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Metacognitive processes and attentional focus in recreational endurance runners

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23 **Abstract**

24 This study examined the metacognitive processes and attentional focus of recreational
25 endurance runners. The emphasis was on understanding the metacognitive processes
26 important to acquire, develop, and refine cognitive strategies in novice endurance exercise
27 participants. The potential impact of metacognitive processes and cognitive strategies on
28 longer-term endurance activity adherence was also of interest. To meet these aims, ten
29 recreational runners were interviewed to retrospectively explore metacognitive processes and
30 attentional focus during running. Data were analysed using deductive and inductive content
31 analyses. The data revealed that runners engaged in a relatively limited array of
32 metacognitive skills and may not possess a detailed knowledge of task-specific attentional
33 strategies to regulate cognition. Few runners engaged in metacognitive planning or reviewing
34 by themselves, for example. Cognitive strategies were developed with experience, however,
35 and often as a consequence of unpleasant, effort-related sensory experiences. Other, more
36 experienced runners were also influential sources for cognitive strategy acquisition. These
37 findings are novel within an endurance activity context. Based on our interpretation of the
38 findings, we propose that interventions to enhance metacognitive abilities and assist novice
39 endurance participants to acquire, develop, and refine task-appropriate cognitive strategies,
40 may be important to longer-term endurance activity adherence.

41

42 **Keywords:** metacognition; cognitive strategies; self-regulation; endurance activity; exercise
43 adherence

44

45 **Introduction**

46 Attentional focus during endurance activity has been of research interest since Morgan and
47 Pollock (1977) first interviewed world-class and non-elite distance runners. Their findings
48 implied that world-class runners predominantly used associative strategies; selectively
49 attending to bodily sensations and using this information to adjust pacing and keep relaxed.
50 In contrast, non-elite runners reported more frequent dissociation, or distraction, to direct
51 attention away from effort sensations (Morgan & Pollock, 1977). Subsequent research has
52 supported the contrasting attentional foci of experienced athletes and less experienced or
53 lower performing participants. Baker, Côté, and Deakin (2005) reported that expert triathletes
54 engaged comparatively more performance-relevant cognitions (e.g. planning transitions,
55 tracking competitors) than mid-pack athletes, whereas back-of-the pack triathletes engaged
56 more task-irrelevant cognitions. More recently, Boya et al. (2017) suggested that expert
57 cyclists focused primarily on speed data to regulate performance during a simulated 16.1 km
58 time-trial. In contrast, novice performers focused more on distance information. The findings
59 indicated a preference for performance-related decision-making among experts, whereas
60 novices may be more concerned with task completion.

61 As these studies indicate, the impact of attentional focus on acute aspects of
62 endurance *performance* has been the primary interest in this domain. Outcomes have
63 included time to completion (e.g. Connolly & Janelle, 2003), physiological variables such as
64 movement economy (e.g. Schücker, Schmeing, & Hagemann, 2016), and subjective
65 responses such as perception of effort (e.g. Stanley, Pargman, & Tenenbaum, 2007). To
66 provide greater clarity on the performance effects of various foci, Brick, MacIntyre, and
67 Campbell (2014) reconceptualised traditionally associative and dissociative cognitions into
68 five attentional categories. Accordingly, associative cognitions were categorised as either
69 *internal sensory monitoring* (e.g. breathing, muscle fatigue), *outward monitoring* (e.g. split-

70 times, distance information), or *active self-regulation* (e.g. pacing, movement technique,
71 cadence, relaxing). Brick and colleagues concluded that active self-regulatory thoughts
72 optimised pace (e.g. when focused on cadence) or improved movement economy (e.g. when
73 relaxing) without necessarily increasing effort perception. In contrast, excessive internal
74 sensory monitoring tended to decrease pace and/or increase perceived effort. Furthermore,
75 Brick et al. (2014) categorised dissociative cognitions as *active distraction* (e.g. conversing)
76 or *involuntary distraction* (e.g. daydreaming). Collectively, distractive cognitions tended to
77 reduce pace and effort perceptions, and elevated affective states such as enjoyment or mood
78 (e.g. Connolly & Janelle, 2003; LaCaille, Masters, & Heath, 2004).

79 A related area that has gained less research impetus is how attentional focus might
80 impact on longer-term exercise adherence. This may be important given that existing
81 behaviour change techniques have a small effect (Hedges' $g = 0.25$) on long-term physical
82 activity (PA) behaviour (Samdal, Eide, Barth, Williams, & Meland, 2017). Specifically,
83 perception of effort is considered an inverse correlate of PA (Bauman et al., 2012) and a
84 source of exercise-induced displeasure and avoidance (Ekkekakis, Vazou, Bixby, &
85 Georgiadis, 2015). Given that one's focus of attention can alter effort perception and
86 affective responses during endurance activity (Brick et al., 2014), it is surprising that only
87 Martin et al. (1984) and Welsh, Labbé, and Delaney (1991) have investigated the longer-term
88 impact of attentional focus on PA behaviour. Intriguingly, Martin et al. (1984) revealed that
89 participants instructed to dissociate (actively distract), or "attend to the environment and
90 other pleasant and distractive stimuli...rather than the ordinary discomfort of exercise" (p.
91 805) had greater attendance (76.6%) during a 12-week aerobic programme than a group
92 instructed to attend to bodily sensations (58.7% attendance). In contrast, Welsh et al. (1991)
93 noted no difference in exercise compliance between a positive self-statement and distraction
94 group, and a no-instruction group during a six-week jogging programme.

95 The findings of Martin et al. (1984) suggest that distractive strategies may be
96 important for endurance activity adherence. However, that study was limited by the absence
97 of a no-intervention control. Furthermore, given the relatively short duration of both studies,
98 the impact of active self-regulatory strategies on longer-term activity adherence remains
99 unknown. This is important considering that distractive cognitions may be less effective at
100 higher exercise intensities (Tenenbaum & Connolly, 2008) and self-regulatory strategies can
101 reduce perception of effort during endurance tasks (Brick et al., 2014). As such, knowledge
102 of the cognitive strategies implemented by recreational exercisers may provide additional
103 insights to understand longer-term PA behaviour. Given the paucity of research in this area,
104 the present study aims to fill this gap and determine the attentional focus of less experienced,
105 recreational endurance exercisers who have successfully maintained their activity over a
106 sustained period of time (e.g. 12 months).

