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Collins, Loel ORCID: 0000-0002-7478-1140 and Collins, David John ORCID: 0000-0002-7601-0454 (2021) Managing the Cognitive Loads Associated with Judgment and Decision-Making in a Group of Adventure Sports Coaches: A Mixed-Method Investigation. Journal of Adventure Education and Outdoor Learning, 21 (1). pp. 1-16. ISSN 1472-9679

It is advisable to refer to the publisher's version if you intend to cite from the work.

<http://dx.doi.org/10.1080/14729679.2019.1686041>

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**Managing the Cognitive Loads Associated with Judgment and Decision-Making in a Group of
Adventure Sports Coaches: A Mixed-Method Investigation**

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Abstract

14
15 We report a study of adventure sports (AS) professionals working in mountaineering, climbing,
16 skiing, kayaking and mountain biking. This paper expands work on professional judgment and
17 decision-making. The article examines the Pro-Active Coping (PAC) strategies used by AS coaches
18 and leaders to manage the cognitive loads of decision-making. A mixed methodology was employed
19 in which a sample of participants completed a PAC Inventory and a sub-group then completed an
20 Applied Cognitive Task Analysis to examine a typical coaching scenario. The study determines that
21 the participants manage their cognitive load in practice with a range of heuristics, avoidance
22 strategies and instrumental support. These include using their own communities of practice,
23 anticipation of events that may cause high acute cognitive load (anticipation planning) and the
24 development of a 'straw-man plan' based on anticipated environmental conditions and client abilities.
25 That plan is subsequently modified in response to the actual conditions and client abilities as
26 observed. These strategies reduce the depletion of the coaches' own cognitive resources by
27 managing the demands throughout the coaching and leadership process. We conclude that the
28 coaches and leaders are aware of the extent of their cognitive resources and manage their
29 expenditure, both of which are indicative of high meta-cognitive ability.

30

31 Research in this journal has recently examined the planning and focus of coaches working in
32 hyper-dynamic environments, a situation characterised by multiple interrelating or even
33 unmanageable factors (Collins & Collins, 2016a, 2016b). This situation is described as ‘a wicked
34 mess’ by Simon, Carson and Collins (2017) and identified by Collins and Collins as causing a high
35 cognitive load. These loads are associated with developing the performance of individuals in
36 continually changing and potentially risky environments. In associated work, Collins, Carson and
37 Collins (2016) identified meta-cognition as a key aspect of the coaching and leadership processes in
38 general. Simon, Collins and Collins (2017) suggest that the complexity of coaching in these contexts
39 is a consequence of the synergies among three linked aspects of the coaching process: (1) the hyper-
40 dynamic environment, (2) the individual being coached and (3) the desired outcomes. Consequently,
41 coaches of AS experience high cognitive loads while simultaneously anticipating, planning and
42 coping within this messy hyper-dynamic context while also attempting to facilitate the development
43 of their students. Cognitive load is the amount of information processing required to perform a given
44 task (Reif, 2010). Cognitive load theory (Sweller, 1998) would assert that decision making would be
45 hampered if working memory capacity is exceeded (De Jong, 2010.) The coaches are susceptible to
46 high cognitive loads that can be acute and chronic. The coach must have the capacity to anticipate
47 acute stressors caused by factors like an unexpected change in conditions or an emergency while also
48 managing chronic stressors, such as anticipating the trajectory of the development of a student in a
49 risky situation in order to assist in goal-setting, practice design and risk management.

50 Limited investigation has been undertaken, however, into how AS coaches and leaders¹
51 manage the loads associated with developing individuals in this context. Accordingly, our aim was
52 to identify how AS coaches ensure that sufficient cognitive resources are available to manage the

¹ For simplicity, we will refer to coaches and leaders simply as ‘coaches’ from this point.

53 chronic daily demands of coaching and the potential acute loads associated with anticipated changes
54 to situational demands. Furthermore, we ask how these strategies differ among coaches at different
55 levels of qualification/experience. Finally, given the importance of increasing the number of female
56 coaches across sport (e.g., Coaching Association of Canada, 2010), we were interested to see if any
57 gender differences existed in this important coaching ability concomitant.

58 **Adventure Sports Coaching**

59 AS coaches work in hyper-dynamic environments and demonstrate an ability to respond and
60 adapt to the changing needs as their students develop, the hyper-dynamic environment and the
61 interaction of these two factors (Collins & Collins, 2016a, 2016b). The focus of this interaction is the
62 motivations and learning needs for the individual to achieve their desired outcomes while
63 maintaining their safe participation. Specifically, the coach operates in response the situation, a
64 situational awareness, and its demands (Endsley, 2005) of the hyper-dynamic environment and the
65 individual learner. Consequently, the coach must be flexible, adaptive and creative. The coach needs
66 a range of experiences, pedagogic skills, practical skills, ability in the activity and—importantly for
67 this paper—sufficient cognitive and meta-cognitive capacity to manage the coaching session. These
68 complex challenges indicate the need for an examination of the characteristics of coaches and the
69 methods they employ to manage these cognitive loads. Accordingly, we first present cognitive load
70 theory, then proactive coping as a potential mechanism for managing cognitive load and self-
71 regulation to cope with the stressors of the coaching ‘mess’ (Simon et al., 2017).

72 **Cognitive Load**

73 Cognitive load theory (Swellers,1998) identifies three linked forms of cognitive load that are
74 dependent on the capacity of the working memory; (1) intrinsic- that is inherent in the demands of
75 the decision and can be influenced by prior knowledge; (2) extraneous- that is generated by the
76 nature of that information, its quality and accuracy; (3)germane - generated by the processing of that

77 information. Intrinsic loads may be reduced by breaking down, sequencing or proceduralising
78 information. Extraneous loads by sense making of new material, referencing to existing schema and
79 mental models and selection via the central executive function. Lack of clarity generates cognitive
80 loads because of the sense making aspect rather than the generation of new schema. A focusing of the
81 cognitive resource via the central executive towards the schema generation reduces the germane load
82 (Chandler & Sweller, 1992). Two additional factors may also affect cognitive load in decision
83 making. Decision fatigue; utilizing cognitive resource via repeated or complex decision making.
84 Importantly this may effect impulsive decisions, ability to balance opposing information in ‘trade-
85 offs’, via avoidance of decisions, ego depletion and impaired self-regulation (Tierney, 2011;
86 Baumeister,2003; Anderson, 2003). Additionally, a decision-making paradox (Triantaphyllou, 2000)
87 may also be a factor in which too many possibilities are considered (Vohs, Baumeister, Twenge,
88 Schmeichel, Tice, and Crocker ,2005)

