' performance.

87 Formalized by Rylands and Roberts (2014), the predictive influence of the starting
88 gate lane on the final ranking is perfectly understood by both riders and coaches. Accordingly,
89 an exciting research issue is whether rider's position on the starting gate might actually affect
90 their start performance. Riders may perform differently when racing from favorable (internal
91 lane) or less favorable (external lane) positions with regards to the first banked turn, due to
92 differences in their psychological state towards the race. In the present experiment, we tested
93 the influence of the gate positions on BMX starts performed in experimental (i.e., using a
94 cycle ergometer) and ecological (i.e., from an actual BMX starting gate) conditions. We also
95 measured riders' state anxiety before racing from favorable or unfavorable positions of the
96 starting gate. Anxiety is one of the most frequently investigated variables in sport psychology
97 and has a long history of theoretical and empirical attention (Cerin, Szabo, Hunt, & Williams,
98 2000; Martinent, Ferrand, Guillet, & Gauthier, 2010). To explain, competitive state anxiety is
99 conceptualized as a situation-specific multidimensional construct including cognitive and
100 somatic components (Martinent et al., 2010; Smith, 2014; Smith, Smoll, & Schutz, 1990). The
101 aforementioned challenging nature of the BMX start (especially for riders positioned in the
102 external lane) and the competitive environment itself could place many psychological
103 demands on riders positioned on the starting gate. Therefore, we hypothesized that riders

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104 positioned in the external lane would perform more poorly than riders racing from the first
105 lane, due to a higher competitive anxiety.

106

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107 2. Methods

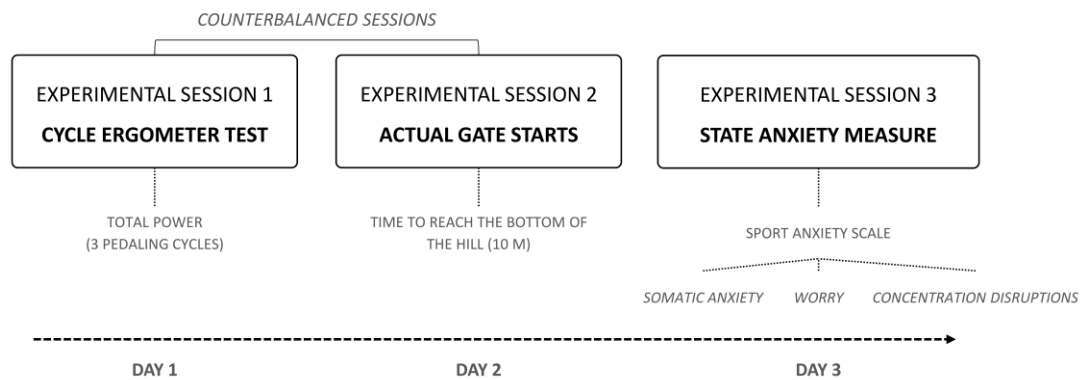
108 2.1. Participants

109 Fifteen national-level BMX riders (11 males, 4 females, mean age 16.5 ± 2.1 years)
110 volunteered to participate in the experiment. They had entered a high school sport-study
111 program for their potential to reach the international level (i.e., 10-12 hours of BMX training,
112 and 4-6 hours of strength conditioning per week). All were healthy, without history of
113 physical injury or neurologic disorders. The local institutional review board approved the
114 present experiment, and participants' written consent was obtained according to the
115 statements of the Declaration of Helsinki (1982). Parental signed consent was obtained for
116 participants under the age of 18.

117 2.2. Experimental settings

118 The study involved three experimental sessions scheduled within one week (Figure 2).
119 We first assessed the start performance from i) a cycle ergometer and ii) from an actual BMX
120 starting gate, according to different lane positions (i.e., internal and external). The two
121 experimental sessions were counterbalanced to prevent carryover effects. The last
122 experimental session evaluated athletes' anxiety state before racing from the internal and
123 external lanes. We measured state anxiety after performance assessment to validate a recent
124 practice of BMX starts from the two lanes of interest. To avoid an influence of the
125 performance on anxiety scores, athletes were not informed of their performance during the
126 two first experimental sessions.

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127

128 *Figure 2.* Summary of the experimental sessions.

129 To assess start performance from the internal and external lanes out of actual
130 competing context, we used a contextualization routine based on motor imagery (MI). MI is
131 the voluntary process of mentally rehearsing an action without engaging in its physical
132 execution (Jeannerod, 1994). The riders were requested to mentally simulate the context of an
133 actual BMX start from the internal and the external lanes (see below for an exhaustive
134 description of the procedure). MI is frequently and spontaneously used among athletes to
135 mentally reproduce the environmental context of competitions, or during pre-performance
136 routines (Guillot & Collet, 2008; Munzert & Lorey, 2013). To ensure that all athletes were
137 able to perform MI adequately, they completed the Movement Imagery Questionnaire 3
138 (MIQ-3) before enrolling to the main experiment (Williams et al., 2012). The MIQ-3
139 measures the subjective difficulty/ease to complete MI of 12 single-joint or whole body
140 movements according to internal/external visual and kinesthetic imagery modalities, on a 7-
141 point Likert scale. The MIQ-3 demonstrated adequate internal reliability with Cronbach alpha
142 coefficients > 0.75 (Williams, Guillot, Di Rienzo, & Cumming, 2015). Participants with an
143 average score < 5 (5 on the 7-point Likert scale corresponding to “*Quite easy to imagine*”)
144 were not enrolled in the experiment ($n = 1$).

