

TITLE

Effects of Anxiety on Anticipation and Visual Search in Dynamic, Time-Constrained Situations

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Abstract

We tested the predictions of Attentional Control Theory (ACT) by examining how anxiety affects visual search strategies, performance efficiency and performance effectiveness using a dynamic, temporal-constrained anticipation task. Higher and lower skilled players viewed soccer situations under two task constraints (near vs. far situation) and were tested under high (HA) and low (LA) anxiety conditions. Response accuracy (effectiveness) and response time, perceived mental effort and eye-movements (all efficiency) were recorded. A significant increase in anxiety was evidenced by higher state anxiety ratings on the MRF-L scale. Increased anxiety led to decreased performance efficiency since response times and mental effort increased for both skill groups while response accuracy did not differ. Anxiety affected search strategies with higher skilled players showing a decrease in number of fixation locations for far situations under HA compared with LA condition when compared with lower skilled players. Findings provide support for ACT with anxiety impairing processing efficiency and, potentially, top-down attentional control across different task constraints.

Keywords: expert performance; soccer; attentional control; perceptual-cognitive skills.

32 **Effects of anxiety on anticipation and visual search in dynamic, time-constrained**
33 **situations**

34

35 Negative emotions such as anxiety can affect cognitive and motor performance
36 (Causar, Holmes, Hodges, & Williams, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007).
37 Cognitive anxiety (or worry) induces negative expectations and concerns about potential
38 consequences (Woodman & Hardy, 2001). Processing Efficiency Theory (PET; Eysenck &
39 Calvo, 1992) interprets anxiety as an aversive emotional state that occurs as a result of threat.
40 Eysenck and Calvo (1992) found that athlete's attention diverts away from primary task
41 processing towards irrelevant or distracting stimuli. First, from a PET perspective, anxiety
42 induces worrisome thoughts that threaten a goal, pre-empting storage in working memory
43 leading to a decreased availability of processing resources for the primary task (Wilson,
44 2008). As a result of increased anxiety, the task situation becomes a dual task, with
45 worrisome thoughts competing for attention (Wilson, 2008). Second, it is assumed that, to
46 minimize anxiety, motivation will be increased to maintain the quality of task performance or
47 *effectiveness* (i.e., response accuracy; Derakshan, Ansari, Hansard, Shoker & Eysenck, 2009).
48 Increased effort leads to a loss of *efficiency* because more resources are invested to maintain
49 the same quality of performance. Overall, it has been shown that effectiveness is less
50 impaired than processing efficiency (Eysenck & Derakshan, 2011).

51 The Attentional Control Theory (ACT; Eysenck et al., 2007) was developed from
52 PET and characterizes anxiety effects on performance more precisely, emphasizing the
53 importance of attention by determining control in a goal-driven (top-down) and a stimulus
54 driven (bottom-up) fashion. ACT relates to the two attentional systems identified by Corbetta
55 and Shulmann (2002) as the explanatory basis which often interact in their functioning. The
56 theory assumes that increased anxiety disrupts the balance between the two attentional

57 systems and leads to increased influences of the stimulus-driven attentional system at the
58 expense of the goal-directed attentional system. Anxious individuals have been found to
59 attend to threat-related stimuli (Eysenck et al., 2007) showing that attention will first be
60 allocated to detect the threat and then to identify a strategy on how to respond, leading to
61 longer response times for the task at hand (Janelle, Singer, & Williams, 1999). As threat-
62 related stimuli are processed first, the inhibition function of the goal-directed attentional
63 system (usually guided by expectations, knowledge, and current goals of the anxious person)
64 is less able to inhibit task unrelated stimuli (Eysenck et al., 2007). Moreover, the shifting
65 function which alters attention between multiple tasks/operations (Derakshan et al., 2009;
66 Eysenck et al., 2007) and allocates attention to task-relevant stimuli is impaired by anxiety
67 (Wilson, 2008). Anxiety leads to alterations in attentional processing with shifts occurring in
68 attentional orientation and gaze behavior while the efficiency of orientation (e.g., search rate)
69 is reduced (Janelle, 2002).

70 In applied settings, researchers have begun to show that anxiety affects perceptual-
71 cognitive abilities (Causer et al., 2011; Murray & Janelle, 2003; Williams, Vickers, &
72 Rodrigues, 2002). In some of these studies, behavioral measures including the recording of
73 gaze behaviors have identified higher search rates (Murray & Janelle, 2003; Williams et al.,
74 2002) or an inefficient use of the fovea (Williams & Elliot, 1999) with increasing levels of
75 anxiety. Williams et al. (2002) examined performance under anxiety in table tennis players
76 by using high and low working memory tasks where shot strategy either varied from trial to
77 trial (high demands) or could be held constant for a couple of trials (low demands). Longer
78 visual tracking of the ball was reported under the high compared with the low anxiety
79 condition. Since experts usually exhibit anticipatory saccades (e.g., towards the expected ball
80 bounce point) monitoring ball flight with peripheral and not foveal vision, the ability to
81 process information with peripheral vision seems to be impaired with anxiety resulting in less

82 efficient visual search (Williams & Elliot, 1999; Williams et al., 2002). Wilson, Wood, and
83 Vine (2009b) tested PET in penalty takers while exploring their visual search behaviors under
84 HA and LA conditions. The speed of fixating the goalkeeper and the absolute fixation
85 duration on this location increased in the HA condition. The authors argue that a higher
86 reliance on top-down strategies would be beneficial to prevent decrements in performance
87 efficiency. Similarly, Causer et al. (2011) tested shot gun shooters in a field setting under HA
88 and LA conditions and observed significantly higher mental effort ratings under the more
89 aversive anxiety condition (cf., Wilson, Smith, & Holmes, 2007). In their study, besides
90 efficiency reductions in the HA condition, performance effectiveness declined as well as
91 showing that the effects of anxiety on performance increases when overall task demands on
92 the central executive function (reflected by perceived effort) become higher. However, shot
93 gun shooting is not very interactive and anticipation of events is less difficult compared to,
94 for example, highly dynamic open-play situations in soccer.