89 **What is Proactive Coping?**

90 PAC stems from notions of positive psychology (Greenglass, 2009) and encompasses two
91 future-oriented aspects of self-regulatory behaviour (Sohl & Moyer, 2009): resource accumulation
92 (pinpointing what is required for success) and preventive coping. These aspects include the use of
93 resources, future appraisal, realistic goal-setting and intrinsic and extrinsic feedback. PAC is a
94 multidimensional process that occurs over time and has four elements: internal control (suggesting
95 aspects of emotional intelligence and a meta-cognitive capacity), planning (suggesting experience
96 and capacity to anticipate), reflection (a capacity to learn from experiences) and self-regulation of
97 internal resources and social support (a community of practice) (Greenglass, 2002). PAC strategies
98 appear to be initiated by the individual, self-determined and occur simultaneously on both cognitive
99 and behavioural levels. Consequently, those who can cope proactively demonstrate initiative, are
100 active when faced with stressors and mobilise cognitive resources to manage those stressors.

101 Greenglass, Schwarzer, Jakuniec, Fiksenbaum, & Taubert, (1999) also suggest that individuals who
102 employ PAC strategies take responsibility for their actions and do not engage in denial or self-blame
103 when faced with the possibility of failure though this seems speculative and warrant further research.

104 **PAC as an aspect of self-regulation.**

105 As mentioned above, self-regulation offers a broad and generalised framework to understand
106 an individual's coping response and may be orchestrated across a wide range of different coping
107 skills and strategies (Baumiester, Vohs, & Tice, 2007). Self-regulation occurs during the
108 performance of a task via a construct of self-imposed or selected rules (Chen & Singer, 1992) and is
109 conceived as dependent on an internal finite resource (Baumiester, Vohs, & Tice 2007). These
110 depletion theories are widely accepted (Vohs, Baumeister, & Schmeichel, 2012), with researchers
111 arguing that the resources underling self-regulation are limited and that using these resources leaves
112 fewer resources for later. In this respect PAC potentially acts on a meta-level to manage these finite
113 resources by focusing cognitive efforts on the most significant or likely potential outcomes and
114 recognising the optimal strategies for a given problem or context, see our comments regarding the
115 central executive earlier. This ensures a more manageable cognitive load by focusing resources for
116 maximum potential return—a meta-level risk-versus-benefit decision. Indeed, some authors have
117 described self-regulation with the analogy of a muscle that can be trained and developed (Baumiester,
118 Vohs, & Tice (2007), an idea which leads to the prospect that both self-regulation and PAC could be
119 trainable. Others (e.g., Efklides et al., 2002) report differences in the performance of self-regulation
120 tasks, however, and in turn highlight that this subject is complex and requiring of further
121 investigation. In short, the analogy may not be as so straightforward as to simply require practice to
122 'train the muscle'.

123 **Anticipation and PAC.** Klein and Snowden (2011) identify and characterise anticipatory
124 thinking as the process of recognising and preparing for difficult challenges. Based on earlier work,
125 Klein, Snowden and Pin (2007) identify aspects of anticipatory thinking that reflect a naturalistic

126 model of decision-making: for instance, pattern matching, in which the circumstances of a situation
127 provide cues and clues that something may be amiss, and trajectory tracking, in which preparation for
128 how events are unfolding has likely implications for identification and recognition of
129 interdependencies and their implications in a given context, recognition primed decision making.
130 Klein and Snowden (2011) describe anticipatory thinking as both ‘sense making’ (p. 5) and a macro-
131 cognitive process that enables the decision-maker to mentally simulate possible courses of action,
132 evaluate the potential problems that may arise and identify possible solutions. It appears logical,
133 however, that anticipation must also operate at a meta-level, enabling management of the PAC
134 strategies. In this respect, it is a strategy of problem detection and solving that requires a ‘reframing’
135 of the problem and the strategies for its solution, a meta-cognitive aspect of the decision-making
136 process. Being able to anticipate allows the coach to foresee the potential for highly acute cognitive
137 tasks. Such a capacity potentially enables the coach to avoid situations of high load if the cognitive
138 resources are unavailable or have been allocated to other events.

139 **Anticipation, PAC, judgment and decision-making.**

140 Previous work has stressed the significance of judgment and decision-making (Collins &
141 Collins, 2013, 2016a, 2016b; Collins, Collins, & Carson, 2016) in high-level coaches who specialise
142 in AS. We argue that judgment and decision-making in this context are consistent with a dual-
143 processes perspective on decision-making and represent a synergy of classic and naturalistic
144 cognitive approaches. Importantly, Collins and Collins (2013, 2015, 2016a, 2016b) argue that there
145 are several conscious processes involved in JDM despite the apparent predominance of naturalistic
146 (such as recognition primed decision making and heuristics) that act in addition to intuitive
147 processes. In short, JDM combines nested classic and naturalistic decision-making processes that
148 vary depending on the context of the decision. Pre, including planning, and post action being
149 predominantly CDM, but not exclusively, in nature with in-action decision making being
150 predominantly but not exclusively NDM.

151 Unsurprisingly, the barriers to anticipatory thinking outlined by Klein and Snowden (2011)
152 reflect a number of heuristic biases identified by a range of authors (Cox, 2007; Girgerenzer, Todd, &
153 ABC Research Group, 1999; Hammond, Keeney, & Raiffa, 1999; McCammon, 2004; Plouso, 1993;
154 Renfrew, Martin, Micklewright, & St Clair Gibson, 2014; Russo & Schoemaker, 1989; Gregg,
155 Hahadevan, & Sedikides, 2017). Reflective of the synergy of CDM and NDM these are potential
156 ‘traps’ in the whole decision-making process.

157 Consequently, and as stated earlier, our aim was to identify how AS coaches ensure sufficient
158 cognitive resources are available to manage the chronic daily demands of coaching and the possible
159 acute loads associated with anticipated changes to the situational demands. Furthermore, we ask how
160 these strategies differ among coaches.