145 *2.3. Experimental sessions*

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146 2.3.1. Cycle ergometer start performance

147 Participants first completed a warm-up of 10 min involving running at a comfortable
148 pace for five min and a series of 10 squat jumps. We then measured the total power developed
149 over three pedaling cycles (pedaling resistance at 80% of the individual maximal power as
150 assessed by the Wingate test, Bar-Or, 1987) using a cycle ergometer (CycleOps Pro Series®
151 400Pro). This sequence was expected to reproduce the early instants of the BMX start. Riders
152 first took place on the cycle ergometer and engaged in 20s of MI focused on the
153 environmental and emotional context of a competitive BMX start from the internal or external
154 lane of the starting gate. The contextualization routine was instructed by the following
155 sentences:

156 *“You are racing in the finals of the national championships. Imagine yourself during*
157 *the last instants preceding the first command of the start. You are racing from the internal*
158 *(external) lane. All your opponents are on your right (left). Visualize the hill slope and the*
159 *track ahead of you, with the first banked turn on the left. Focus on the atmosphere and*
160 *emotions associated to this competing event”.*

161 Immediately after completion of the MI routine, an auditory signal provided the
162 official commands of the BMX start. On a counterbalanced order, riders completed a block of
163 3 trials for each lane (3 min rest between each trial, and 5 min rest between each block).

164 2.3.2. Actual start performance

165 Using photoelectric cells (Newtest Powertimer®, Finland) during an actual BMX
166 track, we measured the time from the starting gate to the bottom of the hill (10 m distance).
167 Participants rode individually as in a time trial. These actual gate starts were not part of a
168 competitive event. Before each trial, athletes underwent the same warm-up and
169 contextualization MI routine. Then, they performed start trials according to the internal and

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170 external lanes of the starting gate. Immediately after completion of the MI procedure, riders
171 orally received the official commands for the start. In a counterbalanced order, athletes
172 completed a block of 3 trials from each lane (3 min rest between each trial and 5 min rest
173 between each block).

174 2.3.3. State anxiety measure

175 We used the French version (Martinent & Ferrand, 2007) of the Sports Anxiety Scale
176 (SAS) (Smith et al., 1990) for data collection before racing from the internal and external
177 lanes. We followed the scoring recommendations from Smith, Cumming, and Smoll (2006),
178 i.e., three original SAS items (items 1, 14, and 20) were deleted given their conflicting factor
179 membership and cross-loadings across previous studies. The SAS consists of 18 items
180 addressing somatic anxiety (8 items, e.g., “*I feel my heart beating*”) and two components of
181 cognitive anxiety: worry (7 items, e.g., “*I doubt myself*”) and concentration disruptions (3
182 items, e.g., “*My mind escapes during the competition*”). Participants addressed each SAS item
183 on a 4-level Likert scale ranging from (1) “*never*” to (4) “*very often*”. The SAS is usually
184 completed from a general viewpoint (i.e., “*trait*” assessment), albeit adaptation for “*state*”
185 measures remains possible (Turner & Barker, 2013). Here, we used the state measure, as we
186 were interested in specific SAS scores across the lanes right before the BMX started.
187 Accordingly, participants completed the MI contextualization routine used during
188 performance measures before completing the SAS, and were specifically instructed to answer
189 “*As if you were right now in the context of the BMX start*”.

190 Several researchers prefer the use of the raw mean inter-item correlation instead of
191 Cronbach’s alpha as a statistical marker of internal consistency because Cronbach’s alphas
192 tend to increase according to the number of items in the scale and the sample size (Clark &
193 Watson, 1995; Nicolas, Vacher, Martinent, & Mourot, in press). For this, a rule of thumb is

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194 offered by Clark and Watson (1995) who recommended that the average inter-item correlation
195 should fall within the range of 0.15-0.50.

196 *2.4. Statistical analyses*

197 All statistical analyses were conducted using R (R Core Team, 2015). The total power
198 and start times were the behavioral dependent variables measuring cycle ergometer and actual
199 gate start performance. The average scores for each SAS scores (i.e., somatic anxiety, worry
200 and concentration disruptions) were the psychological dependent variables. We used a linear
201 mixed model (Bates, Maechler, Bolker, & Walker, 2014) with random intercepts by subjects
202 to assess the effect of LANE POSITION on i) performance (total power and start times), and
203 ii) SAS scores. Then, we used a two-level linear mixed effect analysis controlling for the
204 LANE POSITION effect to evaluate i) whether the start times during actual starts were
205 predicted across lanes by the total power produced during cycle ergometer measures, and ii)
206 whether both start times and total power were predicted across lanes by the SAS scores.
207 Accordingly, we built the corresponding random-coefficient regression models. For all
208 analyses, inspection of the residual plots did not reveal any obvious deviation from
209 homoscedasticity or normality. We measured the effect sizes in terms of the proportion of
210 variance explained by the linear mixed effects models, using the Ω_0^2 method recommended in
211 Xu (2003). We computed the p -values by likelihood ratio tests of the full model against the
212 model without the effect in question (Winter, 2013), with a type 1 error rate of $\alpha = 0.05$.
213 Holm's corrections for multiple comparisons were applied to control the false discovery rate
214 (Holm, 1979).