95 For the examination of anxiety effects in open-play situations, it is important to create
96 experimental tasks and conditions representing situations usually found in the game (Mann,
97 Williams, Ward, & Janelle, 2007). In this regard, defensive players in soccer are typically
98 exposed to open-play situations with two different task constraints: a) situations where the
99 ball is in the other half of the field; and b) more time-constrained situations when the ball is
100 closer to the defender (Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007). In the case
101 of far situations, using a large field of view and being aware of movements of other players,
102 the player in possession of the ball and potential passing opportunities are important
103 considerations for the defender (Helsen & Pauwels, 1993, Williams, Davids, Burwitz, &
104 Williams, 2004). It has been shown that, especially expert players can be described as
105 “skilled scanners” because they show a more extensive visual search strategy compared to
106 less-skilled players (Helsen & Pauwels, 1992, p.381). In contrast, for near situations, soccer

107 defenders have to be aware of fewer information sources converting the previous 11 versus
108 11 situations into, for example, 3 versus 3 or 1 versus 1 situations (Vaeyens et al., 2007).
109 Under these constraints, experts typically show lower visual search rates and potentially use
110 peripheral vision to a greater extent (Williams & Davids, 1998). In this context, previous
111 research in expert hockey players has shown that visual search strategies differed as a
112 function of playing environments (Martell & Vickers, 2004). The different task constraints in
113 soccer are expected to lead to different perceptual-cognitive strategies including different
114 visual search strategies.

115 Roca, Ford, McRobert, and Williams (2013), examined how task-constraints influence
116 perceptual-cognitive strategies using video-based simulations involving 11 versus 11 soccer
117 sequences from a central defender's perspective where the ball was either far from the
118 defender in the other half of the pitch or near to the defender. The underlying processes and
119 interactions between various perceptual-cognitive skills (i.e., postural cue usage, pattern
120 recognition, and situational probabilities) were examined across skill groups. Skilled players
121 made more accurate anticipations and decisions than lower skilled players, with these
122 judgments being underpinned by differences in perceptual and cognitive processes that were
123 unique to the constraints of the task. For example, skilled players employed more fixations of
124 shorter duration towards more informative locations in the display (i.e., opponents/teammates
125 and free space) when viewing the far compared with near situations. In addition, the different
126 perceptual-cognitive skills were shown to interact and differ in importance as a function of
127 the task constraint. In the far situations, skilled players generated more thought processes
128 related to the recognition of patterns within evolving sequences of play, whereas in the near
129 situations more statements were made that referred to the postural orientation of
130 teammates/opponents, followed by expectations about the event outcomes.

131 To effectively use these different perceptual-cognitive skills it is necessary to balance
132 top-down and bottom-up processes in team ball sports since players interact with each other
133 and quick decisions have to be made in regards to which locations deserve attentional
134 priority. As soccer players are typically exposed to significant stressors including both
135 physical fatigue as well as emotions such as anxiety, it could be that these stressors affect the
136 perceptual processes underpinning anticipation. However, there remains a notable lack of
137 empirical research to evaluate whether attentional control in open-play situations is affected
138 by emotions such as anxiety when making appropriate anticipatory judgments. The direct
139 manipulation of task-specific constraints (e.g., position of the ball and players in the field of
140 play) presents, therefore, a valuable vehicle to examine whether anxiety affects the use of
141 different perceptual-cognitive skills across the unique constraints presented by the task.

142 Combining the empirical evidence about perceptual-cognitive skills in open-play
143 soccer situations and theoretical assumptions made by ACT, we expected that threat-related
144 stimuli are processed first and that the inhibition function of the goal-directed attentional
145 system (with expectations and knowledge) is less able to inhibit task unrelated stimuli
146 (Eysenck et al., 2007). As there is no direct opponent in laboratory settings, these threat-
147 related stimuli are most likely worrisome thoughts that compete for attention and need to be
148 inhibited. Most relevant in open-play situations, especially in situations including a high
149 number of players (e.g., 11 vs 11), is the shifting function to allocate attention to task-
150 relevant stimuli. From an ACT perspective, this function should be impaired by anxiety. As it
151 has previously been reported that an efficient visual search behavior in far situations is
152 characterized by *high* search rates, anxiety could impair the ability to shift attention between
153 locations. Thus, rather than increased search rates, anxiety could lead to attentional narrowing
154 with lower search rates and longer fixation durations. In this case, longer fixations would
155 make it harder to scan all areas of interest and, as a consequence, players could miss

156 important information which could affect successful decision making and lead to longer
157 response times. As these extensive visual search behaviors and the underlying cognitive
158 abilities (especially pattern recognition) are likely to be expertise-dependent, it seems
159 important to evaluate whether anxiety effects interact with skill level.

160 Consequently, in this paper, a novel attempt is made to examine whether anxiety
161 differentially impacts on the use of visual search strategies and different perceptual-cognitive
162 skills underpinning anticipation across different task constraints. We explore the efficacy of
163 ACT using a dynamic time-constrained soccer task with different perceptual task demands
164 including near and far situations, as per Roca et al. (2013) by introducing a low and a high
165 anxiety condition. First, we hypothesize classical expertise-driven differences with high
166 skilled players showing higher response accuracies and lower response times than the lower
167 skilled players. Second, replicating the findings of Roca et al. (2013), we predict that the
168 higher skilled group will show higher search rates in the far situations compared with near
169 situations, fixate on less locations in the near compared with far situations and differ in the
170 proportion of viewing time spent fixating different locations between the near and the far
171 situations. If these replications are successful, we can test the effects of anxiety on
172 performance efficiency and effectiveness based on ACT. Therefore, we predict longer
173 processing times and higher mental effort in the HA condition for both groups, and no effects
174 of anxiety on performance effectiveness (i.e., response accuracy) in the HA condition. Since
175 experts are characterized by an analytical visual search behavior in complex situations, a
176 decline in processing efficiency could be interpreted when a reduced search rate is observed
177 in the far situations. Since near and far situations seem to require different perceptual-
178 cognitive skills, we may find different anxiety effects between the two task constraints.