107 In addition to knowledge of endurance participants' attentional focus, how individuals
108 acquire, develop, and refine their cognitive strategies is also of interest. Recently, Brick,
109 MacIntyre, and Campbell (2015) highlighted the importance of metacognitive processes for
110 attentional focus and cognitive control during endurance performance. Metacognition is
111 considered a model of cognition and basic components include *metacognitive knowledge* (e.g.
112 knowledge of cognitive strategies to use and conditional knowledge of when to use them) and
113 *metacognitive skills*, such as planning, monitoring, or reviewing one's cognitions (Flavell,
114 1979; Martini & Shore, 2008). Metacognitive skills represent the control function of
115 metacognition and the ability to implement strategies during a task (Efklides, 2014). Finally,
116 *metacognitive experiences* facilitate monitoring of cognitive processes and include implicit or
117 explicit metacognitive feelings (e.g. feelings of task difficulty) and explicit metacognitive
118 judgements and estimates (e.g. estimating the correctness of a solution) (Efklides, 2014).
119 Metacognition is considered fundamental to effective self-regulation, or the ability to

120 successfully control one's thoughts and actions in accordance with the demands of a task
121 (Dinsmore, Alexander, & Loughlin, 2008; Efklides, 2014). Relevant to the present
122 discussion, Brick et al. (2015) proposed a metacognitive framework of attentional focus and
123 cognitive control during endurance activity. Based on interview data with elite endurance
124 runners, the findings suggested that elite athletes monitored and controlled their cognition
125 during running to optimise performance. Important processes included metacognitive
126 planning of attentional strategies, monitoring task performance and controlling cognition
127 during running, and reviewing, evaluating, and refining their cognitions after running (Brick
128 et al., 2015).

129 As with cognitive strategies, however, ability-related differences in metacognition
130 also exist (e.g. MacIntyre, Igou, Campbell, Moran, & Matthews, 2014). Martini and Shore
131 (2008) highlighted differences in the use of metacognition in both academic and psychomotor
132 tasks and suggested higher-level performers tended to use more planning strategies and
133 monitored and evaluated their performance more accurately. In contrast, inexperienced
134 performers tended not to plan, monitor, or evaluate cognitive performance. Relevant to the
135 present study, Nietfeld (2003) reported a positive relationship between metacognitive strategy
136 knowledge and the ability of middle-distance runners to monitor their pace during a one-mile
137 run. Nietfeld (2003) implied that in a running context, skilled performers operate on
138 intelligent, domain-specific strategies (e.g. active self-regulatory strategies) that are
139 developed as a result of experience. No research has specifically focused on the
140 metacognitive abilities of less experienced endurance participants, however. Furthermore, no
141 studies have applied a metacognitive perspective to understand exercise activity adherence.
142 Accordingly, this investigation sought to examine metacognition, attentional focus, and
143 cognitive control processes in recreational endurance runners. Through individual interviews,
144 the aims were to (i) determine the metacognitive processes of less experienced, recreational

145 endurance runners, and (ii) determine the attentional focus and cognitive strategies used by
146 these runners during running. Finally, based on our interpretations of the resulting data, a
147 third aim was to (iii) explore how metacognitive processes and attentional focus may
148 contribute to longer-term endurance activity adherence.

149 **Method**

150 *Philosophical orientation*

151 A relativist ontology, interpretivist perspective, and a constructivist epistemology
152 were adopted by the researchers (Ritchie, Lewis, McNaughton Nicholls, & Ormston, 2013;
153 Sparkes & Smith, 2014). Firstly, a relativist ontology holds that reality is humanly
154 constructed and subjective realities exist in the form of mental constructions (Sparkes &
155 Smith, 2014). As such, a relativist ontology and qualitative methodology were considered
156 most appropriate for the study of cognitive and metacognitive processes, with an
157 understanding that the research inquiry involved interpretations of participants' own
158 interpretations of their cognitive processes. Secondly, the nature of the relationship between
159 researcher and participant (i.e. epistemology) is constrained by the researcher's ontological
160 approach. A constructivist epistemology holds that in qualitative enquiry the enquirer and
161 participant are inseparable and data result from the interaction between both parties (Sparkes
162 & Smith, 2014). Thus, from relativist ontological and constructivist epistemological
163 perspectives, the objective of this enquiry was to present individual representations of less
164 experienced, recreational endurance runners' metacognitive processes and attentional focus
165 during their running activities (Ritchie et al., 2013; Sparkes & Smith, 2014).

166 *Participants*

167 Less-experienced endurance runners were identified as those who began running
168 within the previous 12 months and had participated in a beginner running programme in that

169 time. In addition, recreational runners were defined as those who practice their activity for
170 approximately two hours per day at least three days per week (De Pauw et al., 2013).
171 Following institutional ethical approval, a recruitment email was sent to local running clubs
172 with beginner running programmes (e.g. *Couch to 5k*) for onward distribution. Inclusion
173 criteria at the time of recruitment were that participants had completed the programme within
174 the previous 12 months and were still recreationally active as runners. Accordingly, criterion-
175 based purposive sampling (Patton, 2002) was used to ensure only runners meeting these
176 characteristics were included. Ten runners (six women) who responded to the recruitment
177 email, met the criteria, and were willing to participate, were interviewed ($M_{\text{age}} = 40.85 \pm 8.16$
178 years). At the time of interview, it had been 10.98 ± 3.52 months since participants first
179 began to run and 9.28 ± 3.25 months since their first running event. Participants ran on
180 average 2.80 ± 0.86 days per week for a total of 20.58 ± 9.28 km per week and were
181 classified as recreationally trained runners (performance level 2; De Pauw et al., 2013). Most
182 participants had completed a furthest running event of 5 km, but two had completed a 10 km
183 event, one had completed a half-marathon, and two had completed a full marathon.

184 Sequential analysis of interview transcripts following each interview ensured the
185 researchers were able to recognise when data saturation was becoming apparent (Sparkes &
186 Smith, 2014). Following interview number seven, a reduction in new information was
187 observed and no new or additional categories emerged in the final three interviews.
188 Accordingly, the analysis suggested that data saturation had occurred by the tenth interview.

189 ***Data Collection***

190 *Pre-interview information*

191 Following procedures outlined by Brick et al. (2015), participants were emailed a pre-
192 interview information sheet one week before the interview. This information sheet outlined

193 the interview process, the types of questions to be asked, and provided an example of
194 cognitive strategy use during running (counting repeatedly to 100 during each mile of
195 running; Radcliffe, 2011). This allowed participants to familiarise themselves with the area of
196 research and potential lines of questioning, and to clarify the purpose of the study.

197 *Qualitative interview guide*

198 Qualitative, semi-structured interviews were employed and Brick et al.'s (2015)
199 interview guide was adapted for use. The guide consisted of six sections that probed and
200 explored runners' running history, their attentional focus during running, the cognitive
201 strategies used during both training and competition (if applicable), how runners monitored
202 the effectiveness of their attentional focus, and how cognitive strategies were acquired,
203 developed, and refined over their running career. Questions asked of elite runners, but not
204 applicable to the present sample (e.g. mental strategies used early in a runner's career, for
205 example as a junior athlete), were not included in the interview guide for this study.