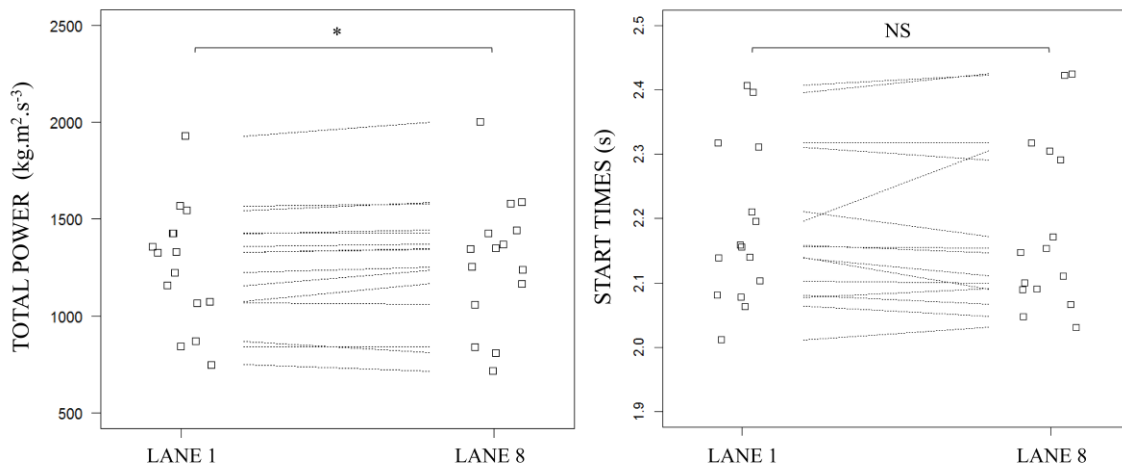
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216 **3. Results**

217 *3.1. LANE POSITION effect on total power, start times and SAS scores*

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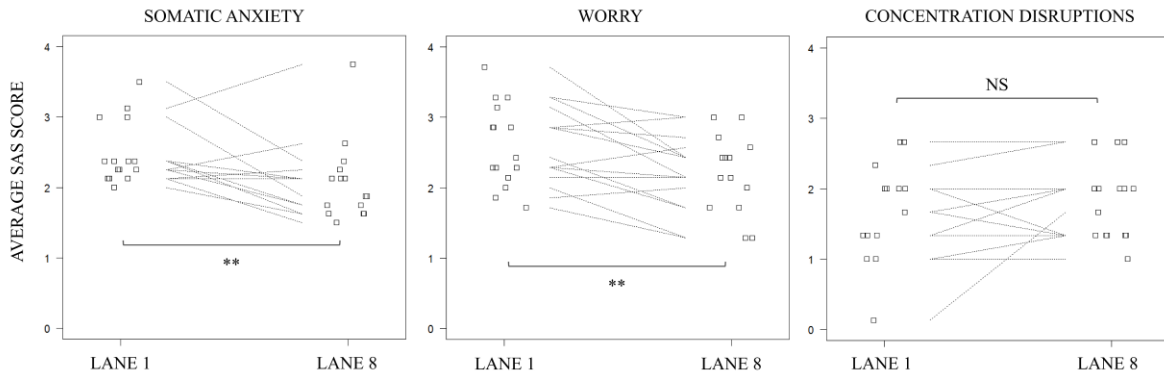
218 The LANE POSITION affected the total power ($\chi^2(1) = 4.23, p = 0.03, \Omega_0^2 = 0.99$, see
219 Figure 3). The total power was lower ($19.6 \text{ kg.m}^2.\text{s}^{-3}$, $\text{IC95\%} = 22.5$) when the start performed
220 was simulated from the internal lane ($1241.3 \text{ kg.m}^2.\text{s}^{-3} \pm 321.0$) compared to the external lane
221 ($1279.8 \text{ kg.m}^2.\text{s}^{-3} \pm 334.4$). By contrast, we found no effect of LANE POSITION on start
222 times ($\chi^2(1) = 0.46, p = 0.49, \Omega_0^2 = 0.97$) (Figure 3).



223
224 *Figure 3.* Motor performance data from cycle ergometer and actual gate start sessions,
225 according to the different lanes. *Note.* * $p < 0.05$, NS = Not Significant.