179

180

Method

181 **Participants**

182 Twenty-two male soccer players participated. Participants were assigned to the higher
183 skilled or lower skilled group based on their playing experience. The higher skilled players (n
184 = 11; M age = 18.55 years, SD = 2.8) were either recruited from the academy of a Premier
185 League club in England (n = 8) or were undergraduate students with playing experience at
186 county level or above (n = 3). Higher skilled players had been competing for an average of
187 4.9 years on their highest playing level which ranged from county level ($n=3$) or national
188 level ($n=4$) to international level ($n=4$). Their mean number of years of soccer experience was
189 7.18. Players in the lower skilled group (n = 11; M age = 22.91 years, SD = 4.51) had been
190 playing soccer either at recreational ($n=4$) or amateur level ($n=7$) for an average of 5.9 years.
191 Their mean number of years of soccer experience was 6.18. All players had playing
192 experience as a defender. All players reported normal or corrected to normal vision. The
193 study was conducted in accordance with the ethical guidelines of the lead university.

194 **Measures**

195 **The Mental Readiness Form-Likert (MRF-L).** The cognitive anxiety scale of the
196 MRF-L (Krane, 1994) was used to assess state anxiety. The one-dimensional scale (1 - 11)
197 was displayed on the screen after every fifth trial while participants had to rate their cognitive
198 anxiety by saying the number that matched their current thoughts ranging from calm (1) to
199 worried (11). The scale was validated by Krane (1994) and revealed intercorrelations for the
200 cognitive anxiety item between the MRF-L and the CSAI-2 (Martens, Burton, Vealey, Bump,
201 & Smith, 1990) of 0.58.

202 **The Rating Scale for Mental Effort (RSME).** Mental effort (RSME, Zijlstra, 1993),
203 which can be defined as the amount of processing resources invested in the task (Williams et
204 al., 2002), was assessed to compare invested effort in both anxiety conditions and across
205 tasks. It is a one-dimensional scale which requires participants to estimate the effort invested

206 in the task. The scale ranges from 0 to 150 with three verbal anchors corresponding to 0 (not
207 at all effortful), 75 (moderately effortful), and 150 (very effortful). The scale (0.88) provides
208 a valid and reliable measure of mental effort (Veltman & Gaillard, 1996). The scale was
209 displayed after participant's anticipatory response to each trial and participant's had to say
210 how much effort they invested in the previous task by saying a corresponding number.

211 **Response Accuracy.** Response accuracy was defined as whether or not the
212 participant correctly selected the next action of the player in possession of the ball at the
213 moment of video occlusion, such as he passed to a player X..., shot at goal, or continued
214 dribbling forward (Roca et al., 2011).

215 **Response Time.** Response time was defined as the time (in ms) between the point of
216 video occlusion and the onset of the verbal response (e.g. "pass to ...", "shot...", or
217 "dribble..."). The verbal response was recorded with the integrated microphone of the eye-
218 tracker. The number of frames between both events was multiplied by the duration of one
219 frame.

220 **Visual Search Behaviors.** Visual point-of-gaze was recorded using a mobile eye-
221 tracking system (Applied Science Laboratories, Bedford, MA, USA). The eye-tracker
222 consists of a video based monocular system that measures eye point-of-gaze with respect to a
223 head-mounted scene camera. The system measures the relative position of the pupil and
224 corneal reflection in relation to each other by using an infrared light source at a frame rate of
225 30 Hz. Moreover, a scene image is provided by the head-mounted camera. Both sources are
226 automatically linked and result in a computed point-of-gaze superimposed as a cursor onto
227 the scene image. The accuracy of the system is specified with $\pm 1^\circ$ visual angle, with a
228 precision of 1° in both horizontal and vertical direction. Before the start of every condition, a
229 five-point calibration grid was projected onto the screen and was used to adjust the eye-
230 tracker.

231 A fixation was defined as the time ($\geq 100\text{ms}$) the eye remained stationary within 1.5°
232 of movement tolerance (Ward, Williams, & Bennett, 2002). A new fixation location was
233 counted every time the point of fixation switched to another a priori defined location (i.e.,
234 player in possession [PiP], ball, opponent, teammate, free space; see also Roca et al., 2011,
235 2013). The mean number of fixations per trial, mean fixation duration (in ms), and the mean
236 number of fixation locations per trial were assessed. Furthermore, percentage viewing time
237 which referred to the total viewing time spent fixating upon each area of the display (Ward et
238 al., 2002) was also analyzed.

239 **Test film**

240 The test videos of 11 versus 11 defensive soccer situations were filmed from the first-
241 person perspective of a central defender using professional and semi-professional soccer
242 players. These stimuli were evaluated by three Union of European Football Associations
243 (UEFA) qualified soccer coaches and a number of these clips have been used in previous
244 published reports (for further details on the production of the video clips, see Roca et al.
245 2011, 2013). Each clip lasted about 5s and was occluded 120ms prior to the final action taken
246 by the player in possession of the ball. This action could be an attacking pass, a shot on goal
247 or the continuation of a dribble. The test film included a total of 24 offensive scenarios. An
248 additional five clips were included as practice trials for both conditions. The 24 test trials
249 were subdivided into equal numbers of far and near situations. The trial was counted as a far
250 situation if the scene ended in the opponents defensive half (i.e., far away from the
251 perspective of the defender), whereas when a trial ended in the opponents offensive half (i.e.,
252 near to the defender) the trial was identified as a near task. The order of far and near
253 situations was randomized beforehand and kept constant across participants. An additional
254 randomization of all clips was executed for the second condition. Those clips remained
255 constant across participants.

256 Procedure

257 Participants were informed in written form and signed the agreement to take part in
258 the study. After adjusting and calibrating the eye-tracking system, participants viewed each of
259 the action sequences in a standing position at a distance of 2.80 m from a large screen (2.90 x
260 1.30 m), subtending a visual field of 27°(h) x 13°(v). Participants viewed five practice trials
261 to familiarize themselves with the task procedure which required them to respond quickly and
262 accurately after the video occlusion by deciding on the next action of the player in possession
263 of the ball. They were instructed to say “pass to a player X...”, “shot” or “dribble”.