161 MethodIn order to reflect the sample size accurately and enable sufficient breadth and
162 richness of the responses, a two-part mixed approach was employed that used the PAC Inventory
163 (PCI) (Greenglass, Schwarzer, Jakuniec, Fiksenbaum, & Taubert, 1999) as a quantitative
164 questionnaire and (2) an Applied Cognitive Task Analysis (ACTA) (Militello & Hutton, 1998) as a
165 qualitative structured interview instrument (Teddlie & Tashakkori, 2009). Parts 1 and 2 were both
166 piloted and cognitive interviews undertaken (Drennan, 2003) with representative samples and
167 reappraised prior to use. To avoid interviewer bias, the interview was structured with open-ended
168 questions to engage participants and elicit open-ended, rich and deep responses (Frey & Fontana,
169 2005; Patton, 2002). The small potential sample of suitably expert coaches influenced our choice of
170 a mixed approach and our choice for depth in preference to breadth of inquisition. With regard to
171 credibility and data interpretation, the authors are both qualified and active AS coaches and leaders.
172 Both hold a range of the high-level qualification in a range of AS, a combined experience of over
173 sixty years in kayaking, canoeing, mountaineering and skiing.

174 **Part 1: Proactive Coping Inventory**

175 As a starting point, we hypothesised that we would see a full range of proactive coping strategies
176 across the participants and that these may differ dependant on sex and experience.

177 **Participants.** Following institutional approval, a purposive sample of active British AS coaches
178 (n = 65) was invited to take part in the study at professional development training conferences in the
179 UK over the winter period 2017–18. To ensure a sufficient level of domain expertise, experience and
180 inherent quality in terms of participants' self-reflective abilities, purposive sampling was employed
181 based on the following criteria: (1) a minimum of five years' coaching experience since senior
182 accreditation as a coach or leader, (2) active engagement in AS coaching over that period and (3) a
183 willingness to examine their professional practice. Participants were clearly delineated by gender (n=
184 41males and n=18 females) and split into two groups based on years of experience in AS coaching (>5
185 years low experience and < 5years high experience)

186 **Procedure.** Once consent was received, a copy of the PCI (Greenglass, Schwarzer, Jakuniec,
187 Fiksenbaum, & Taubert, 1999) was forwarded to each coach. The PCI comprises seven scales
188 consisting of fifty-five items: PAC (n = 14), Reflective Coping (n = 11), Preventative Coping (n =
189 10), Avoidance Coping (n = 3), Instrumental Support Seeking (n = 8), Emotional Support Seeking (n
190 = 5) and Strategic Planning (n = 4). These scales examine, on a cognitive and behavioural level,
191 ways of coping based on resourcefulness, responsibility and vision. Participants were asked to
192 confidentially and anonymously complete the PCI by scoring responses to each item using a four-part
193 Likert scoring response (1: not true at all, 2: barely true, 3: somewhat true and 4: completely true).

194 **Data processing and analysis.** Data collected from the PCI were analysed in line with the
195 recommendation of the PCI originators (Greenglass et al., 1999), using two 2 X 7 (Sex X Factor) and
196 (Experience X Factor) ANOVAs, with Greenhouse-Geisser adjustment used throughout. At this
197 point, participants were also asked whether they would be willing to participate in the ACTA part of

198 the research. Six were randomly selected from those who agreed. A mutually convenient date and
199 time for the second stage were agreed following consent from participants.

200 **Results.** Of the participants (n=65), 96% response rate was achieved(n=63). Four further
201 were discarded for failing to meet the response criteria, erroneous or unclear answers. Consequently,
202 the final data set equates to a 94% completion rate and sample size of n = 59. An initial descriptive
203 analysis of those responses was completed, followed by a comparison of results between experience
204 and gender, (Table 1.)

205 *Insert Table 1 close to this point*

206 Significant Mauchly Test results for sphericity in the data led to the use of the conservative
207 Greenhouse-Geisser adjustments as recommended by Abdi (2010). No significant interactions were
208 apparent in the experience values. In the gender analysis, results demonstrated an unsurprising
209 significant main effect for Factor (unsurprising and spurious, as the factors are evaluated with
210 different scales) but also and of interest, a significant interaction between gender and factor
211 ($F(4.67.266) = 2.48, p < .05$) albeit with a small effect size (Partial $\eta^2 = .04$). This was followed up
212 by a Tukey test, which showed this to be due to differences in proactive coping, instrumental support
213 and avoidance seeking (see Table 1).

214 **Brief discussion of results for Part 1.** The lack of significant differences between
215 participants of different experience levels may reflect an aspect of participation in AS. Either
216 participation in AS attracts individuals who have these characteristics or active participation
217 encourages the development of proactive coping strategies. We conjecture that this may be a unique
218 aspect of coaching in this domain, namely that coping skills may be present in the coaches as a result
219 of being independent practitioners in AS before becoming coaches. This is an area worthy of further
220 investigation. Recent research (e.g., Frühauf, Hardy, Pfoestl, Hoellen, & Kopp 2017) has identified
221 reflection and learning from experience as an integrated aspect of AS. This may be an attribute that

245 The following knowledge audit took the form of a semi-structured interview focused on constructing
246 and expanding the diagram

247 **Knowledge audit.** The knowledge audit identified how the coaches' expertise was used. The
248 knowledge audit aimed to capture important aspects of the coach's expertise and focused on
249 knowledge categories that have been found to characterise expertise of coaching in similar contexts.
250 These included diagnosis and prediction, situational awareness and demands, adaptability and
251 flexibility, perceptual skills, development of and knowledge of when to apply tricks of the trade and
252 heuristics, improvisation, meta-cognition, recognition of anomalies and compensation for equipment
253 limitations. Probes and questions (see Table 3) were used to elicit domain-specific knowledge or
254 skills and further examples. Depth was also achieved, allowing the nature of these skills, specific
255 events and strategies to be examined. Initial probes were followed by increasingly specific questions
256 that examined examples, cues and strategies of decision-making. Finally, potential errors were
257 discussed.