206 *Interviews*

207 All participants provided written informed consent before the interview began. The
208 interviews consisted of two discrete phases. First, the interviewer spent time (approximately
209 20 min; not recorded) with each interviewee to review the pre-interview information, to
210 confirm the purpose of the study and the interview process, and to allow the interviewee ask
211 any questions they might have. This phase provided the opportunity to develop trust and
212 rapport, to make the interviewee feel comfortable, and to minimise social dissonance (Myers
213 & Newman, 2007). The formal interview (phase two; recorded) began with an initial
214 exploration of each runner's attentional focus during running. Following this, participants
215 were provided with a list of attentional foci typically engaged by runners. For consistency,
216 this list was identical to that utilised with elite runners by Brick et al. (2015), was developed

217 based on the review of Brick et al. (2014), and stimulated identification and recall of
218 attentional foci to facilitate deeper discussion (Sparkes & Smith, 2014). The interviewer also
219 explained any terms participants may not have been familiar with. All interviews were
220 conducted face-to-face by the first author. The formal interviews lasted, on average, $33.10 \pm$
221 5.70 min. Each interview was digitally recorded and transcribed manually verbatim and
222 totalled 119 pages of double-line spaced text. To ensure transcription accuracy, member-
223 checking was performed to allow participants the opportunity to amend and clarify content
224 (Tracy, 2010). Transcripts were returned to participants via email within seven days of
225 interview. All participants confirmed the accuracy of transcriptions.

226 *Data Analysis*

227 A content analysis was deemed most appropriate given the exploratory nature of this
228 study (Willig, 2013). Adhering to the three phases of content analysis (i.e. preparation,
229 organising, and reporting; Elo & Kyngäs, 2008), the first author initially immersed himself in
230 the data, listening to interview recordings repeatedly and rereading transcripts multiple times.

231 A categorisation matrix suitable for data analysis was developed by Brick et al. (2015)
232 to incorporate the metacognitive processes and attentional focus of elite endurance runners.
233 The rationale for employing this matrix was to compare and contrast the metacognitions and
234 attentional focus of recreational runners with their elite counterparts. Accordingly, a
235 deductive content analysis was employed. Given the idiosyncratic nature of attentional
236 strategies, however, transcripts were screened for novel content and an inductive content
237 analysis was also employed to fully develop and refine the categorisation matrix (Elo &
238 Kyngäs, 2008). As such, analysis involved an abductive logic (Blaikie, 2007; Ritchie et al.,
239 2013) using both novel information from the interview data and pre-established categories
240 from Brick et al. (2015).

241 *Trustworthiness and confirmability*

242 To establish trustworthiness and enhance the rigour of the analysis, Willig (2013)
243 recommends that qualitative researchers should refer to others' interpretations of the data.
244 Accordingly, the second and third authors independently analysed the interview data.
245 Through critical discussion and evaluation (i.e. peer debriefing), the authors repeatedly
246 reviewed their analysis and interpretations to refine the matrix where necessary. The second,
247 third, and fifth authors also ensured reflexivity by challenging the first author's assumptions
248 on analysis and interpretation. These processes were important to ensure interpretations of the
249 data were consistent between multiple researchers and to confirm that category labels were
250 sufficiently inclusive of data from both elite (Brick et al., 2015) and the present recreational
251 runners. As a further step to enhance rigour and trustworthiness, an independent analyst,
252 familiarised with the study procedures and the categorisation matrix, analysed a random
253 sample (20%) of the transcripts. The independent analyst acted as a 'critical friend' and
254 offered a critique and additional insights into the data, facilitating further reflexivity on data
255 analysis and interpretation (Sparkes & Smith, 2014). Accordingly, areas of disagreement
256 were discussed and refinements were made to the matrix and to inclusion/exclusion criteria
257 where necessary. Once refined, and with consensus reached, categories were established and
258 the results were synthesised. As a final step in the quality assurance process, and to allow
259 confirmability, all study documents including the pre-interview information sheet, the
260 interview guide, the attentional focus list, the interview raw data, the coding frame, and
261 inclusion/exclusion criteria for categories and subcategories are available for independent
262 judgement (see https://osf.io/aj4k2/?view_only=b99feed29b9c4c99a1799b8e79a09cd5).

263 **Results**

264 In line with the first aim of the study, to determine the metacognitive processes of less
265 experienced, recreational endurance runners, the findings are organised under two

266 metacognitive dimensions. *Metacognitive skills* important to regulate cognition are presented
267 first, followed by *metacognitive experiences*. Given the attentional focus and cognitive
268 strategies endurance participants engage in during running (i.e. the second aim) are important
269 to monitor and control cognition, the attentional foci that participants reported are integrated
270 into the *monitoring during running* (internal sensory monitoring and outward monitoring)
271 and *controlling cognition during running* (active self-regulatory strategies and distractive
272 strategies) subsections of the metacognitive skills dimension. The findings are presented
273 using interview quotations as evidence of participants own interpretations of their mental
274 processes (i.e. a relativist ontology). The range of cognitive and metacognitive processes
275 reported are presented fully in Fig 1.

276 ***Metacognitive skills and regulation of cognition***

277 *Planning before running*

278 No participants reported metacognitive planning before training, whereas a few
279 runners reported *planning tactics and pacing* before race events. Those individuals who did
280 report planning tactics and pacing planned alone, whereas one runner also reported planning
281 with a running partner. Tactical plans were primarily focused on task-oriented, but less
282 competitive goals such as completing a run or setting a personal best time. In addition, no
283 runners reported metacognitive planning of active self-regulatory strategies other than tactics
284 and pacing before race events. One participant did report *planning other cognitive strategies*,
285 however, and recounted planning music to listen to as a distractive strategy.

286 *Monitoring during running*

287 Monitoring processes consisted of both *internal sensory monitoring* and *outward*
288 *monitoring*. All runners reported *monitoring bodily sensations* and the most frequently
289 reported were *breathing* and *exertional pain and muscular fatigue*. Most runners reported

290 sensations of exertion as unpleasant, particularly when they first began to run. One runner
291 (Participant 7; P7) revealed how monitoring breathing sensations dominated their focal
292 awareness early in their running career and often proved an unpleasant experience that led to
293 negative self-statements:

294 I couldn't get my breathing right at the start. My total attention was on
295 breathing...And it was only, actually, when I ran with [my brother] one day... and he
296 was like, 'Your breathing is *all* wrong! You've got to breathe in through your nose
297 and out through your mouth and go slow.' I *couldn't* do it, it took me weeks to
298 regulate it! And it was only once I had that, I was able to focus on anything else. It
299 was totally just on being able to do my breathing, and, 'Why am I doing this, why am
300 I putting myself through it? I hate this, I hate running! Why am I doing it?'

301 Outward monitoring most frequently consisted of *monitoring the course/route/terrain*,
302 *monitoring other runners*, and *monitoring split-times and distance* information. Monitoring
303 the course/route/terrain was associated with pace-related decision-making, particularly if a
304 route contained hills. Although many participants reported monitoring *other runners*, this was
305 mostly for less competitive or non-competitive reasons such as to avoid finishing last or to
306 use others as a distraction. Some runners also reported monitoring specific route features (e.g.
307 lampposts, bridges) to mentally break the distance into smaller segments (i.e. chunking), or to
308 know if a run was almost completed. These relationships between monitoring and active self-
309 regulatory strategies (e.g. pacing, chunking) led to the next category to emerge from the data:
310 controlling cognition during running.