264 Participants were required to rate mental effort after every trial. After every fifth trial,
265 participants had to rate state anxiety using the Mental Readiness Form-Likert (MRF-L;
266 Krane, 1994). The quality of eye-tracker calibration was checked in advance of every trial by
267 comparing the superimposed gaze position with the position of the red dot indicating the
268 position of the ball at the start of each scene.

269 Conditions

270 A repeated-measures design was employed whereby each participant had to perform
271 under two counterbalanced conditions: a low (state) and a high (state) anxiety condition. In
272 the low anxiety condition (LA), participants were asked to anticipate the next action of the
273 player in possession quickly and accurately. To further increase the non-evaluative nature of
274 the task, the investigators told participants that their results would not be compared to others.
275 Feedback was not provided during or after the LA condition (see Williams et al., 2002).

276 In the high anxiety condition (HA), a competitive scenario was created by telling
277 participants that their results would be compared to other players. Moreover, it was
278 mentioned that results would be evaluated by the coach (cf., Causer et al., 2011; Williams &
279 Elliot, 1999; Wilson, Vine, & Wood, 2009a; Wilson et al., 2009b). To further increase
280 anxiety, *ego-threats* were induced by making players aware of the eye-tracking camera and

281 the HD video camera and emphasizing the importance of their results on the success of the
282 study (see also Williams & Elliot, 1999; Wilson et al., 2007). Furthermore, two types of *false*
283 *feedback* were used to increase anxiety. A high pitched auditory signal (frequency: 797 Hz;
284 musical note: G5; duration: 1.5 s), played with a stereo audio system with both speakers
285 behind the participant, together with a displayed green tick, indicated a correct response and a
286 low pitched auditory signal (frequency: 71 Hz; musical note: D2; duration: 1.5 s), together
287 with a displayed red “X”, indicated a wrong response. The decision for auditory signals is
288 based on results of Collier and Hubbard (2001) who found that high pitched tones are
289 associated with happiness and low pitch tones with unhappiness. The false feedback was
290 provided after the rating mental effort, so that mental effort was not based on the feedback,
291 but on the displayed soccer situation. The tone itself should then induce worrying thoughts
292 affecting the next situation, which started immediately after the tone. In the high anxiety
293 condition, the pattern of correct and wrong answers was kept constant for all participants.
294 During the 24 trials, the 12 most difficult trials were always followed by a low pitched signal.
295 Players were told beforehand that their results would be compared to those of other players.
296 After every fifth trial, a distribution was shown to the players indicating that their results
297 were below average (second type of false feedback, similarly used in Wilson et al., 2009a, b).
298 The difference between achieved results and the displayed average results was progressively
299 increased. After completing the second condition of the study, participants were debriefed
300 about the deception and the aim of the study was explained to them in detail.

301

302 **Data Analysis**

303 Eye-tracking data were analyzed using ‘ASL-results plus Gaze Map’. The software
304 automatically identified point-of-gaze with x- and y-coordinates and calculates the number of
305 fixations as well as the fixation duration (by identifying fixation onset and offset for each

306 fixation) for every trial. The aggregated data were then exported into a csv-file for each
307 participant and anxiety condition. The location of each detected fixation was assigned based
308 on fixation onset and offset values, using the automatically computed point-of-gaze in the
309 scene image in the Gazetracker software. All dependent variables were averaged for every
310 participant, anxiety condition and task constraints separately. Statistical analyses were
311 conducted with IBM SPSS Statistics 22. Two participants (one from each group) were
312 excluded from analysis of the visual search behavior due to a loss of point of fixation in the
313 HA condition in over 25% of the trials. In contrast to Roca et al. (2011, 2013), the visual
314 search behavior of all successfully recorded trials was examined for each of the 10
315 participants per group. Overall, less than 2% of the trials could not be analyzed in regards to
316 fixation location because the point of fixation could not be displayed.

317 Response accuracy, response time, and mental effort were statistically analyzed using
318 an anxiety condition (low/high) x task constraint (near/far) repeated measures ANOVA with
319 expertise as the between-group factor (higher-skilled/lower skilled). In regard to the variable
320 percentage viewing time, an additional fourth factor (fixation location) was included
321 (ANOVA: anxiety condition x task constraint x fixation location x group). Significant
322 interactions were evaluated using Bonferroni-corrected post-hoc tests. The effect sizes were
323 calculated using partial eta squared values (η_p^2). A significance level was set at $p < .05$ (*) for
324 all statistical analyses. High significance will be reported if $p < .01$ (**). As large effect sizes
325 ($f = 0.4$) were expected (based on Roca et al., 2013) and α was set to .05 ($\beta = .10$) A priori
326 calculations of optimal sample sizes (G*Power 3; see Faul, Erdfelder, Lang, & Buchner,
327 2009) indicated that a sample of 20 participants provided sufficient power.

328

329

Results

330 Anxiety Manipulation

331 A main effect for anxiety was observed, $F(1,20) = 13.13, p < .01, \eta_p^2 = .40$. Players
332 reported higher cognitive state anxiety in the HA ($M = 4.49, SD = 1.31$) compared to the LA
333 condition ($M = 3.17, SD = .87$). There was no group main effect, $F(1,20) = 1.98, p < .01, \eta_p^2$
334 $= .09$, and no interaction between group and anxiety, $F(1,20) = 0.0, p = .98, \eta_p^2 = .00$. The
335 time course of mean anxiety ratings per group is illustrated in Figure 1.

336

337

Insert Figure 1 about here

338

339 **Response Accuracy**

340 A significant main effect was observed for group, $F(1,20) = 23.93, p < .01, \eta_p^2 = .55$.
341 The higher skilled group recorded higher accuracy scores ($M = 70.46\%, SD = 9.91$) than the
342 lower skilled group ($M = 49.77\%, SD = 9.91$). There was no main effect for anxiety, $F(1,20)$
343 $= 0.06, p = .81, \eta_p^2 = .00$, and no main effect for task constraint, $F(1,20) = 0.06, p = .81, \eta_p^2$
344 $= .00$. None of the interactions reached significance (all $p > .29$). The average response
345 accuracies are presented in Table 1.