258 *Insert Table 3 close to this point*

259 **Simulation interviews.** The simulation interview focuses more specifically on the coach's
260 cognitions within the coaching process. The stimulus scenario was selected and adapted from five
261 possible scenarios used in AS coach training, with the same challenging scenario presented verbally
262 to each participant. This described a situation in which a student was failing to learn a key skill
263 relevant to their progression and in which the coach's regular approaches had failed. In the scenario,
264 the student was reported as getting frustrated and tired. The simulation probed for situation
265 assessment, actions, critical cues and potential errors (see Table 3). A guide was constructed with
266 questions influenced by critical incident technique (Flanagan, 1954) as a 'knowledge elicitation
267 strategy' (Flin, O'Connor, & Crichton, 2008, p. 222). The interviews allowed us to elicit key
268 information and explore experiences in greater depth. Specifically, the process involved a
269 partnership between interviewer and interviewee, the key element of which was an exploration with

270 the interviewee of what information was influential when assessing a situation or selecting a
271 particular course of action (Flin et al., 2008).

272 ***Cognitive-demands table.*** After conducting these three stages of the ACTA, a cognitive-
273 demands table (Table 4) was used to analyse the data and focus the analysis on the research aims and
274 objectives. The table provides a format that focuses analysis on the research aims by reviewing the
275 common themes that emerge from the data derived from stages 1, 2 and 3. We focused on difficult
276 cognitive elements, why those aspects are difficult, the anticipation and addressing of these
277 challenges (cues and strategies) and anticipated common errors. The table identifies common themes
278 in the data, connecting information and relationships.

279 **Part 2: Analysis and Results Applied Cognitive Task Analysis**

280 All participants identified the highest cognitive load as being associated with two interrelated
281 stages in the initial context of meeting unknown students (Table 4). The first was the decisions
282 associated with the initial planning of the activity prior to embarking on the coaching itself, in which
283 a venue and location were identified. This reflected the individualised focus of the whole coaching
284 process from the outset. Second was a linked stage in which an in the field audit of the initial
285 planning assumptions and decisions were made. These two stages led directly to the initial coaching
286 interactions that generated less cognitive demand. The cognitive demand lies in the initial venue
287 selection and consolidation of a straw-man plan, namely one that is meant to be reconfigured as
288 information is consolidated.

289 *Insert Table 4 close to this point*

290 **General Discussion**

291 **Initial meeting and activity with clients.** An initial information-gathering stage prior to
292 meeting the clients was associated with a high cognitive load. Coaches 5 and 6 both preferred to

293 contact the clients in advance of any planning, whilst coaches 1, 2, 3 and 4 all started gathering
294 information immediately prior to coaching by reviewing weather and condition forecasts and client
295 details from booking forms. In both approaches the process reflected the expectation of the coach's
296 employers; coaches 5 and 6 work within small coaching providers, while coaches 1, 2, 3 and 4 work
297 with larger organisations and are constrained by logistical and practical demands.

298 Irrespective of the order, this initial information-gathering stage initially appeared to be a classic
299 decision-making process in which optimal information and time are invested in an effort to select an
300 initial coaching venue and potential content. Participants drew explicitly on reflection (Schön, 1983),
301 of their own experience with potential venues in particular conditions, seeking venues that allowed
302 for multiple options and flexibility in terms of activity and task. Coaches 1, 2 and 6 identified the
303 'habitual' use of particular venues that met these requirements 'I know of good venues that allow me
304 to see what I need...' (C6), this approach appeared to implicitly recognised a need to retain cognitive
305 resources for later demands, though was not explicitly highlighted by the coaches. Coaches 2 and 5
306 identified a potential habitual and familiarity heuristic (Cox, 2007; Girgerenzer, Todd, & ABC
307 Research Group, 1999; Hammond, Keeney, & Raiffa, 1999; McCammon, 2004; Plouso, 1993;
308 Renfrew, Martin, Micklewright, & St Clair Gibson, 2014; Russo & Schoemaker, 1989; Gregg,
309 Hahadevan, & Sedikides, 2017) but recognised the potential for biases and traps with this approach;
310 both guarded against these by recognising the potential for this occurrence and auditing the decision-
311 making process and exploiting their community of practice, a meta-cognitive aspect of the coach's
312 activity. Coach 4 described this venue selection stage as 'a straw-man plan' in which logistical
313 aspects (transportation, lifts, shuttles etc.) could be fixed, thus reducing cognitive load at this point in
314 the process but enabling all other aspects to be checked, challenged and reconfigured. The logistical
315 aspects effectively became absolutes, providing a framework within which decisions about the
316 activity and interaction with clients could be made. This approach, however, was used to manage the

317 coach's own cognitive resources in anticipation of a second, linked—but more cognitively
318 demanding—stage: the field audit cited earlier, which formed the focus of the initial coaching
319 session. Implicitly, the coaches appeared to recognised the extent of and manage their own cognitive
320 resources, , though this appear tacit in nature (Polyanni, 1958/1998; Nonaka & Takenchi, 1995) and
321 requires further investigation.

322 **The Field Audit.** The information gathered regarding weather, conditions and the self-
323 reported client abilities was used to inform venue choice and the immediate first couple of hours of
324 coaching. A holistic view of the client, the environment and the interaction of the two was developed
325 and then continually refined, updated and modified throughout the coaching interaction as part of an
326 initial field audit. An escalating heuristic was applied to the client, see our note earlier regarding
327 Cialdini, (2001). Coach 3 stated that 'the more time I spend with the clients, the more accurate my
328 knowledge about their abilities and behaviour in the environment'. This further reduced cognitive
329 load by reducing the options considered, some initial options are disregarded while others are
330 reprioritised. Coaches 1 and 4 also highlighted that their abilities included responses to coaching and
331 behaviour in the field under a range of conditions. This reflected the coaches' confidence in the
332 information gathered as much as its accuracy: greater confidence for the coach in their decision-
333 making reduced cognitive demands by reducing the variables and the extent of their influence but
334 would be clearly prone to heuristic traps.