311 *Controlling cognition during running*

312 Most runners recounted using the active self-regulatory strategies of *pacing and*
313 *tactical decisions, using social support, and chunking distance or time*. All runners indicated

314 that the primary tactical decision was learning from unpleasant sensory experiences and
 315 slowing down during the initial stages of ensuing activities. As such, each runner reported
 316 scenarios where they began too quickly during running activities early in their running career
 317 and experienced unpleasant physical sensations as a result (e.g. breathing, muscular fatigue).
 318 Subsequently, internal sensory feedback, coupled with experiential knowledge of running
 319 distances, was vital to improve pace-related decision-making. The following quote (P5)
 320 captured the importance of these processes to consciously adapt pacing as runners gained
 321 experience:

322 That has been the big factor...I know whenever I'm starting off now I'm not busting
 323 myself and I know after a couple of miles I'm not going to be exhausted.... Before it
 324 was an unknown how I was going to feel after a mile.... Now I'm taking it easy and if
 325 I feel...better...I go a bit faster. But if I know I'm going too fast, I'll slow down
 326 again. And I'm always thinking, 'How do I feel? ...Is my breathing heavy?'

327 The non-competitive nature of most runners was emphasised by pace-related
 328 decision-making. Specifically, many runners prioritised the intrinsic benefits of running and
 329 running too quickly often equated to reduced enjoyment, as one individual (P3) recounted:

330 Even we did a 5 km run...and one of our trainers said to me, 'Stop going towards the
 331 back, you're going to run it with me!' And I ran it with him, and I did do it quite a lot
 332 quicker than normal! ...And he said, 'See! See!', and I said, 'Yes, but I didn't enjoy
 333 it! I hated every minute of that because I pushed myself! If I'd stayed with those ones
 334 [slower runners], I'd have enjoyed that run!'

335 In addition, the majority of runners reported *using social support* to cope with the
 336 demands of running. Participants described receiving direct encouragement from fellow
 337 runners or focusing their thoughts on significant others (e.g. family members) to increase

338 motivation, complete a run, or maintain running activity. One runner (P1) highlighted the
 339 reciprocal nature of social support between runners:

340 I think one of the things I've learned is that I'm a better motivator of other people, and
 341 supporter, and encourager, more so than I would for me! For me, I would just say, 'ah
 342 sack this!' But if it's somebody with me, and they keep me going, I'll go, because I
 343 don't want to be letting them down. And vice versa, you know?

344 Linked to outward monitoring of route features, *chunking distance or time* allowed
 345 many runners to focus on proximal sub-goals during longer-distance running. Although one
 346 runner expressed a dislike for chunking, and experienced an urge to stop when reaching a
 347 proximal target, several runners found chunking beneficial, as typified by the following quote
 348 (P4):

349 No, I'd never stop. In my own head, the last 5k that I did, I just kept focusing on the
 350 finish line. I just wanted to... it was the last one I did, and it was just lamppost to
 351 lamppost, and it was like, 'Right, I can see something', and I focused on a car...that
 352 was parked..., and once I got to that car, I focused on to the next thing I could see

353 Most runners reported focusing on *running technique* and often this involved basic
 354 cues to maintain posture (e.g. keep head up, back straight) or focus on their arm swing. These
 355 cues were often learned from coaches during beginner running programmes. Similarly, use of
 356 *relaxation* resulted from a focus on bodily sensations and involved strategies learned from
 357 coaches such as relaxing one's arms. Many runners also reported frequent *negative self-talk*
 358 (e.g. an urge to stop) during running. Again, this often resulted from a focus on unpleasant
 359 bodily sensations or from outward monitoring (e.g. of an upcoming incline). Some
 360 individuals, though not all, reported countering negative thoughts with motivational self-talk

361 or mantras. One runner (P10) typified the approach to countering negative self-statements
362 with more motivational self-talk:

363 And anything else I'd be thinking of are just random things, like it could be, like, 'I
364 hope I don't get a stitch', or I'm maybe going up a hill and I'm thinking, 'I can do
365 this!' We're struggling up the hill and I think, 'Right, we've done this before, I *can* do
366 it!' Just telling myself I can do it.

367 In addition to active self-regulatory strategies, distractive strategies were also
368 important to cope with the demands of running. Most runners reported *using other people for*
369 *distraction and conversing*. Many runners also reported *using active distraction/switching off*
370 or using the *scenery/route as a distraction* (Fig 1). Runners' predominantly non-competitive
371 orientation was exemplified by their use of conversing. Typically, conversing was engaged in
372 to actively distract from bodily sensations, prevent boredom, or to reduce the self-regulatory
373 demands of running. The following quote (P8) highlights the perceived benefits of running
374 with others and conversing as opposed to running alone:

375 Running on your own, you tend to think more when you're running on your own.
376 When you're running with other people, if you're chatting, you're not thinking...the
377 mental thing going on in your head isn't happening, because you're chatting to
378 somebody...you tend not to think of the run as much as you would if you were
379 running on your own...where you've a constant battle in your head about the run...

380 Other distractive strategies were also employed when running alone and often
381 involved reflective thoughts (e.g. of family, work). In contrast, one runner reported *avoiding*
382 *involuntary distraction* and suggested it might result in a loss of concentration and stopping
383 during a run.

384 A few runners currently *used music* as a distractive strategy. However, it is
385 noteworthy that many others had previously used music but no longer did (see *metacognitive*
386 *judgements and estimates*). For these runners, music detracted from their ideal pacing
387 strategy (i.e. they ran too fast) or distracted from their preferred attentional focus (both active
388 self-regulatory and other distractive), a consideration typified by a 5 km and 10 km runner
389 (P8):

390 I know a lot of people listen to music, but I don't! I've tried it, but...it just puts me off
391 thinking about the run and what I have to do. It distracts me! Now maybe that's a
392 good thing...but sometimes I try to focus...I want to focus on my run.

393 This approach to sampling a cognitive strategy, evaluating its effectiveness, and
394 subsequently retaining or eliminating the strategy led to the next category to emerge from the
395 data: metacognitive reviewing and evaluating.

396 *Reviewing and evaluating after running.*

397 Most participants reported *acquiring cognitive strategies through experience*,
398 typically of unpleasant sensory feedback. Of these, some acquired self-regulatory strategies
399 other than pacing through experience. Strategies included chunking, motivational self-talk,
400 and imagery. This excerpt from a 5 km runner (P2) recounted how their imagery and mantras
401 evolved as a result of breathing sensations experienced early in their running career:

402 It's...developed slowly over time. And I think it's because the breathing is so difficult
403 at the start. I had to try and control the breathing. And I kept it in step with the [foot]
404 steps... And as the breathing and the steps were together, the arms were...moving
405 together, this visualisation of...a steam engine...that's where that came in. And with
406 that came the repetitions of... 'I feel strong...I feel powerful!'