346 **Response Time**

347 The ANOVA indicated significant main effects for anxiety, $F(1,20) = 9.29, \eta_p^2 = .31,$
348 $p < .01$, task constraint, $F(1,20) = 31.30, p < .01, \eta_p^2 = .61$, and group, $F(1,20) = 11.32, p <$
349 $.01, \eta_p^2 = .36$. Participants took longer time to respond under HA compared with LA
350 conditions. Moreover, participants took longer to respond in the far situations compared with
351 the near situations. Furthermore, the main effect for group shows that higher skilled players
352 responded earlier than the lower skilled players. A Task Constraint x Group interaction was
353 observed, $F(1,20) = 12.05, \eta_p^2 = .38, p < .01$. The lower skilled group responded later for the
354 far situations compared with near situations ($p < .01$), while the higher skilled group did not
355 show significant differences in response time between the two task constraints ($p = .15$). All

356 other interactions were not significant (all $p > .20$). The average response times are presented
357 in Table 1.

358 **The Rating Scale of Mental Effort (RSME)**

359 The ANOVA revealed a significant main effect for anxiety, $F(1,20) = 13.77, p < .01,$
360 $\eta_p^2 = .41$, task constraint, $F(1,20) = 8.17, p < .05, \eta_p^2 = .29$, and group, $F(1,20) = 6.55, p <$
361 $.05, \eta_p^2 = .25$. Participants reported higher mental effort scores in the HA compared with the
362 LA condition and rated effort to be higher for far situations in comparison with near
363 situations. The higher skilled group reported lower mental effort than the lower skilled group.
364 A significant interaction for Anxiety x Task Constraint was observed, $F(1,20) = 7.33, p < .05,$
365 $\eta_p^2 = .27$. During the LA condition, players showed greater mental effort ratings for the far
366 situations as compared with near situations ($p < .01$), while mental effort increased in the HA
367 condition for the far and near situations without significant differences between the two task
368 constraints ($p = .29$). No other significant interaction could be observed (all $p > .14$). The
369 average RSME ratings are presented in Table 1.

370

371 Insert Table 1 about here

372

373 **Visual Search Behaviours**

374 **Visual search rate.** The ANOVA showed a significant main effect in mean number
375 of fixations per trial for task constraint, $F(1,18) = 33.22, p < .01, \eta_p^2 = .65$. Players employed
376 fewer fixations in the near ($M = 10.33, SD = 0.87$) compared with the far situations ($M =$
377 $11.40, SD = 1.02, p < .01$). No effects were found for mean fixation duration (all $p > .18$).
378 ANOVA for the mean number of fixation locations revealed significant main effects for
379 anxiety, $F(1,18) = 9.25, p < .01, \eta_p^2 = .34$; task constraint, $F(1,18) = 14.42, p < .01, \eta_p^2 = .45,$
380 and group, $F(1,18) = 10.40, p < .01, \eta_p^2 = .37$. The anxiety main effect shows that

381 participants fixated fewer locations in the HA ($M = 6.21$, $SD = 0.93$) compared with the LA
382 condition ($M = 6.93$, $SD = 0.79$), while the task constraint main effect indicated more fixated
383 locations in the far ($M = 11.40$, $SD = 1.02$) compared with the near situations ($M = 10.33$, SD
384 $= 0.87$). The main effect for group showed that lower skilled players fixated fewer locations
385 ($M = 5.78$, $SD = 1.10$) than the higher skilled players ($M = 7.36$, $SD = 1.10$). Significant two-
386 way interactions were found for Task Constraint x Group, $F(1,18) = 8.38$, $p < .05$, $\eta_p^2 = .32$,
387 and Anxiety x Task Constraint, $F(1,18) = 21.08$, $p < .01$, $\eta_p^2 = .54$. The first interaction
388 indicates that higher skilled players fixated more locations in the far situations ($M = 8.00$, SD
389 $= 1.00$) compared with lower skilled players ($M = 5.87$, $SD = 1.10$). The latter two-way
390 interaction shows that the number of fixated locations in the HA condition was higher in the
391 far situation ($M = 7.67$, $SD = 0.74$) compared with the near situation ($M = 6.19$, $SD = 0.92$, p
392 $< .01$) but no differences between task constraints in the LA condition ($p = .97$). However,
393 the reported main and interaction effects were superseded by a significant three-way
394 interaction for Anxiety x Task Constraint x Group, $F(1,18) = 7.37$, $p < .05$, $\eta_p^2 = .29$. Higher
395 skilled players fixated fewer locations in the far situations under the HA condition ($M = 6.69$,
396 $SD = 1.29$) compared with LA condition ($M = 9.16$, $SD = 1.05$; $p < .01$), whereas the lower
397 skilled players did not show this effect (LA_far: $M = 6.16$, $SD = 1.05$ vs. HA_far: $M = 5.57$,
398 $SD = 1.52$, $p = .19$). For the near situations neither the higher skilled ($p = .99$) nor the lower
399 skilled players ($p = .95$) differed between HA and LA condition in terms of the number of
400 fixated locations. These data are presented in Figure 2.

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Insert Figure 2 about here

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Percentage of viewing time. ANOVA revealed a significant main effect for fixation
location, $F(1,18) = 366.88$, $p < .01$, $\eta_p^2 = .95$. Participants spent significantly more time

406 fixating on the player in possession of the ball ($M = 51.09\%$, $SD = 4.40$) in comparison to any
407 other location. This effect was followed by viewing time being spent on the ball ($M =$
408 21.66% , $SD = 3.69$) and opponents ($M = 17.10\%$, $SD = 3.17$), respectively. Less time was
409 spent viewing teammates ($M = 5.05\%$, $SD = 1.00$) and free space ($M = 3.53\%$, $SD = 0.67$),
410 with these differing significantly from all other viewing locations. There was also a
411 significant Fixation Location x Group interaction effect, $F(1,18) = 18.53$, $p < .01$, $\eta_p^2 = .51$.
412 Post hoc testing showed that the higher skilled group spent more time fixating on the
413 opponents ($M = 21.70\%$, $SD = 4.48$), teammates ($M = 6.30\%$, $SD = 1.41$), and free space (M
414 $= 4.50\%$, $SD = 0.95$) compared to their lower skilled counterparts ($M = 12.50\%$, $SD = 4.48$;
415 $M = 3.78\%$, $SD = 1.41$ and $M = 2.55\%$, $SD = 0.95$, respectively; all $p < .01$). In contrast,
416 lower skilled players spent a higher proportion of time fixating on the ball ($M = 28.78\%$, SD
417 $= 5.22$) compared with skilled players ($M = 14.55\%$, $SD = 5.22$, $p < .01$).