226 The average inter-item correlation for the SAS subscales in both the internal and
227 external lines ranged from 0.17 to 0.41, providing evidence for the reliability of the SAS
228 scores in the present study. No LANE POSITION effect emerged on concentration
229 disruptions scores ($\chi^2(2) = 1.34, p = 0.24, \Omega_0^2 = 0.81$). LANE affected worry scores, which
230 were higher ($0.40, \text{IC95\%} = 0.25$) when BMX starts were simulated from the internal ($2.6 \pm$
231 0.59) compared to the external lane (2.2 ± 0.54) ($\chi^2(1) = 8.93, p = 0.002, \Omega_0^2 = 0.83$).
232 Likewise, LANE POSITION affected somatic anxiety which was higher ($0.41, \text{IC95\%} = 0.29$)
233 from the internal (2.48 ± 0.45) compared to the external lane (2.06 ± 0.56) ($\chi^2(1) = 7.36, p =$
234 $0.006, \Omega_0^2 = 0.67$), as shown by Figure 4.

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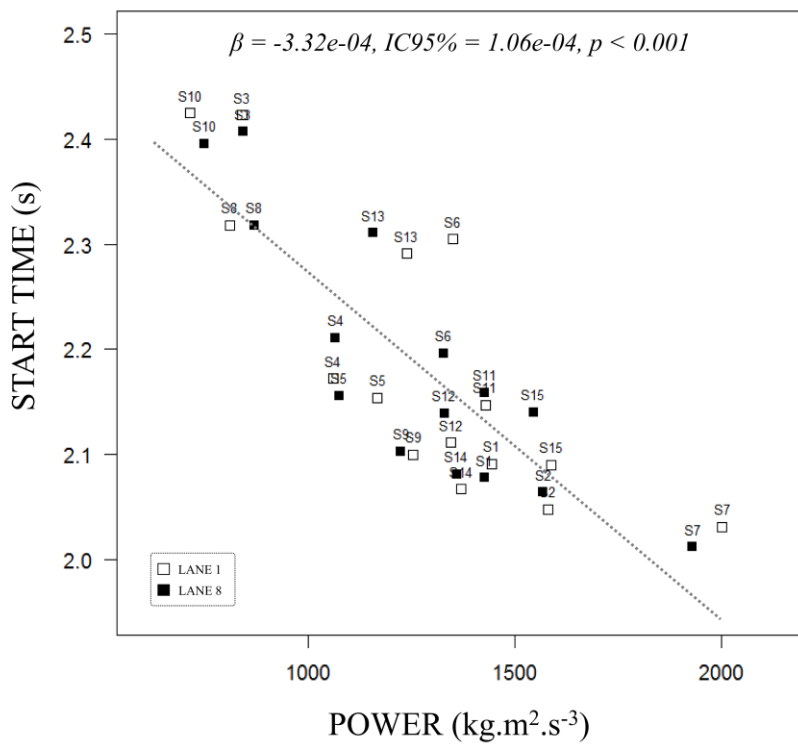
236 *Figure 4. SAS scores across lanes. Note. ** p < 0.01, NS = Not Significant.*

237 3.2. The effect of total power and state anxiety on start times

238 Results of the random-coefficient regression model controlling for the LANE

239 POSITION effect are depicted in Figure 5 and 6. Start times were predicted across lanes by

240 the total power ($\chi^2(1) = 19.27, p < 0.001, \Omega_0^2 = 0.98$) (Figure 5).

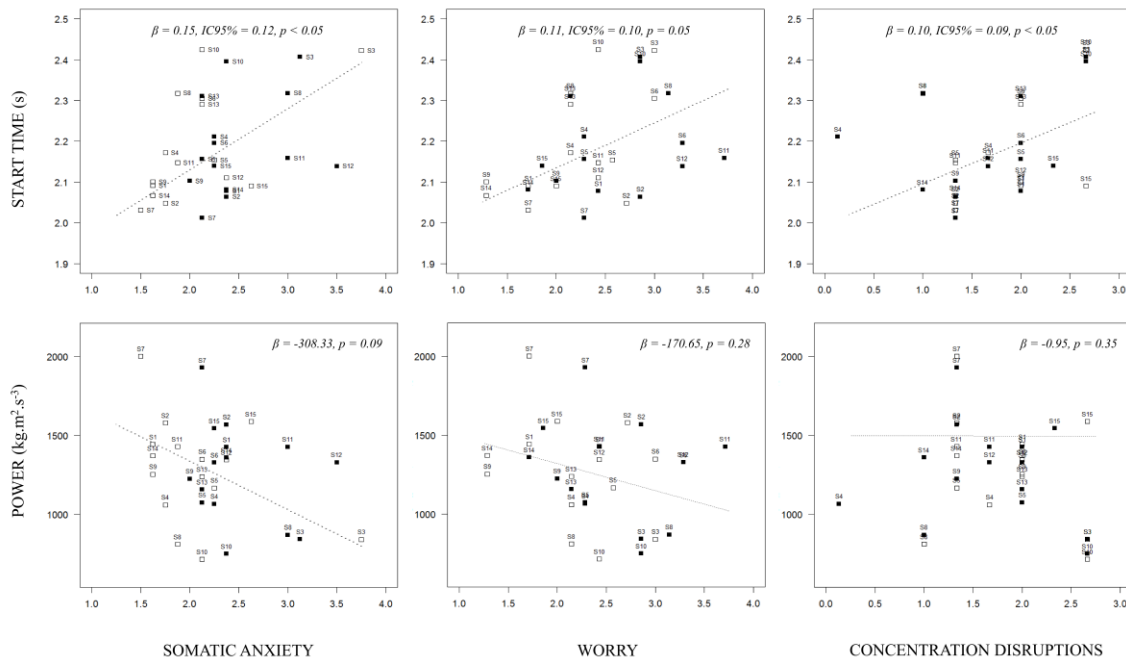


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242 *Figure 5.* Regression slope showing the effect of total power on total times during BMX starts
 243 simulated from the context of the internal and external lanes.