407 The majority of participants also reported *acquiring, reviewing, and evaluating*
 408 *cognitive strategies and performance with others*. These others were typically more
 409 experienced runners and no participants reported using a sport psychologist. Participants
 410 acquired a range of self-regulatory strategies from other runners, including pacing and
 411 tactical information, chunking, relaxing, and motivational self-talk. These cognitions were
 412 frequently judged as effective and were subsequently retained. Accordingly, metacognitive
 413 experiences that influenced both cognitive control during running and metacognitive
 414 reviewing after running were the final category to emerge.

415 ***Metacognitive experiences***

416 *Metacognitive feelings*

417 The majority of runners' data suggested they experienced *feelings of knowing* and
 418 *feelings of difficulty*. Several participants indicated *knowing when to apply a cognitive*
 419 *strategy* and the choice of strategy often depended on the route distance (i.e. longer versus
 420 shorter), the type of activity (i.e. training versus a race), bodily sensations experienced, or
 421 whether running with others or alone. To exemplify, a frequent 5 km runner (P6) expanded
 422 on the decision of when to engage in conversation and when to avoid it:

423 It's my run and if somebody comes and distracts me, grand. But if I'm struggling, I
 424 would stop talking. ...If they're...running behind me, I would up the pace to get away
 425 from them... I've done that a couple of times, if somebody tried to make conversation,
 426 I'm thinking, 'I'm not in the mood for conversation!' But then there's a couple of
 427 parkruns that have been really good; lovely morning, nice weather, met somebody I
 428 haven't met in ages, chatted to them for a wee while, and then realised I'm a bit out of
 429 breath here, I don't want to talk to you anymore because it's distracting me!

430 Despite individual preferences for attentional strategies in most runners, a few runners
431 reported *knowing one does not know a cognitive strategy to apply* in situations. Specifically,
432 these participants reported either not knowing enough about some strategies (e.g. running
433 technique) or described scenarios where they were unable to cope with unpleasant sensations
434 or negative self-talk without support from others. Similarly, although running was often
435 reported as *feeling hard*, many individuals revealed these feelings were more prevalent when
436 running alone.

437 *Metacognitive judgements and estimates*

438 All participants made *judgements of effective cognitive strategies* and *judgements of*
439 *ineffective attentional focus*. Specifically, socially-oriented strategies such as using social
440 support and conversing were mostly judged as effective. Often this was because running felt
441 easier or runners did not need to engage alternative cognitive strategies. Consequently, for
442 some individuals running with others was perceived to reduce the *self-regulatory demands* of
443 running activity as exemplified by runners' use of conversing (see *controlling cognition*
444 *during running* subsection). Perhaps not surprisingly, negative self-talk was judged as
445 ineffective by several runners. Importantly, context-dependent judgement of strategies was
446 also apparent. Some runners judged conversing as effective in some situations but less
447 effective in others, for example. Similarly, although some runners judged listening to music
448 as effective, many others judged music as ineffective or no longer effective.

449 **Discussion**

450 This study examined the metacognitive processes and attentional focus of less
451 experienced, recreational endurance runners. Previous research on attentional focus has
452 predominantly concentrated on endurance performance (Brick et al., 2014). In contrast, this
453 qualitative investigation attempted to gain novel insights into the metacognitive processes

454 and attentional focus of recreational runners for whom performance outcomes may be less of
455 a concern. In line with the first two aims of the study, the findings suggest that as novices, the
456 present runners may not have had the well-developed metacognitive skills or possessed the
457 intricate knowledge of task-specific cognitive strategies as their more experienced
458 counterparts (Brick et al., 2015). No runners reported metacognitive planning of active self-
459 regulatory strategies other than pacing and tactics, for example. Furthermore, metacognitive
460 reviewing and evaluating after running was mostly conducted with other, more experienced
461 runners rather than alone. These findings suggest that beginner runners may be less strategic
462 in their thinking (Nietfeld, 2003) and less likely to plan or evaluate their attentional strategies
463 during running (Martini & Shore, 2008). There was evidence that participants developed their
464 metacognitive abilities and cognitive strategies as task-specific experience accrued, however.
465 These findings are novel within an endurance activity context. As such, this discussion will
466 concentrate on the evolution of participants' domain-specific metacognitive skills and
467 attentional focus during their relatively brief running careers. Findings with regard to
468 metacognitive experiences will be integrated into the discussion where relevant.

469 A primary focus of attention for participants when they first began to run was on
470 internal sensory stimuli, and, specifically, on breathing and effort-related sensations.
471 Respiratory frequency is a correlate of perceived effort (Nicolò, Marcora, & Sacchetti,
472 2016). Consequently, excessive attention to bodily sensations, without engagement of
473 situationally-appropriate cognitive strategies, may exacerbate effort perception and
474 unpleasant affective responses during endurance activity (Brick et al., 2014; Ekkekakis et al.,
475 2015). Thus, an initial challenge for novice participants may be to develop the metacognitive
476 knowledge and skills required to regulate cognition and reduce focal awareness of effort-
477 related sensations (Bigliassi, 2015).

478 The interview data does indicate that the runners evolved their attentional focus
479 through a number of metacognitive processes as they gained experience. First, the findings
480 revealed that sensory cues became an important source of information for pace-related
481 decision making. Previously, Brick et al. (2015) noted that elite runners attended most to
482 informational aspects of internal sensory stimuli and used these cues to regulate endurance
483 performance. Similarly, the present runners learned that adjusting pace, particularly slowing
484 down, was important to avoid unpleasant sensory consequences. Previous research has
485 revealed that less experienced athletes often begin endurance activities at an intensity they
486 cannot sustain (Deaner, Carter, Joyner, & Hunter, 2015). Over time, however, experiential
487 knowledge of running distances and perceived effort improves pace-regulation (Marcora,
488 2010). As such, rather than attempting to distract from bodily sensations, which may be futile
489 at higher intensities (Tenenbaum & Connolly, 2008), beginner runners might be encouraged
490 to learn from sensory experiences (via metacognitive reviewing and evaluating) and use these
491 cues to regulate exercise intensity (see Fig 2a and 2b). Given that both cognitive *and* affective
492 factors influence metacognitive monitoring and control (Efklides, 2014), unpleasant sensory
493 experiences may facilitate the acquisition of strategies (e.g. pacing) to regulate intensity
494 during endurance activity.