335 Strategies to elicit accurate information were employed by all coaches, though these did differ
336 by coach and by case. Coaches 3, 5 and 6 initially focused on technical ability and performance,
337 while coaches 1, 2 and 4 initially sought indications of personal traits and pedagogic points, this
338 appeared to reflect the background. As a secondary focus, the attention switched, addressing the
339 remaining points and triangulating the information to create a holistic view of the clients as both
340 performers and learners. The order of this aspect of the information-gathering reflected the coaches'

341 own mental models of the situational demands faced in that context and anticipated contexts as the
342 coaching process evolved. Bar-Eli, Plessner and Rabb. (2011) comment that this may prove
343 suboptimal because key information is missed, ignored or negated and links this this is due to a
344 cognitive capacity constraint. However, the emerging ‘picture’ of the client and their development
345 enhanced the coaches’ confidence in their decision-making, though this in itself may become a
346 heuristic and prone to bias and assumption. While Cialdini, (2001) does warns against heuristics that
347 increase cognitive effort this instance, appeared to lessen the cognitive load by reducing the inherent
348 questioning of their decisions by accepting some fixed points and consolidating others. These appear
349 to be logistical but also created by the instructor based on their background as cited earlier. No
350 heuristic was applied to the weather and conditions reports; these forecasts were updated regularly in
351 the mid- and long-term plans, while short-term anticipation of changes in conditions and weather was
352 based on the coach’s field observations, training and experience. Thus, a cognitive resource was
353 retained to address any potential acute stressors that could be generated by unanticipated changes in
354 conditions, coach 5 described this as ‘a weather eye’ meaning a situational awareness and
355 comprehension of the demands of the context. The nature of this cognitive resource—whether it is a
356 ‘ring fenced’ resource, perhaps as an aspect of working memory and linked to executive function, or
357 an additional one, retained as an ‘overdraft’ in long term memory—appears unclear and warrants
358 further investigation.

359 **Retaining Flexibility.** All the coaches anticipated deficiencies and inaccuracies in the
360 information available at a local level. These included, for example, the reliability of regional weather
361 forecasts in a local context, anomalies and inconsistencies in condition reports as an effect of local
362 weather and challenges in identifying client’s abilities as an outcome of client misrepresentation or
363 misperception. Consequently, the coaches used naturalistic decision-making, (Kahneman,2011,
364 Klein, 2008, 2015) in an effort to reduce the cognitive load prompted by sub-optimal information

365 while also retaining flexibility. Specifically, a conservative heuristic was applied: the less confidence
366 the coach had in the information available, the more conservative the choice of venue. Secondly, and
367 relatedly, an inverse heuristic was applied in which the more uncertain or dynamic the conditions, the
368 lower the assumed ability of the clients. This assumption did not relate to the level of client
369 performance but rather the durability, robustness and resilience of the client's performance under the
370 pressure generated by the conditions. An anticipation of performance collapse under pressure was
371 accommodated as an aspect of this heuristic. Consequently, the coach's adjustments to the task and
372 delivery at the venue augmented the variety required in venue selection highlighted earlier. This
373 combination of classic and naturalistic approaches supports our earlier contention that decision-
374 making in this context is synergetic in the planning stages. We speculate, however, that such
375 scepticism regarding weather and conditions reports may be reflective of the UK context of this study
376 and is worthy of further investigation. These decisions would be less demanding in situations in
377 which weather patterns or conditions are more predictable or fixed.

378 **Use of the Community of Practice.** The community of practice, in this case immediate
379 colleagues and associates, was used to gain additional information regarding venues, seek support for
380 decisions, a check and challenge, and reducing cognitive load by increasing the quality of the
381 information available. This appeared to support the notion that it is the uncertainty and paucity of
382 information, not its amount, that generates cognitive and germane load. The point at which the degree
383 of certainty becomes acceptable is specific to the coach, clients and context; the riskier the context,
384 the more certainty is required. Multiple interrelated factors are at play: for example, high coach-to-
385 client ratios (e.g., 1:8) with well-known students in benign conditions—a sheltered lake—has a lower
386 cognitive load than a lower coach-to-client ratio (e.g., 1:2), with unknown clients in highly dynamic
387 conditions. This suggests that the cognitive load stems from the synergy of environmental and
388 coaching demands (situational awareness and demands) rather than just the numbers of students
389 involved, beyond the simple issue of reducing the span of control. This may challenge long-held

390 beliefs that more advanced conditions automatically necessitate a lower client-to-coach ratio in
391 favour of a more nuanced decision based on the student's ability in context. Knowledge of student
392 ability becomes a factor, as a coach with capable and known students may be able to operate in a
393 more advanced environment than the same coach with the same number of unknown students.
394 Clearly, though, a logical increase in demand brought about by an increased span of control cannot
395 be overlooked. In short, the notions of low coach to student ratio is not as simplistic as the idea that
396 advanced conditions equal a low ratio and is worthy of future investigation.

397 Of interest, coaches 1, 2 and 4 were selective in their use of the community of practice.
398 Specifically, they sought out particular sources, linking their choice to trust, empathy and relationship
399 to the learning outcomes for their proposed activity. As a consequence, the available CoP was
400 largely based on professional respect and relevance to the proposed activity. Coaches 3, 5 and 6 used
401 an even narrower group of immediate colleagues via closer friendship links. Interestingly, the
402 coaches perceived the use of the CoP as a 'sign of weakness' (C2, C3, C5 and C6) and viewed it as a
403 trait of less-experienced instructors, C3 highlighted a 'potential to be sandbagged'²². On
404 investigation, this reflected the perceptions of a small group of respected and influential instructors
405 whose seniority was based on experience and high levels of personal performance but not on specific
406 pedagogic training. As such, this was a historical issue and highlighted the ongoing transition in AS
407 coaching from high performers becoming coaches to suitably trained professional coaches. Coach 6
408 articulated this transition as 'being a *rock climbing* instructor or a rock climbing *instructor*',
409 describing a difference in the perception of their role. Coach 5 described this as 'the paddler
410 sustaining their paddling habit by doing a bit of coaching on the side'. This may reflect either the

²² 'Sandbagged': describes advice given either intentionally or unintentionally that may result in greater work for the coach,

411 professionalisation of coaching or the growth of the outdoors sector and is worthy of further
412 investigation.

413 **Creating Wholistic Client View**, Following the gathering of information, creation of a
414 strawman plan and fixing of the logistics assures that a suitable flexible and secure location are
415 selected. The primary purpose of this initial activity was to complete a ‘field audit’. Coach 1 stated:

416 So, I'm stood there in this place that I've chosen, gone through all the process of
417 deciding what to do and what I could do. Getting there, what is the actual weather in
418 front of me? What are the people in front of me? And then there is a kind of resilience
419 to what is actually happening.