244 SAS scores for somatic anxiety predicted start times across lanes ($\chi^2(1) = 4.97, p <$
 245 $0.02, \Omega_0^2 = 0.97$, see Figure 6). Likewise, SAS scores for worry and concentration disruptions
 246 predicted start times across lanes ($\chi^2(1) = 6.61, p = 0.05, \Omega_0^2 = 0.97$ and $\chi^2(1) = 3.92, p = 0.04,$
 247 $\Omega_0^2 = 0.98$, respectively). However, albeit a marginal trend emerged for somatic anxiety ($\chi^2(1)$
 248 $= 2.79, p = 0.09, \Omega_0^2 = 0.99$), the relationship between SAS scores and the total power did not
 249 reach the statistical threshold ($p > 0.05$, Figure 6).



250
 251 *Figure 6.* Regression slopes showing the effect of the SAS scores on the total power and start
 252 times recorded during BMX starts simulated from the internal and external lanes. *Note.*
 253 Square points are labelled according to each participant (i.e., 1 to 15). SAS = Sport Anxiety
 254 Scale.

255

256 4. Discussion

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257 This study examined the influence of gate start position on BMX start performance
258 and state anxiety among young national-level BMX riders. We hypothesized that riders might
259 perform more poorly from the external lane, due to an altered psychological state before
260 racing associated with higher competitive anxiety (i.e., increased worry and/or concentration
261 disruptions). The results challenged the main hypothesis, since they revealed higher (and not
262 lower) anxiety scores when racing from the internal lane, which is nonetheless considered the
263 most favorable position with respect to the first banked turn.

264 We assessed the BMX start performance in both experimental (i.e., cycle ergometer)
265 and ecological (i.e., actual gate start) contexts. BMX start trials were simulated for each lane
266 using a contextualization MI routine. Measuring actual gate starts during an actual competing
267 event or as participants raced against each other in training situations would certainly
268 emphasize the hypothesized lane effect on anxiety and performance, i.e., increased challenge.
269 Nonetheless we avoided embedding a social component in the experimental paradigm
270 (participants knew each other and their respective levels). We assumed that the measures we
271 performed in standardized environments would therefore enable a greater control and
272 reproducibility of the findings. Participants did not report any difficulties to comply with MI
273 instructions. Accordingly, the contextualization routine was considered a relevant
274 methodological approach to study the influence of emotional and environmental contexts
275 encountered during actual BMX starts. MI is known to adequately reproduce the
276 psychological states encountered by athletes during actual competitions (Guillot & Collet,
277 2008; Munzert & Lorey, 2013), up to reproducing stressful events yielding coping strategies
278 (Hall et al., 2009). The contextualization MI routine enabled to implement a similar
279 experimental procedure to measure the BMX start performance in both experimental and
280 ecological contexts.

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281 On the cycle ergometer, the total power output was higher after the contextualization
282 MI routine focusing on the environmental/emotional context from the external lane. By
283 contrast, the lane had no effect on start times measured from an actual gate start, albeit
284 participants completed a strictly identical MI contextualization routine. The fact that cycle
285 ergometer performance but not actual start times might be affected by the position on the
286 starting gate could originate from i) differences in the efficacy of the contextualization MI
287 routine and/or ii) the nature of dependent variable quantifying motor performance. Indeed, for
288 cycle ergometer measurements, riders were in a perfectly neutral environment (relative to the
289 MI routine content) and the dependent variable of motor performance directly reflected riders'
290 pedaling output, with no influence of external factors. By contrast, riders were in their
291 accustomed outdoor training environment during actual gate start trials. While one could
292 expect that such context would increase MI quality (Guillot, Collet, & Dittmar, 2005), it was
293 in fact very distinct from the MI routine which focused on a competitive situation. This could
294 have hampered the efficacy of the contextualization due to the discrepancies between the
295 actual and imagined context. This possibly occurred to a lesser extent during cycle ergometer
296 measures since athletes were in a neutral laboratory environment. Furthermore, we measured
297 start times based on the time elapsed from the gate start to the bottom of the hill (10m length).
298 Start times were not only dependent on the pedaling performance, but also from the linear
299 acceleration provided by the descent from the hill. This possibly yielded some ceiling effects
300 compared to cycle ergometer measures. Also, human simple reaction times, preceded
301 sometimes by preparatory cues, usually range from 0.2 to 2.5s (Collet, 1999; Schmidt &
302 Gordon, 1977), which accounted for 10-15% of start times. Nonetheless, total power and start
303 times were highly correlated (Figure 5), hence supporting the consistency/reproducibility of
304 experimental procedures.