495 The runners also reported employing other self-regulatory strategies, such as using
496 social support, chunking, relaxing, focusing on basic technical cues, and motivational self-
497 talk that evolved with experience. Of these, recent research has highlighted the positive
498 effects of social support, including family, friends, and fellow runners, on physical activity
499 initiation and maintenance in beginner runners (Wiltshire & Stevinson, 2018). In addition, the
500 process of chunking, or setting – and attaining – more proximal sub-goals during a longer-
501 duration task, has been shown to increase self-efficacy perceptions and subsequent task
502 persistence (Stock & Cervone, 1990). Finally, cognitive strategies such as relaxation, cueing

503 running technique, and motivational self-talk have been shown to reduce perceptions of effort
504 and/or improve endurance performance (e.g. Blanchfield, Hardy, de Morree, Staino, &
505 Marcora, 2014; Miller & Donohue, 2003). Despite these benefits for both running
506 participation and performance improvement, many individuals did report difficulty regulating
507 their own cognitions during running. Specifically, these participants indicated that running
508 with a partner often felt easier (metacognitive feeling of difficulty) and was judged as more
509 effective as they did not have to use as many self-regulatory strategies as when running alone.
510 This further signifies that novice runners may not have as well-developed metacognitive
511 skills as their more experienced counterparts (Brick et al., 2015) and encounter greater
512 difficulties controlling cognition as a result. In support, Schücker et al. (2016) proposed that
513 inexperienced runners may need greater cognitive resources to adopt novel attentional foci.
514 Accordingly, running with others, and distracting from the activity, may reduce the cognitive
515 demands (e.g. working memory) associated with an endurance task by negating the need to
516 engage self-regulatory strategies. Crucially, changes in neural connectivity can improve
517 cognitive efficiency and self-regulatory capabilities over time. Specifically, Raichlen et al.
518 (2016) reported that trained endurance runners have greater connectivity between brain
519 regions associated with executive functions, attention, and motor control (e.g. frontal cortex,
520 frontoparietal network) than non-athlete controls. These contentions provide an additional,
521 neurocognitive basis to explain why novice endurance participants may find cognitive control
522 more difficult and use more distractive strategies than their elite counterparts (e.g. Brick et
523 al., 2015; Morgan & Pollock, 1977).

524 In line with these latter contentions, distractive cognitions (e.g. conversing, reflective
525 thoughts) were important to cope with the demands of running and increase positive affect in
526 the present sample. Distractive cognitions are generally considered less strategic for
527 competitive participants because of a detrimental effect on pace and performance (Brick et

528 al., 2014; Nietfeld, 2003). Reduced pace may be advantageous for novice runners, however,
529 and distraction may be most effective when the primary activity goals are to maximise
530 enjoyment and positive affect (LaCaille et al., 2004), alleviate boredom (Pennebaker &
531 Lightner, 1980), and reduce perceptions of effort (Stanley et al., 2007). Judgements that
532 conversing was less effective in some contexts, however, and data concerning the use of
533 music by some runners may offer interesting insights into the longer-term evolution of
534 attentional strategies. Specifically, although some runners reported using music as a
535 distractive strategy during running, many other participants had used music earlier in their
536 running career but no longer did. Substantial evidence supports the ergogenic and affect-
537 enhancing benefits of asynchronous music during exercise tasks (Jones, Karageorghis, &
538 Ekkekakis, 2014; Karageorghis & Priest, 2012). In line with the present data, however,
539 untrained individuals have been shown to experience more positive affective responses than
540 trained runners when using music at varying intensities (Brownley, McMurray, & Hackney,
541 1995). In addition, Hallett and Lamont (2016) presented survey data to suggest that faster
542 runners tend not to use music during running. From a metacognitive perspective, a reduced
543 dependence on music, and occasional inclination not to converse, may reflect an increased
544 knowledge of, and preference for, active self-regulatory strategies as runners gain experience.
545 These findings may also indicate improved executive functioning and attentional control
546 (Raichlen et al., 2016) and a growing reliance on informational aspects of internal sensory
547 cues to effectively regulate pacing during endurance exercise activity (Brick et al., 2015).

548 The findings that metacognitive reviewing and evaluating were engaged
549 predominantly with others, and that more experienced runners were important sources to
550 acquire cognitive strategy information are also noteworthy. From an evolutionary
551 perspective, Shea et al. (2014) proposed that humans developed the ability to express their
552 cognitions to facilitate adaptive group behaviours. In the present context, communicating

553 task-relevant cognitive information to more experienced others (e.g. “I don’t know how to
554 cope with longer distance runs”) may facilitate the acquisition of self-regulatory cognitions to
555 engage in the future (e.g. “chunk the run into smaller segments”). Accordingly, for novice
556 runners, supra-personal (Shea et al., 2014) or socially shared (Efklides, 2014) metacognition
557 may be important to acquire domain-specific metacognitive knowledge of cognitive strategies
558 to use, and conditional knowledge of when to use them. From an applied perspective, the
559 finding that no runners accessed a sport psychologist is typical for recreational participants
560 (McCormick, Meijen, & Marcora, 2016) and reinforces the utility of easily-assessable
561 evidence-based psychological interventions for recreational athletes to learn task-relevant
562 cognitive strategies (e.g. Lane et al., 2016; Meijen, Day, & Hays, 2016).

563 In line with the third aim of this study, the findings may also offer novel insights into
564 the effects of metacognitive processes and attentional focus on longer-term endurance
565 activity adherence. First, it was apparent that internal sensory stimuli (e.g. breathing
566 sensations) dominated the focal awareness of participants at the beginning of their running
567 career. An excessive focus on bodily sensations is associated with an elevated perception of
568 effort (Bigliassi, 2015; Brick et al., 2014; Nicolò et al., 2016) which, in turn, is an inverse
569 correlate of physical activity (Bauman et al., 2012). Perceived effort is also a source of
570 exercise-induced displeasure and negative affect (e.g. Ekkekakis et al., 2015). Thus, an initial
571 intervention with beginner runners may be to use internal sensory cues such as breathing for
572 pace-related decision-making (see Fig 2b). This may have important implications, such as
573 increasing positive affect during activity and, consequently, improving the likelihood of
574 longer-term exercise adherence (Brand & Ekkekakis, 2018). Furthermore, beginner
575 participants’ interpretations of adjustments in physiological and affective states during
576 running may also influence their perceived capability to perform or complete physical
577 activity tasks (i.e. self-efficacy; Bandura, 1997). Self-efficacy is a strong predictor of physical

578 activity behaviour and exercise self-efficacy is considered particularly important during the
579 initial stages of exercise adoption (Ashford, Edmunds, & French, 2010; Higgins, Middleton,
580 Winner, & Janelle, 2014). In support, Raedeke and Dlugonski (2017) recently demonstrated
581 that a 10-week cognitive-behavioural intervention targeting sources of self-efficacy,
582 including interpretation of perceived effort, monitoring feeling states, and managing exercise
583 discomfort, increased walking step-count in overweight adults. Whether similar intervention
584 components can improve affective responses, self-efficacy, and adherence to beginner
585 running programmes is currently unknown and demands future research attention.

586 Distractive strategies (e.g. conversing, reflective thoughts, music) were also important
587 for the present runners. At lower exercise intensities, distraction may reduce boredom and
588 increase positive affect (e.g. LaCaille et al., 2004; Pennebaker & Lightner, 1980) and these
589 outcomes may explain why active distractive strategies have been associated with improved
590 adherence during shorter-term, lower-intensity physical activity programmes (Martin et al.,
591 1984). The present data hint that acquiring and developing task-relevant active self-regulatory
592 strategies may be important for longer-term endurance exercise adherence, however.