420 Coach 5 stated that ‘no plan survives first contact....’, paraphrasing an old military adage. An
421 initial audit of the venue selection—literally, what the coach is observing at the venue against the
422 forecasted weather and conditions—precedes any activity. Coach 4 highlighted the significance of
423 this literal reality check. This was a specific point in an ongoing audit of forecast against reality.
424 Coach 6 noted that the option is always retained to change venue, a Plan B, which will have been
425 amongst a limited number those already considered and retained as a safe fall back that ensures some
426 activity, security and the opportunity to audit the clients. If weather and conditions appear as
427 predicted, an internal, two-part question for the coach—is this as I expect and will it change as I
428 expect?—is then applied to the clients. Consequently, the objective of the session is to generate a
429 ‘picture’ (C1 and C4) of the client as a learner in context.

430 Profiling performers is not new and, unsurprisingly, the coaches employed a range of
431 observation and questioning strategies (Giblin, Farrow, Ball, & Abernethy, 2015). These appear
432 highly individualised, both towards the performer and coach (McGarry, 2009) with coaches having
433 preferred approaches, questions and assumptions based on their experiences and forming a set of
434 highly personal heuristics built within the absolutes mentioned earlier. In this respect, a synergy of
435 classic and naturalistic decision-making was apparent. Coach 5 described these as structured and

436 unstructured observation, which also applied to synergetic questions applied by the coach. An audit
437 is implied by coaches 2 and 4 and explicitly identified by coaches 1, 3, 5 and 6. In short, the question
438 ‘Does the client’s perception of their ability match what the coach observes?’(C1) has clear safety
439 and pedagogic implications. Again, the coach asks the internalised question, ‘Is this as I expect?’, in
440 this case regarding the behaviour of the client in response to both coaching and the environment.
441 Understanding this aspect of a client’s behaviour has safety implications as it directly influences goal
442 setting, venue selection, safety measures and coaching approach. Anticipating client responses, their
443 rate of development and their response to the environment reduces acute cognitive load by ensuring
444 that the coach can gauge and adjust the environment and activities that that client may undertake.

445 Coaches 1, 2, 3, 4 and 6 described a need for holistic observation and questioning via
446 increasingly structured activities. The coaches’ conclusions were drawn from an appraisal of
447 technical performance and the clients’ understanding of that performance in a range of different
448 contexts. Notably, however, the coaches also paid particular attention to the behaviour of the clients,
449 their responses to questions and their body language. Coaches 1, 2, 3 and 4 all referred to ‘the whites
450 of their eyes’ as indications of fear. Coaches 2, 4, 5 and 6 all looked for changes in client behaviour
451 in the immediate, short and midterm as environments changed. Coaches 1 and 3 identified ‘delaying
452 tactics’ (C1) and ‘faffing’³ (C3) as strategies employed by clients prior to activity about which they
453 felt uncertain. Coaches 3 and 6 identified changes in performance, such as ‘shortening of paddle
454 strokes’ (C5) or ‘reduction in stability’ on uneven terrain (C6), which both coaches attributed to
455 increasing anxiety that was a consequence of change. Importantly, the coaches used these
456 observations in comparison with earlier observations in less stressful environments, although this was
457 not explicitly articulated in the decisions about venue selection highlighted earlier.

³ ‘Faffing’: an informal term meaning spending one’s time doing a lot of things that are not important instead of the thing one should be doing.

458 Information gathered in the audit was used at two levels: initially, an *act on* (immediate safety), *store*
459 *for later* (learning) or *ignore* basis, and an almost immediate secondary level that applied that created
460 two sub-categories: namely, *act*, then *store*, in order to see a coaching and learning response.
461 Conversely, a ‘store then act later’ could also be applied, combined with other information that could
462 identify a root cause to a performance problem. Two aspects appeared to be at play in this respect:
463 (1) a triangulation of stored information and (2) a prioritising of information in relation to any safety
464 concerns. Coach 5 described this as ‘looking for a root cause’. Outwardly, this approach demanded
465 greater cognitive effort than just responding to the multiple individual signs, while addressing cause
466 rather than each sign reduced cognitive load later in the coaching interaction, in this respect, the
467 events of high cognitive loads—can be timed, when other demands are lower. The coaches
468 recognised that, by avoiding repeated and less effective interventions in favour of a single accurate
469 intervention, the cognitive load can be managed on coach and the learner. In this respect, it involves
470 reducing the cognitive load by redesigning the straw-man plan and reducing and reordering the
471 possible options.

472 The coaches manage the demands of new and novel situations at a macro level by using a
473 problem-solving strategy that starts with the last decision and action by the coach; if a learning
474 impasse is encountered and is preceded by a change in task, this is the most likely cause of the
475 problem, for example. If, however, the impasse follows the coaches’ feedback, the coaches’ delivery
476 of that feedback is to be examined. Two interrelated heuristics emerge: the first based on the most
477 probable cause drawn from the coach’s experiences and preferences and the second based on a
478 particular response. Such heuristics appear to illustrate the coaches’ recognition of the cumulative
479 impact of arousal levels generated by the environment, for instance. Implicitly, this suggests a
480 recognition of the student’s own finite resources for coping and the effect of exceeding that capacity,

481 as the coaches appear to be managing both their own and their clients' cognitive resources, a practical
482 application of Sweller (1998) cognitive load theory

483 A third heuristic is also at play that reflects the effect of change on the client. If something is
484 changed (e.g., the task, environment or actions of the client), the performance is anticipated to
485 decline while the client processes the change. Coach 5, for example, reported a need for further
486 action only when improvement was not observed after several attempts. Coach 1 also reported
487 making changes to the coaching of a client in advance of the anticipated need in order that learning
488 may occur. This suggests that learning is recognised by the coach a cognitive rather than just
489 observable process. With respect to the chronic cognitive load, it is managed in two ways: reducing
490 the frequency of feedback that requires thought and observation and, as cited earlier, avoiding
491 repeated less effective interventions, management of clients and coaches the intrinsic, extrinsic and
492 germane cognitive loads. Conversely, acute cognitive load may be addressed by encouraging
493 replication of a particular skill without a longer-term learning objective. For instance, an unexpected
494 change in conditions may oblige a client to replicate a particular skill for safety reasons. A simple
495 'show, tell and copy' rather than consideration of a more sophisticated pedagogic approach requires
496 the coach to match the approach with the demands of both the clients and the environment. Matching
497 the pedagogic approach with the desired outcome—in other words, picking the right 'tool' for the
498 job—emerges as a cognitive load management strategy.