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305 Results also revealed no lane effect on concentration disruption scores. However,
306 participants experienced higher scores of somatic anxiety and worry when racing from the
307 internal lane by comparison with the external lane. This could be explained by the fact that
308 riders have “nothing to lose” when racing from an unfavorable gate start position, whereas
309 riders racing from the internal lane might experience higher strain due to the fear of failure
310 and/or forthcoming confrontations with other riders (e.g., challenging trajectories before the
311 first banked turn) which might increase the risk of fall (Sagar, Lavallee, & Spray, 2007).
312 While facilitative effects of anxiety on performance have been reported (e.g., Hanton, Neil, &
313 Mellalieu, 2008; Neil, Hanton, Mellalieu, & Fletcher, 2011), the present results are consistent
314 with an appraisal account of state anxiety (Lazarus, 2000; Martinent & Ferrand, 2015). This
315 theoretical framework postulates that: i) the individual’s meaning of a situation potentially
316 triggers state anxiety rather than the situation itself; and ii) this meaning is dependent on the
317 process of appraising the personal significance of adaptive encounters with the environment
318 (Lazarus, 2000). Racing from the internal line could have exacerbated the appraisal of “*facing*
319 *perceived uncertain threat to self*” (Martinent & Ferrand, 2015, p. 15), leading riders
320 positioned in the internal lane to experience higher state anxiety than riders from the external
321 lane. The choice of a sample of adolescent athletes appeared relevant since they were likely to
322 have less sophisticated self-regulation and coping abilities compared to expert and adult riders
323 (Martinent & Decret, 2016). This was expected to control confounding effects on the
324 hypothesized influence of the start lane on the dependent variables.

325 Regression coefficients also revealed that anxiety scores negatively predicted the start
326 performance (i.e., high total power and low start times), albeit the prediction of total power
327 from the SAS scores did not reach statistical threshold ($p = 0.09$ for somatic anxiety).
328 Considering the overall negative relationships found between the SAS scores and the indexes
329 of BMX start performance, coping strategies aiming at limiting somatic and cognitive anxiety

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330 maybe relevant (Nicholls & Polman, 2007). Importantly, such coping strategies may be
331 efficient through helping riders getting rid of *excessive* anxiety rather than attempting to limit
332 somatic anxiety and worry to the lowest. This postulate corroborates literature frameworks in
333 supporting the concept of zone of optimal function (Hanin, 1997), which accounts for
334 individual patterns of anxiety-performance relationships. By individually defining an optimal
335 anxiety range, for instance based on the specificities of a given sporting activity, the zone of
336 optimal function theory acknowledges sporting circumstances where very high anxiety is
337 required to achieve peak performance (Raglin, 1991). This is overall congruent with the fact
338 that riders exhibited i) higher performance and ii) lower somatic anxiety and worry in the
339 context of BMX starts from the external position compared to the internal lane. Zabala et al.
340 (2009) underlined the importance of individualized interventions to improve technical
341 components. Present findings reveal a potentially deleterious effect of the internal lane on
342 performance, and provide scientific rationale for individualized interventions aiming at
343 limiting somatic anxiety and worry during BMX start.

344 In the present study, BMX rider's start performance and anxiety states across different
345 lanes were inferred using a contextualization paradigm. The findings might be applicable
346 beyond the context of BMX racing. We already mentioned that several closed/semi-closed
347 motor skills overlapped the model of handicap races where it would take the specific form of
348 positional advantages/disadvantages at the start. Noteworthy, transient situations in open
349 skills are also associated with comparable positional advantages/disadvantages. These precede
350 explosive efforts with the possibility of direct (i.e., physical) confrontations between the
351 competitors. For instance, in collective sports, game situations where an offensive player is
352 provided an opportunity to score – the defensive player being temporarily outplayed – are
353 frequent (e.g., soccer, handball). In such situations, the offensive player engages an explosive
354 effort (e.g., racing alone and converting a goal) with a positional advantage on the defensive

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355 player. It remains uncertain whether such scenarios result in parallel alterations of
356 anxiety/performance to those highlighted during the BMX gate start. This might nonetheless
357 represent a relevant perspective to the present findings.

358 Future experiments should seek for direct investigation in actual competitive contexts.
359 Caution should be exercised before generalizing the findings due to our small and
360 homogeneous sample (i.e., BMX riders of national level, 10-12 hours of BMX training per
361 week, 4-6 hours of strength conditioning per week). Further research should also
362 comprehensively examine the relationship between riders' psychological state and their
363 performance within a larger sample of athletes from different levels of age/expertise. Other
364 constructs (i.e., stress appraisals, coping strategies) not included in the present study should
365 also be considered. From an appraisal theory perspective, cognitive appraisals of stress
366 (threat, challenge and loss), coping strategies, and state anxiety have been conceptualized as
367 core psychological processes to explain within-person variations in performance because they
368 allow athletes to continuously adjust to ever-changing contextual demands (Doron &
369 Martinent, 2016; Lazarus, 2000). As a result, it would be fruitful to test whether: i) the
370 influence of stress appraisal on riders' BMX start performance could be mediated by their
371 state anxiety experienced in the start gate; and ii) the influence of state anxiety on riders'
372 BMX start performance could be mediated by different types of coping strategies.