593 Although stronger empirical data is needed to support this contention, recent meta-analytical
594 evidence suggests that strategies to facilitate self-regulation may explain the positive effects
595 of longer-term behavioural change interventions (Samdal et al., 2017). As such, a novel
596 interpretation of the present findings is that acquiring active self-regulatory strategies other
597 than pacing (e.g. chunking, relaxation, motivational self-talk) and using these strategies in a
598 contextually-appropriate manner may be important to longer-term endurance activity
599 adherence. Accordingly, future research investigating the effectiveness of active self-
600 regulatory strategies on endurance activity adherence is an additional priority for attentional
601 focus and physical activity researchers.

602 Finally, social factors may also play an important role in acquiring cognitive
603 strategies and developing metacognitive skills. Recent research has highlighted the
604 importance of social capital to initiate and maintain activity in beginner runners (Wiltshire &
605 Stevinson, 2018). Social capital includes social ties (e.g. family, friends) that help to initiate
606 running activity and provide practical and affective support, and other runners that offer
607 information on performance strategies and motivational techniques (Wiltshire & Stevinson,
608 2018). Our study adds to this from a metacognitive perspective to guide future research in
609 this domain. Specifically, we highlight the role of socially shared metacognitions with more
610 experienced runners and coaches to help novices acquire and develop context-appropriate
611 cognitive strategies potentially important to longer-term endurance exercise adherence.

612 A number of limitations should be noted for this study. First, at just over 33 min, the
613 duration of phase two of the interviews may be considered comparatively short. The runners
614 were relatively inexperienced, however, and had not completed many longer-distance runs or
615 races. As a result, these runners did not recount the detailed procedural or contextual
616 knowledge of cognitive strategies previously reported by their elite counterparts (Brick et al.,
617 2015). In support, all participants indicated they had nothing further to add on completion of
618 the interview. Second, the present data may also suggest a refinement of the categories and
619 subcategories proposed by Brick et al. (2015) based on the population under investigation.
620 Specifically, some categories, such as metacognitive planning before training, may be more
621 relevant to elite competitors than recreational participants. Finally, interpretation of the data
622 should also be considered in light of recent propositions (published after data acquisition and
623 analysis in this study) to improve rigour in qualitative research. Specifically, Smith and
624 McGannon (2017) recently suggested a need to involve activities beyond those traditionally
625 advocated for qualitative researchers (e.g. Tracey, 2010). Important to an investigation of
626 endurance runners' metacognitions and attentional focus, additional activities might include

627 post-interview member reflections, for example, to fully explore potential differences in the
628 interpretations of their cognitive and metacognitive processes (Smith & McGannon, 2017).

629 In sum, the findings suggest that beginner, recreational runners may not have as well-
630 developed metacognitive skills or possess the detailed knowledge of task-specific cognitive
631 strategies as their more experienced, elite counterparts. The present runners' metacognitive
632 skills and attentional strategies developed and evolved as they gained more experience,
633 however. These findings are novel in the endurance research literature and may have
634 important implications for research and applied practice. Specifically, the findings may
635 contribute to our understanding of the self-regulatory processes important to longer-term
636 endurance exercise adherence. From a metacognitive perspective, it may be that augmenting
637 cognitive strategies with additional metacognitive knowledge (e.g. conditional knowledge of
638 when to use strategies) and encouraging the use of metacognitive skills (e.g. planning and
639 reviewing one's attentional focus) may help to optimise strategy acquisition with novice
640 participants (Fig 2b). This may be especially important to cope with the demands of, and
641 improve affective experiences during, endurance activity. Comparable metacognition-
642 augmented interventions have proven beneficial in other domains of psychology research
643 (e.g. Moritz et al., 2015). We propose that a similar approach may enhance applied practice to
644 improve longer-term adherence to recreational endurance activity.

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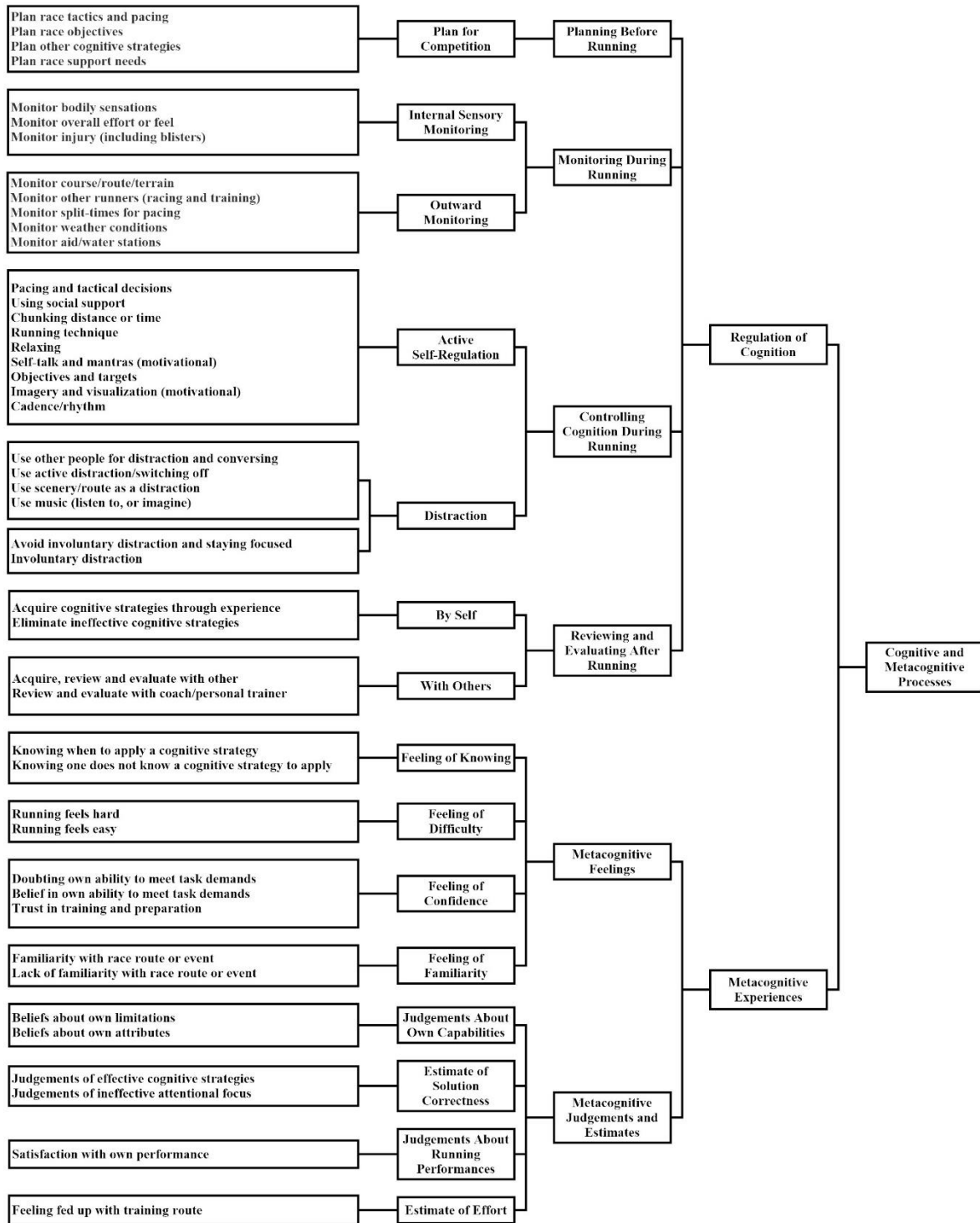
813 Figure 1. Cognitive and metacognitive processes in the regulation of performance and control
814 of cognition in recreational endurance runners.