499 On a micro level, the coaches use a combination of loose (Nicolson, 1971) or component
500 parts, small functional units and some structural procedures in different combinations to facilitate a
501 solution. Existing components, units and procedures are adapted and repurposed in preference to
502 redesigned novel solutions, thus lessening cognitive demands. Integrated within this process is
503 reflection in action (Schön, 1983), on the effect of the coaches' actions and on action in order to

504 integrate the novel solution into the coaches' repertoire. Coaches 1, 2 and 5 highlighted both
505 opportunistic and actively created chances for reflection during the activity.

506 **Limitations and Future Research**

507 Reflecting the geographic constraints and sample size, further investigation could logically
508 examine the coping strategies from a larger and more geographically diverse sample. We speculated
509 earlier that two aspects of the study—(1) the scepticism of this sample regarding weather and
510 conditions reports and (2) the increased professionalisation of coaching in this context (the use of the
511 community of practice and perceptions of coaches' roles)—may both be reflective of the UK context.
512 More generally, in reporting on this sample of experts, it is logical to examine the training and
513 development of proactive coping strategies in non-expert coaches. Specifically, and reflecting the
514 need for these coaches to participate alongside their students in the activity, we would also ask
515 whether managing the cognitive demands of participation in AS may predispose coaches to
516 integrating these demands into the coaching process. The degree and genesis of the small but
517 significant gender effects detected is also worthy of further investigation, especially if this aspect is
518 shown to play a role in coaching efficacy and/or the workload imposed. Finally, reflecting the
519 inherent risks associated with coaching in these activities, it would be useful to examine further how
520 coaches may ring-fence cognitive resources to deal with the acute demands of potential emergencies.

521 **Conclusion**

522 What emerges from this study is management through proactive coping, rather than reduction
523 of cognitive load by the coaches. This may reflect the characteristics of high-level performance in
524 this domain. Coaches accommodate the finite nature of their own cognitive resources in order to
525 manage the demands and take steps to ensure adequate cognitive resources are available for the
526 anticipated peaks in demand. We speculate that an element of those resources may be ring-fenced to

527 respond to the acute demands of emergencies, although this will require further investigation. This
528 may reflect a willingness to take tougher decisions and work harder in anticipation of greater savings
529 later rather than easy options immediately: in short, coping with demands by managing the coaches'
530 resources based on the anticipated demand, which in turn derives from the coaches' own reflections
531 on their experience of their own professional practices.

532 With respect to proactive coping strategies, the cognitions and behaviour of the coaches focus
533 on their goal-setting capacity. Primarily, this is self-regulation, driven by the goal. The coaches have
534 clearly established goals for their interaction with clients that focus and prioritise their actions and
535 thus their cognitive load. The male coaches in part 2 focused their goals around outcome, while the
536 female coaches focused their goals around process. We suggest that a middle-ground position
537 appears optimal and that as coaches' experience grows, an ability to move between process and
538 outcome focus becomes optimum.

539 With respect to instrumental support seeking, the coaches all used their community of
540 practice. Significantly, the male coaches restricted their community of practice to trusted friends and
541 immediate colleagues, whilst the female coaches used a broader community of practice that relied on
542 professional respect and recognition of the aims of the coaching. All reflected on the perception of
543 using the community of practice as a sign of weakness, which possibly reflects a historic culture
544 within the domain that places value on personal ability at the expense of pedagogic skills. Our own
545 work has highlighted a middle-ground position in this regard (Collins & Collins, 2012, 2016) that
546 still merits further investigation. With respect to avoidance coping, the planning process, information
547 gathering and audit act to delay or mitigate the cognitive load by virtue of reducing variables and thus
548 complexity, which in turn reduces the number of possible options, building and developing a holistic
549 image of the clients as learners in context. This study has deepened our comprehension of the
550 decision-making processes in expert coaches in this domain and illustrated a set of heuristics that are

551 synergistically with other decision-making processes to manage cognitive load. We highlight the
552 level of cognition used by experts in this domain. The coaches acknowledge their finite cognitive
553 resources and take steps to prioritise their use in anticipation of demand to ensure both client safety
554 and development.

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714 Table 1: PCI Results

	<u>Gender</u>	<u>Mean</u>	<u>Std. Deviation</u>	<u>N</u>
<u>Proactive Coping</u>	<u>Female</u>	<u>42.17</u>	<u>6.474</u>	<u>18</u>
	<u>Male</u>	<u>44.73</u>	<u>4.410</u>	<u>41</u>
	<u>Total</u>	<u>43.95</u>	<u>5.208</u>	<u>59</u>
<u>Reflective Coping</u>	<u>Female</u>	<u>33.61</u>	<u>3.550</u>	<u>18</u>
	<u>Male</u>	<u>33.63</u>	<u>6.110</u>	<u>41</u>
	<u>Total</u>	<u>33.63</u>	<u>5.426</u>	<u>59</u>
<u>Strategic Planning</u>	<u>Female</u>	<u>11.94</u>	<u>1.955</u>	<u>18</u>
	<u>Male</u>	<u>11.59</u>	<u>2.202</u>	<u>41</u>
	<u>Total</u>	<u>11.69</u>	<u>2.119</u>	<u>59</u>
<u>Preventative Coping</u>	<u>Female</u>	<u>27.11</u>	<u>3.848</u>	<u>18</u>
	<u>Male</u>	<u>28.80</u>	<u>5.269</u>	<u>41</u>
	<u>Total</u>	<u>28.29</u>	<u>4.910</u>	<u>59</u>
<u>Instrumental Support</u>	<u>Female</u>	<u>26.00</u>	<u>4.044</u>	<u>18</u>
	<u>Male</u>	<u>23.85</u>	<u>4.783</u>	<u>41</u>
	<u>Total</u>	<u>24.51</u>	<u>4.644</u>	<u>59</u>

Emotional Support

<u>Female</u>	<u>15.44</u>	<u>3.989</u>	<u>18</u>
<u>Male</u>	<u>14.56</u>	<u>3.647</u>	<u>41</u>
<u>Total</u>	<u>14.83</u>	<u>3.742</u>	<u>59</u>

Avoidance-Seeking

<u>Female</u>	<u>7.11</u>	<u>2.676</u>	<u>18</u>
<u>Male</u>	<u>8.37</u>	<u>1.785</u>	<u>41</u>
<u>Total</u>	<u>7.98</u>	<u>2.154</u>	<u>59</u>