418 A significant Fixation Location x Task Constraint interaction was observed, $F(1,18) =$
419 35.05 , $p < .01$, $\eta_p^2 = .66$. The ball was fixated more in the near ($M = 27.13\%$, $SD = 4.34$)
420 compared to the far situations ($M = 16.20\%$, $SD = 3.65$), while in the far situations the
421 locations of opponents ($M = 19.25\%$, $SD = 3.32$), teammates ($M = 6.65\%$, $SD = 1.63$), and
422 free space ($M = 5.13$, $SD = 1.31$) were viewed for longer than in the near situations ($M =$
423 14.95% , $SD = 3.67$; $M = 3.45\%$, $SD = 1.03$ and $M = 1.93\%$, $SD = 0.94$; all $p < .01$),
424 respectively. Moreover, the three-way interaction Fixation Location x Task Constraint x
425 Group was significant, $F(1,18) = 13.27$, $p < .01$, $\eta_p^2 = .78$. The higher skilled group showed
426 significant differences for all viewing areas between the two task constraints (all $p < .01$),
427 while the lower skilled group only showed significant differences for time spent viewing the
428 player in possession of the ball ($p = .01$) and ball ($p < .01$). All other main or interaction
429 effects failed to reach significance (all $p > .07$). The mean data for percentage viewing time
430 are presented in Figure 3.

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Insert Figure 3 about here

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Discussion

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We tested the predictions of ACT and examined the effects of anxiety on processing efficiency and effectiveness using multiple dependent-measures and realistic simulations of dynamic, time-constrained anticipation situations. It was assumed, based on ACT, that performance efficiency would decrease in the HA condition (i.e., higher response times and mental effort ratings) while performance effectiveness (i.e., response accuracy) would not differ between the anxiety conditions. A particularly novel aspect of this study was the manipulation of different task constraints (i.e., near vs. far situations). We hypothesized that anxiety would differentially impact on the perceptual-cognitive skills underpinning anticipation and that these effects could vary across different task constraints. Our prediction was based on previous published reports where differences in visual search behaviors have been reported across these two task constraints (see Roca et al., 2013; Vaeyens et al., 2007). Additionally, we expected to find expertise-based differences including faster response times and higher response accuracies for the higher skilled when compared with the lower skilled players (Mann et al., 2007; Roca et al., 2011, 2013).

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Anxiety was successfully increased with a combination of manipulations (i.e., ego threats, competitive environment, and false feedback) leading to higher ratings of anxiety across conditions. Moreover, the inclusion of false feedback had a particularly pronounced effect on anxiety levels. The MRF-L ratings (Figure 1) suggest that anxiety increased when participants dropped behind illustrated average results (i.e., performance accuracies) of players tested in former studies (false feedback manipulation). The absolute anxiety ratings are low, but comparable with those reported by Cocks, Jackson, Bishop, and Williams (2015)

456 and Wilson et al. (2007), especially, in case of the Wilson study, for their low trait-anxious
457 individuals. It could be the case that participants in our study showed higher levels of state
458 anxiety but are more likely to have lower trait anxiety. Although other studies have used the
459 same anxiety-inducing manipulations, there is clearly a difference to environments normally
460 experienced in the game (e.g., crowd, other players, different kinds of time pressure) which
461 would be hard to recreate under controlled laboratory settings.

462 The predictions of ACT are confirmed since performance accuracy (effectiveness) did
463 not differ between HA and LA conditions across participants while response times and
464 mental effort increased for the HA condition indicating a decrease in processing efficiency.
465 Findings for the effect of anxiety on mental effort support previous work (e.g., Causer et al.,
466 2011; Wilson et al., 2009a, b) and provide further evidence to highlight the moderating role
467 of effort under HA conditions (Wilson, Smith, Chattington, Ford, & Marple-Horvat, 2006).
468 The effort compensating process seems to be necessary to prevent performance dropping
469 below a certain level (Zijlstra, 1993), while increasing motivation to cope with the task
470 (Wilson et al., 2009b). Just as in other sporting domains (Causer et al., 2011; Murray &
471 Janelle, 2003) performance accuracy did not differ between anxiety conditions emphasizing
472 the role of mental effort in dynamic, temporally-constrained anticipation tasks. Since anxiety
473 leads to an allocation of attention to threat-related stimuli (Eysenck et al., 2007), the response
474 times show that it takes participants longer to identify a strategy on how to respond to the
475 task at hand. Skill-based differences for response time and mental effort were observed with
476 lower skilled players reporting longer response times and higher mental effort ratings than the
477 higher skilled group. These results could be explained by the higher skilled players more
478 refined domain-specific perceptual and cognitive skills (Mann et al., 2007; Ward & Williams,
479 2003).

480 The visual search behaviors differed between the two groups as a function of task
481 constraints and levels of anxiety. As expected, higher skilled players employed a greater
482 number of fixations towards more informative locations (i.e., opponents/teammates and free
483 space) when viewing the far compared to the near task condition (Roca et al., 2013). The
484 higher search rates seem to be beneficial in 11 versus 11 situations (Helsen & Pauwels, 1992;
485 Roca et al., 2011, 2013; Williams et al., 1994), especially when the ball is far away from the
486 defender (Roca et al., 2013). It has been assumed by Williams (2000) that in complex
487 defensive situations with less time pressure on defenders there might be time to use a more
488 extensive visual search to analyze the displayed situation. This more exhaustive strategy
489 allows players to be aware of a number of sources of information (e.g., location of ball, own
490 position, and/or movements of attacking players and teammates) and, potentially, facilitates
491 pattern recognition (Roca et al., 2013).