815 Figure 2a. Without knowledge of active self-regulatory strategies, internal sensory
816 monitoring (1) may dominate focal awareness. Beginner runners may attempt to use
817 distractive strategies (3), but these may be futile at higher intensities making running feel
818 harder (2) (adapted with permission from Brick et al., 2015).

819 Figure 2b. Based on previous running experiences (Fig 2a), metacognitively plan a pacing
820 strategy before running (1). Use internal sensory and outward environmental cues as a source
821 of information (2) for pace-related decision making during running (4) via metacognitive
822 feelings of difficulty (3). After running, use metacognitive judgements (5) for metacognitive
823 reviewing and evaluating (6) to update metacognitive planning for future running (adapted
824 with permission from Brick et al., 2015).

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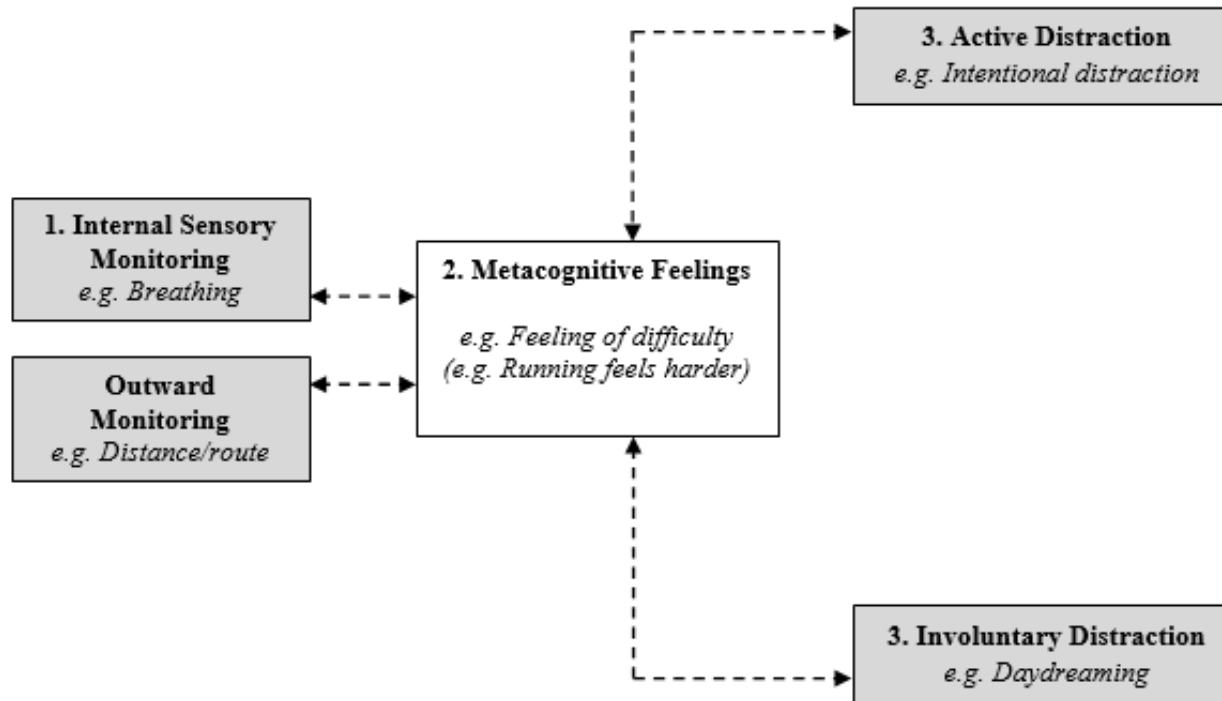
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829 Figure 1.

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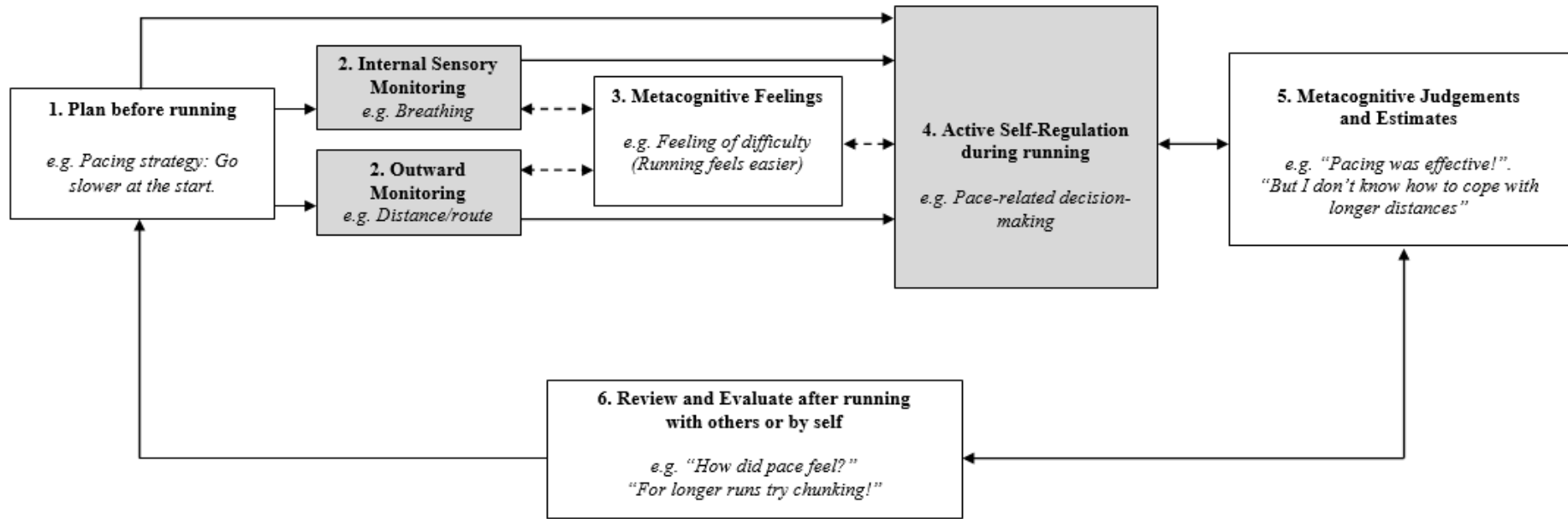
833 Figure 2a.

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840 Figure 2b.