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745 Table 2: ACTA participant details

<u>Coach</u>	<u>Gender</u>	<u>Specialism</u>
<u>1</u>	<u>Female</u>	<u>Alpine mountaineering</u>
<u>2</u>	<u>Female</u>	<u>Alpine mountaineering</u>
<u>3</u>	<u>Male</u>	<u>Mountaineering, white-water kayaking</u>
<u>4</u>	<u>Female</u>	<u>Mountaineering</u>
<u>5</u>	<u>Male</u>	<u>White-water kayaking</u>
<u>6</u>	<u>Male</u>	<u>White-water kayaking, mountain biking</u>

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<u>Question</u>	<u>Guide</u>	<u>Prompts</u>	<u>Time</u> <u>(minutes)</u>
<u>Task Diagram</u>	<u>What are they?</u>	<u>Highlight on</u>	<u>20</u>
<u>Prepare a task diagram for an</u>	<u>Situational demands</u>	<u>diagram</u>	
<u>AS activity in which the</u>		<u>Articulate and</u>	
<u>participants are unknown to</u>		<u>field notes from</u>	
<u>the coach and the conditions</u>		<u>interview</u>	
<u>have required selection of a</u>		<u>Ensure clarity</u>	
<u>venue from a limited range of</u>		<u>and</u>	
<u>possibilities</u>		<u>understanding</u>	
<u>Of the steps you have just</u>		<u>of diagram.</u>	
<u>identified, which require</u>			
<u>difficult cognitive skills?</u>			
<u>Knowledge Audit</u>	<u>Cues?</u>	<u>Noticing</u>	<u>5</u>
<u>Have you had experiences</u>	<u>What?</u>		
<u>where part of the situation</u>	<u>When?</u>		
<u>just jumped out at you?</u>	<u>How?</u>		

<u>Are there ways of working smarter or accomplishing more with less that you have found especially useful?</u>	<u>Heuristics</u> <u>Improvisation</u> <u>Tricks of the trade</u> <u>Contextual practices</u>	<u>Job Smart</u>	<u>5</u>
<u>Can you think of an example when you have improvised or noticed an opportunity to do something better?</u>	<u>Improvisation</u> <u>Adaptation</u> <u>Flexibility</u>	<u>Opportunities/</u> <u>Improvisation</u>	<u>5</u>
<u>Can you think of a time when you realised that you would need to change the way you were working in order to get the job done?</u>	<u>Self awareness</u> <u>EI</u> <u>CI</u> <u>Of own DM</u>	<u>Meta-cognition</u>	<u>5</u>
<u>Can you describe an instance when you spotted a deviation from the norm, or knew something was amiss?</u>	<u>Atypical</u> <u>Unusual</u> <u>Exceptional</u>	<u>Anomalies</u>	<u>5</u>

<u>Have there been times when</u>	<u>Nature of that experience</u>	<u>5</u>
<u>the events pointed in one</u>	<u>How long?</u>	
<u>direction, but your judgement</u>	<u>Where?</u>	
<u>told you to do something else?</u>	<u>What?</u>	
<u>Or when you had to rely on</u>	<u>Potential errors</u>	
<u>experience to avoid being led</u>	<u>Pitfalls</u>	
<u>astray?</u>	<u>Problems with approaches</u>	
	<u>Limitations</u>	

Simulation Interview

<u>A situation in which a student</u>	<u>Challenge is pedagogic, NOT</u>	<u>What do you do</u>
<u>is failing to learn a key skill,</u>	<u>technical</u>	<u>when...?</u>
<u>relevant to their progression.</u>	<u>This should be kept to teaching</u>	
<u>The coaches' regular</u>	<u>approaches, NOT changes to</u>	
<u>approaches have failed and</u>	<u>technique that are perceived as</u>	
<u>the student is now getting</u>	<u>simpler</u>	
<u>frustrated and tired.</u>		

The coach may not be able to
respond to this reflecting
narrowness in pedagogic approach
rather than declarative knowledge.
Rate the ease of response 1-5 (1
impossible, 5 miss understanding
of req't)

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Initial meeting and activity with new clients

<u>Difficult Cognitive Element</u>	<u>Why Difficult</u>	<u>Common Errors</u>	<u>Cues and strategies used</u>
<u>Information Gathering</u>	<u>Inconsistency in available information</u>	<u>Recognition of these as variables and need for audit in short mid and long term</u>	<u>Use of heuristics</u> <u>Flexibility of environment and task</u>
	<u>Venue selection acting as a constraint</u>	<u>Commitment to a venue that does not offer the requisite variety</u>	<u>'Soft' plan</u> <u>Synergy of CDM and NDM</u> <u>Community of Practice</u>
<u>Audit of Plan</u>	<u>Accuracy of information</u> <u>Continual updating, adjusting of a</u>	<u>Assuming clients perception of own skill is accurate</u>	<u>Varied locations at a venue</u> <u>Observation and questioning</u>

<u>holistic model that</u>	<u>Underestimate impact of</u>	<u>Synergy of CDM</u>
<u>incorporates, the</u>	<u>environment</u>	<u>and NDM</u>
<u>client, environment,</u>	<u>Confirmation and expert</u>	<u>Information used on</u>
<u>learning and there</u>	<u>halo heuristic trap</u>	<u>an Act, store, ignore</u>
<u>interaction</u>	<u>'Hard plan'</u>	<u>basis also act then</u>
		<u>store and store then</u>
		<u>act later, prioritising</u>
		<u>Integration with mid</u>
		<u>and long term plan</u>

Student failing to Learn

<u>Difficult Cognitive</u>	<u>Why Difficult</u>	<u>Common Errors</u>	<u>Cues and</u>
<u>Element</u>			<u>strategies used</u>
<u>Exhausting existing</u>	<u>High cognitive load</u>	<u>Fault allocation.</u>	<u>Process to find the</u>
<u>knowledge</u>	<u>associated with</u>	<u>Linear single solution</u>	<u>solution</u>
	<u>adaptability,</u>	<u>Co-linear solution with</u>	<u>Loose parts with</u>
	<u>creativity and client</u>	<u>options for different</u>	<u>functional units</u>
	<u>expectation</u>	<u>procedures</u>	<u>Dendritic</u>
			<u>(possibilities</u>

stemming from 769

single route) 770

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