492 In regards to the effects of anxiety, researchers have reported changes in the efficiency
493 of gaze behaviors with increasing levels of anxiety (Janelle, 2002; Murray & Janelle, 2003;
494 Williams & Elliot, 1999; Williams et al., 2002). In our study, anxiety was observed to affect
495 visual search as a function of the task constraints for the higher skilled group when making
496 anticipation judgments. In the far situations, a high visual search rate and the use of foveal
497 vision would be beneficial since detailed information is required and foveal vision has,
498 compared to peripheral vision, a higher resolution making an analytical search behavior
499 appropriate. The reduced number of fixated locations could, therefore, be interpreted as
500 inefficient use of the fovea under HA conditions (Williams & Elliot, 1999). In particular,
501 higher skilled players showed a significant decrease in number of fixation locations for the
502 far situations under the HA as compared to the LA condition. These findings provide support
503 for previous research (e.g., Williams et al., 2002; Wilson et al., 2009b) in which longer visual
504 fixations on specific locations in the display were found under HA compared with LA

505 conditions. From an ACT perspective, one explanation for fixating fewer locations when
506 anxious could be the difficulty in shifting attention between locations. It could be the case
507 that the shifting function is impaired by worrying thoughts (Derakshan et al., 2009). Besides
508 the impaired shifting function, the inhibition of worrying thoughts could be reduced in the
509 HA condition (Derakshan et al., 2009), leading to a less efficient visual search behaviors
510 during dynamic temporal-constrained situations, resulting in longer response times and
511 higher mental effort. However, as performance effectiveness did not change, the ACT
512 prediction of reduced processing efficiency with constant effectiveness is supported. In the
513 lower skilled group, the data suggest that top-down and bottom-up processes would still be in
514 balance. Since Roca et al. (2013) reported that less skilled players employ less cognitive
515 statements and these memory representations are assumed to guide the visual search behavior
516 (Roca et al., 2011, 2013), it could be the case that lower skilled players generally rely more
517 on the stimulus-driven attentional system, making worrying thoughts less influential and the
518 visual search behavior more robust.

519 Although we did not directly measure different perceptual-cognitive skills (i.e.,
520 postural cue usage, pattern recognition, and situational probabilities) in this study (as per
521 Roca et al., 2013), it could be suggested, based on the results, that anxiety appears to impact
522 upon the use of these skills across different task constraints. Under HA the higher skilled
523 players shifted attentional control from broad (i.e., more fixations and towards more disparate
524 areas of the display) to narrow (i.e., less fixations and mainly towards the player in
525 possession of the ball and the ball itself) in the far situations. Thus, greater levels of anxiety
526 appear to have had a negative effect on higher level cognitive function, particularly in
527 relation to the ability to recognize familiarity and structure in the evolving patterns of play
528 across task constraints. This latter finding is important since the differential effect of anxiety
529 on how the various perceptual-cognitive skills interact has recently been documented in the

530 literature in a study by Cocks et al. (2015). The underlying assumption is that a number of
531 different and/or additional constraints affect how influential different perceptual-cognitive
532 skills are at any given moment when making anticipation judgments.

533 There are some limitations in the current study that should be acknowledged. First, a
534 larger sample size should be used to reliably examine interaction effects between anxiety,
535 task constraints and expertise. Although expert players are sometimes hard to access, future
536 researchers should try to increase the number of participants to ensure adequate statistical
537 power. Furthermore, perceptual-cognitive skills such as postural cue usage, pattern
538 recognition, and situational probabilities need to be further tested under HA and LA
539 conditions to verify the potential explanations of observed anxiety effects in this study.
540 Moreover, it is advised to first, identify stressors experienced in real game situations for the
541 individual and then manipulate these stressors in controlled laboratory settings to further
542 increase anxiety effects.

543 In sum, anxiety effects on processing effectiveness and processing efficiency were
544 examined for higher skilled and lower skilled soccer players using complex 11 versus 11
545 soccer situations with varying (perceptual) task demands in near and far situations. The
546 predictions of ACT were supported for both groups since performance effectiveness did not
547 differ across LA and HA conditions while performance efficiency was decreased for both
548 groups in the HA condition only. The latter finding was apparently based on higher ratings of
549 mental effort and longer response times. The results reveal expertise differences in regard to
550 anxiety effects since the number of fixated locations decreased in the higher skilled group for
551 the far situations. Since experts have superior pattern recognition abilities than less
552 experienced players, it is suggested that attentional processes are particularly impaired by
553 anxiety. Our data provide support for ACT predictions using a novel highly dynamic
554 temporal-constrained task with implications for theory and practice across domains.

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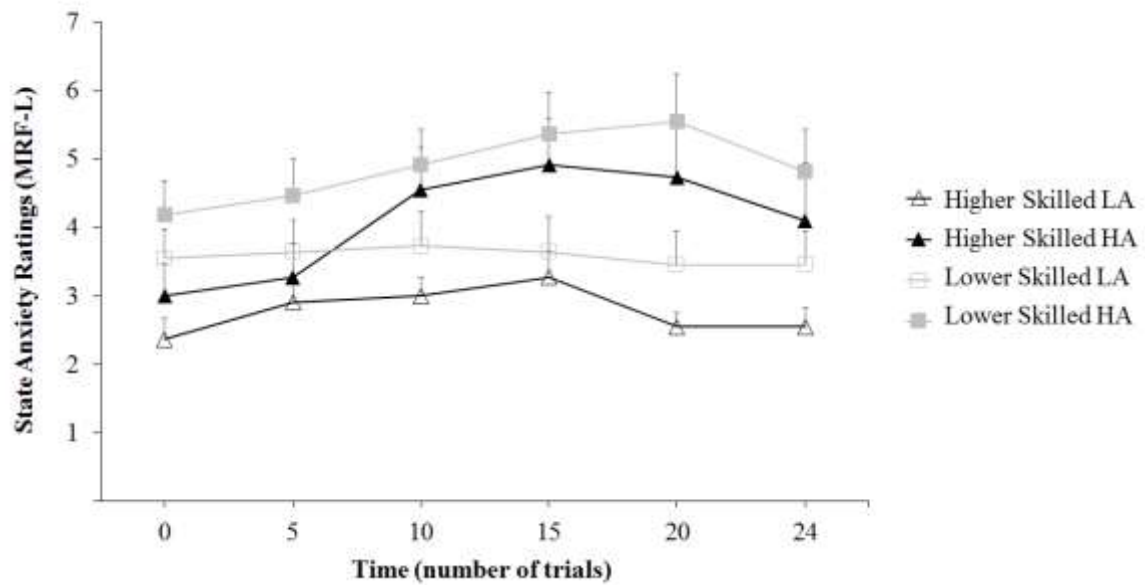
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649 **Figure 1**