373 Despite these limitations, our investigation provides meaningful insights on the
374 influence of the psychological state on the BMX start performance. Although past research
375 has predominantly focused on biomechanical factors involved in start performance of high-
376 level riders (Cowell et al., 2011; Herman et al., 2009), the present study underlines that state
377 anxiety should be considered a relevant factor.

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GATE START IN BMX, PERFORMANCE AND ANXIETY

379 5. References

380 Bar-Or, O. (1987). The Wingate Anaerobic Test An Update on Methodology,
381 Reliability and Validity. *Sports Medicine*, 4(6), 381-394. doi: 10.2165/00007256-198704060-
382 00001

383 Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). lme4: Linear mixed-effects
384 models using Eigen and S4. R package version 1.0-6. [http://CRAN.R-](http://CRAN.R-project.org/package=lme4)
385 [project.org/package=lme4](http://CRAN.R-project.org/package=lme4)

386 Cerin, E., Szabo, A., Hunt, N., & Williams, C. (2000). Temporal patterning of
387 competitive emotions: A critical review. *Journal of Sports Sciences*, 18(8), 605-626. doi:
388 10.1080/02640410050082314

389 Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective
390 scale development. *Psychological assessment*, 7(3), 309

391 Collet, C. (1999). Strategic aspects of reaction time in world-class sprinters. *Percept*
392 *Mot Skills*, 88(1), 65-75

393 Cowell, J. F., Cronin, J. B., & McGuigan, M. R. (2011). Time motion analysis of
394 supercross BMX racing. *Journal of sports science & medicine*, 10(2), 420-421

395 Debraux, P., & Bertucci, W. (2011). Determining factors of the sprint performance in
396 high-level BMX riders. *Computer Methods in Biomechanics and Biomedical Engineering*,
397 14(sup1), 53-55. doi: 10.1080/10255842.2011.591638

398 Doron, J., & Martinent, G. (2016). Trajectories of psychological states of women elite
399 fencers during the final stages of international matches. *J Sports Sci*, 34(9), 836-842. doi:
400 10.1080/02640414.2015.1075056

GATE START IN BMX, PERFORMANCE AND ANXIETY

401 Englert, C., & Bertrams, A. (2014). The effect of ego depletion on sprint start reaction
402 time. *Journal of Sport & Exercise Psychology*, 36(5), 506-515

403 Guillot, A., & Collet, C. (2008). Construction of the Motor Imagery Integrative Model
404 in Sport: a review and theoretical investigation of motor imagery use. *Int Rev Sport Exerc*
405 *Psychol*, 1(1), 31-44

406 Guillot, A., Collet, C., & Dittmar, A. (2005). Influence of environmental context on
407 motor imagery quality. *Biol Sport*, 22, 215-226

408 Hall, C. R., Munroe-Chandler, K. J., Cumming, J., Law, B., Ramsey, R., & Murphy,
409 L. (2009). Imagery and observational learning use and their relationship to sport confidence. *J*
410 *Sports Sci*, 27(4), 327-337. doi: 10.1080/02640410802549769

411 Hanin, Y. L. (1997). Emotions and athletic performance: Individual zones of optimal
412 functioning model. *European yearbook of sport psychology*, 1, 29-72

413 Hanton, S., Neil, R., & Mellalieu, S. D. (2008). Recent developments in competitive
414 anxiety direction and competition stress research. *International Review of Sport and Exercise*
415 *Psychology*, 1(1), 45-57. doi: 10.1080/17509840701827445

416 Herman, C., McGregor, S., Allen, H., & Bollt, E. (2009). Power capabilities of elite
417 bicycle motocross (BMX) racers during field testing in preparation for 2008 Olympics.
418 *Medicine & Science in Sports & Exercise*, 41(5), 306

419 Hodgkins, T., Slyter, M., Adams, K., Berning, J., & Warner, S. (2001). A comparison
420 of anaerobic power and ranking among professional bmx racers. *Medicine & Science in*
421 *Sports & Exercise*, 33(5), S246

GATE START IN BMX, PERFORMANCE AND ANXIETY

422 Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scand J Stat*,
423 6, 65-70. doi: 10.2307/4615733

424 Ille, A., Selin, I., Do, M. C., & Thon, B. (2013). Attentional focus effects on sprint
425 start performance as a function of skill level. *J Sports Sci*, 31(15), 1705-1712. doi:
426 10.1080/02640414.2013.797097

427 Jeannerod, M. (1994). The representing brain: neural correlates of motor intention and
428 imagery. *Behav Brain Sci*, 17(02), 187-202. doi: 10.1017/S0140525X00034026

429 Lazarus, R. S. (2000). How emotions influence performance in competitive sports.
430 *Sport Psychol*

431 Martinent, G., & Decret, J.-C. (2016). Coping profiles of young athletes in their
432 everyday life: A three-wave two-month Study. *European Journal of Sport Science*, (in press).
433 doi: doi: 10.1080/17461391.2015.1051131

434 Martinent, G., & Ferrand, C. (2007). A cluster analysis of precompetitive anxiety:
435 relationship with perfectionism and trait anxiety. *Personality and Individual Differences*, 43,
436 1676-1686

437 Martinent, G., & Ferrand, C. (2015). A Field Study of Discrete Emotions: Athletes'
438 Cognitive Appraisals During Competition. *Res Q Exerc Sport*, 86(1), 51-62

439 Martinent, G., Ferrand, C., Guillet, E., & Gauthier, S. (2010). Validation of the
440 French version of the Competitive State Anxiety Inventory-2 Revised (CSAI-2R) including
441 frequency and direction scales. *Psychology of Sport and Exercise*, 11(1), 51-57. doi:
442 <http://dx.doi.org/10.1016/j.psychsport.2009.05.001>

GATE START IN BMX, PERFORMANCE AND ANXIETY

443 Munzert, J., & Lorey, B. (2013). Motor and visual imagery in sports *Multisensory*
444 *imagery* (pp. 319-341): Springer.