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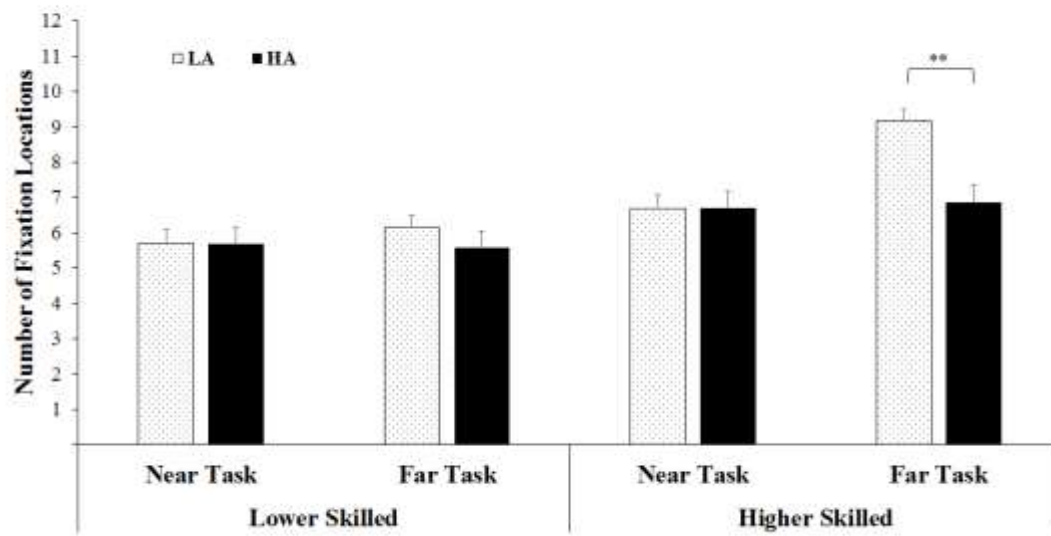


651

652 *Figure 1.* State of anxiety ratings (M and SE) across test trials per group in low (LA) and high

653 (HA) anxiety conditions.

654

655 **Figure 2**

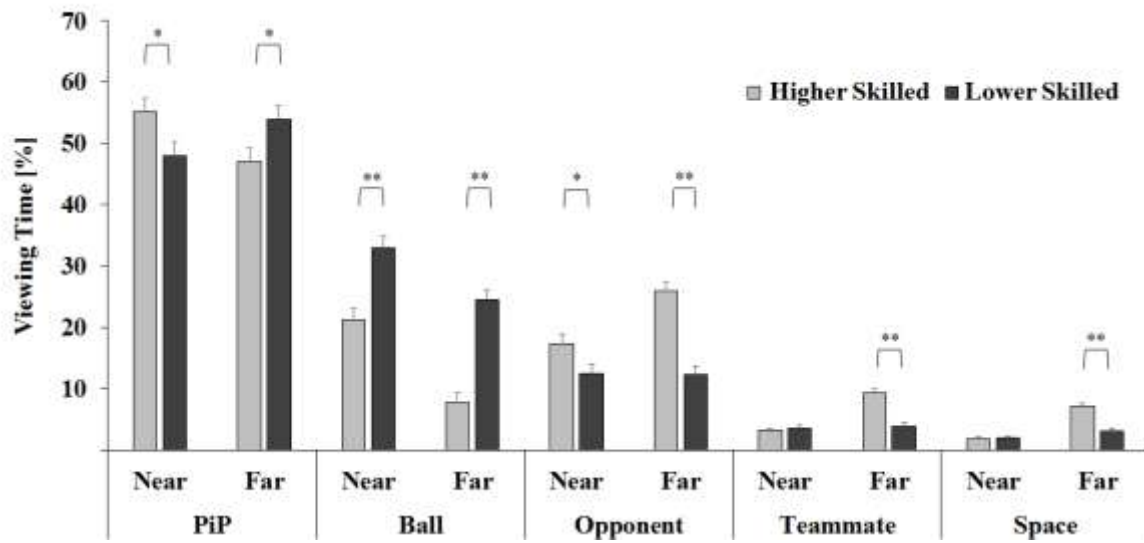
656

657 *Figure 2.* Number of fixation locations (*M* and *SE*) per group and task constraint in low (LA)658 and high (HA) anxiety conditions. $**p < .01$

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660

661 **Figure 3**



662

663 *Figure 3.* Percentage time (*M* and *SE*) spent viewing each location across task constraint for

664 higher skilled and lower skilled players. (*PiP*, player in possession of the ball) * $p < .05$, ** p

665 $< .01$

666

667 **Table 1**

668 Table 1. Group response accuracy, response time and mental effort ratings (*M* and *SE*) across task
 669 constraints and anxiety conditions

670

Group	Anxiety Condition	Task Constraint	Response Accuracy (%)	Response Times (ms)	Mental Effort
Higher Skilled	HA	near	68 (5)	1505 (253)	41 (4)
		far	74 (2)	1602 (236)	40 (4)
	LA	near	69 (5)	1155 (139)	33 (5)
		far	70 (1)	1388 (139)	37 (5)
Lower Skilled	HA	near	50 (3)	2232 (250)	56 (6)
		far	48 (4)	3027 (266)	60 (4)
	LA	near	50 (5)	1858 (230)	49 (6)
		far	49 (5)	2473 (309)	55 (5)

671