445 Neil, R., Hanton, S., Mellalieu, S. D., & Fletcher, D. (2011). Competition stress and
446 emotions in sport performers: The role of further appraisals. *Psychology of Sport and*
447 *Exercise, 12*(4), 460-470

448 Nicholls, A. R., & Polman, R. C. J. (2007). Coping in sport: A systematic review.
449 *Journal of Sports Sciences, 25*, 11-31

450 Nicolas, M., Vacher, P., Martinent, G., & Mourot, L. (in press). Monitoring stress and
451 recovery states: Structural and external stages of the short version of the RESTQ Sport in elite
452 swimmers before championships. *Journal of Sport and Health Science*

453 R Core Team. (2015). R: A language and environment for statistical computing.
454 Vienna, Austria: R Foundation for Statistical Computing. Retrieved from [http://www.R-](http://www.R-project.org/)
455 [project.org/](http://www.R-project.org/).

456 Raglin, J. S. (1991). Anxiety and sport performance. *Exerc Sport Sci Rev, 20*, 243-274

457 Rylands, L., & Roberts, S. J. (2014). Relationship between starting and finishing
458 position in World Cup BMX racing. *International Journal of Performance Analysis in Sport,*
459 *14*(1), 14-23

460 Sagar, S. S., Lavallee, D., & Spray, C. M. (2007). Why young elite athletes fear
461 failure: Consequences of failure. *J Sports Sci, 25*(11), 1171-1184. doi:
462 10.1080/02640410601040093

GATE START IN BMX, PERFORMANCE AND ANXIETY

463 Schmidt, R. A., & Gordon, G. B. (1977). Errors in Motor Responding, "Rapid"
464 Corrections, and False Anticipations. *J Mot Behav*, 9(2), 101-111. doi:
465 10.1080/00222895.1977.10735099

466 Slyter, M., Pinkham, K., Adams, K., Durham, M., Moss, C., & Wenger, T. (2001).
467 *Comparison of lower body power output between expert and professional bicycle motocross*
468 *racers*. University of Louisville.

469 Smith, R. E. (2014). Performance anxiety, cognitive interference, and concentration
470 enhancement strategies in sports. In I. G. Sarason, G. N. Pierce & B. R. Sarason (Eds.),
471 *Cognitive interference: theories, methods, and findings* (pp. 261-284): Lawrence Erlbaum
472 Associates, Inc.

473 Smith, R. E., Cumming, S. P., & Smoll, F. L. (2006). Factorial integrity of the sport
474 anxiety scale: a methodological note and revised scoring recommendations. *J Sport Exerc*
475 *Psychol*, 28, 109-112

476 Smith, R. E., Smoll, F. L., & Schutz, R. W. (1990). Measurement and correlates of
477 sport-specific cognitive and somatic trait anxiety: The sport anxiety scale. *Anxiety Research*,
478 2(4), 263-280. doi: 10.1080/08917779008248733

479 Turner, M., & Barker, J. B. (2013). Examining the efficacy of rational-emotive
480 behavior therapy (REBT) on irrational beliefs and anxiety in elite youth cricketers. *J Appl*
481 *Sport Psych*, 25(1), 131-147

482 Williams, S. E., Cumming, J., Ntoumanis, N., Nordin-Bates, S. M., Ramsey, R., &
483 Hall, C. (2012). Further validation and development of the movement imagery questionnaire.
484 *J Sport Exerc Psychol*, 34(5), 621-646

GATE START IN BMX, PERFORMANCE AND ANXIETY

485 Williams, S. E., Guillot, A., Di Rienzo, F., & Cumming, J. (2015). Comparing self-
486 report and mental chronometry measures of motor imagery ability. *Eur J Sport Sci*, 1-9. doi:
487 10.1080/17461391.2015.1051133

488 Winter, B. (2013). Linear models and linear mixed effects models in R with linguistic
489 applications. *arXiv:1308.5499*. [<http://arxiv.org/pdf/1308.5499.pdf>]

490 Xu, R. (2003). Measuring explained variation in linear mixed effects models. *Statistics*
491 *in Medicine*, 22(22), 3527-3541. doi: 10.1002/sim.1572

492 Zabala, M., Sánchez-Muñoz, C., & Mateo, M. (2009). Effects of the administration of
493 feedback on performance of the BMX cycling gate start. *Journal of Sports Science &*
494 *Medicine*, 8(3), 393

495

496

497