Putting Together First- and Third-Person Approaches for Sport Activity Analysis: The Case of Ultra-Trail Runners' Performance Analysis

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Abstract This study aimed to characterize the activity of ultra-trail runners by combining data from their personal experiences with physical measurement indicators of their running performance. Ten runners' first-person analyses of the *Tor des Geants* race were processed using course of action theory [1]. Runners' experiences were represented in a succession of macrosequences and characterized using their typical components. These were associated with third-person data about their elevation velocities assessed using motion sensors. Results showed different patterns of activity related to runners' aims and levels of performance. Three typical experiences were highlighted as frequently observed in such races and showed a strong association with overall elevation velocities. A fourth typical experience, one that followed a difficult race situation, presented finer-grained sensitivity that distinguished variations between ascent and descent velocities. Results were analyzed in relation to the sense-making process associated with routine or controlled activity.

Keywords Agentive experience · Enaction · Awareness · Course of action · Sense-making · Ultra-trail · Velocity · Time

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1 Introduction

Ultra-endurance race performances constitute sporting situations rich in data for understanding how people are able to surpass themselves. Research into sport psychology has examined the experiences of such athletes in order to understand how their ability to surpass themselves is linked to the way they manage their efforts during a race. This has shown that athletes' performances during an ultra-race can emerge from three typical activity states: preservation, survival, or revival states. The preservation state corresponds to the use of anticipatory strategies to finish the race or avoid withdrawal, such as reducing one's pace or using psychological coping strategies [2]. The survival state is defined as the consequence of the negative impact of sleep deprivation, emotional disturbance due to the duration of effort, and lost energy reserves [3]. The revival state is linked to positive mood states involving the influence of group cohesiveness among ultra-trail runners during parts of the race and self-awareness or mental stamina [4]. Succinctly, the research revealed that the two key factors for performing well in ultra-endurance events were planning the race in detail in order to control the pace and being able to cope with the inevitable survival situations which runners encounter [5].

Recent studies have also tried to further these principles by analyzing the differences between race withdrawers and finishers using an in-depth analysis of the content and ordering of such activity states. Rochat et al. [6] showed that certain relationships and ordering between the survival and preservation states allowed withdrawers to be distinguished from finishers. Antonini Philippe et al. [7] made a qualitative analysis of how runners progressively fell into the survival state, eventually pushing them to withdrawal. Hence, these in-depth analyses of activity states in relation to runners' feelings have progressively become a heuristic path towards a better understanding of the organization of such performance. However, the main limitation of all these studies was that they were exclusively centered on a first-person experience approach (i.e., a phenomenological level of analysis). Recent research in sport sciences has combined the third-person approach with analyses using a first-person approach [8]. We therefore sought to combine a third-person approach into our activity state analysis. Knowing that runners are very careful about the times they reach different key points in the race and frequently use their GPSs to monitor their velocity and effort, we chose to examine their velocity in relation to their experiences of activity states. Our research question was, "To what extent are the activity states experienced by runners associated with their real velocities during the race?"

To do this, we used course of action theory [1] and analyzed runners' activities as has been done in other sports performance studies [9, 10]. A course of action is a theoretical object that reflects the world enacted by a genuine agent in a situation. A course of action is characterized by the Elementary Units of Meaning (EUM) that mainly emerge from the association between the agent's intentional state (i.e., the range of possible actions that he or she can undertake) and the situation-related judgments of a proprioceptive, perceptive, or memory-based nature (i.e., Representamen). The course of action is thus the ordered linking together of EUM during a period of an agent's activity. It can also be characterized by emergent or higher order structures of meaning, such as sequences (i.e., a succession of EUM that corresponds to a same concern for an agent) and macro-sequences that represent the meaningful concerns of the agent during a succession of sequences.

In summary, by combining runners' first experiences with kinematic data from their race, we aimed to carry out a deeper analysis of how they "made sense" of their situation and were able to achieve different kinds of race performances.

2 Method

2.1 Participants

Ten runners between 23 and 58 years old (5 females, 5 males) volunteered to participate in this study. All had at least five years' experience in ultra-trail competitions (M = 9, SD = 2.6) and trained for an average of 80 km per week (SD = 30).

2.2 Data Collection

Data was collected during 2015 *Tor des Géants* ultra-trail race (332.5 km, 24,000 m change in elevation). There are six *life bases* distributed along the track (at 48.6, 102.1, 148.7, 200.3, 236.3, and 283.5 km). Owing to weather conditions, the race was interrupted and then definitively stopped before all the participants had finished it: at that moment, six study participants had run about 200.3 km, two had run 236.3 km, and the last two had run 283.5 km.

Three types of data were collected during the race: self-assessment data, field notes and leg movement. The self-assessments were made at the start of the race and at each life base,in order to rate: (a) the intensity of the effort carried out so far (E), (b) the level of tiredness (T), (c) the intensity of muscle damage experienced (D), and (d) the level of well-being (WB). This was done using a 10-point Likert scale for effort and 7-point Likert scales for the other assessment. Field notes related to the runners' states were recorded by the researchers during the time runners spent at each life base. They consisted of observations on the way they arrived at the life base, spent their time there, and restarted the race. Leg movement was assessed using Physilog® 4 Silver motion sensors (Gait Up SA, Lausanne, Switzerland) attached to each participant's ankle. This standalone wearable sensor incorporates a microcontroller, memory, tri-axial accelerometer (range $\pm$ 16 g-forces), tri-axial gyroscope (range $\pm$ 2000/s), barometric pressure sensor (precision of $\sim$10 cm in altitude), and a tri-axial magnetometer (disabled for this study). The sensor module is small (50 mm $\times$ 37 mm $\times$ 9.2 mm), weighs only 19 g, and has battery life up to 23 h. Batteries were changed at each life base. Accelerometer and gyroscope data were recorded with a sampling frequency of 100 Hz and the barometer was sampled at 25 Hz. The Physilog® collected each runner's elevation velocity and steps per minute throughout the race.

After the race, self-confrontation interviews were conducted by showing each runner his or her race map, recorded field notes, and self-assessment ratings at each life base. These interviews aimed to provoke the re-emergence of elements from the runners' recent past experiences when faced with traces of their own activities. As has been done in various sport studies, athletes were asked to describe, explain, and comment on their experiences, situating them within the context of the unfolding race [6, 7, 9, 10].

2.3 Data Coding

In line with previous sport sciences studies, the verbal narratives and traces of runners' past activities were coded into elementary units of activity using involvement and representamens (i.e., what was meaningful to them). These were then grouped into sequences, and then into macrosequences (MSs) in order to identify various levels of agentive experience. A succession of MSs characterized patterns in each runner's activity state [6].

We focused on each MS of each pattern by characterizing them using qualitative indicators (involvement and representamen) and quantitative data such as the distance covered and the values from the self-assessments. Each runner's average elevation velocity (i.e., ascent and descent) was also calculated. When a finer-grained analysis was needed (i.e., no significant effect had been observed), these average velocities were calculated by distinguishing between ascent and descent. Because the Physilog® recordings were continuous, data were pre-filtered using two steps: first, data under the value of 50 steps per minute were deleted (these data matched stops at life bases and nutritional resupply points); second, data for the flat sections of the race were deleted (less than 10 % of the total distance) in order to only use data corresponding to ascents and descents.

3 Results

Three patterns of running activity were identified: the *economical runner*, the *explorer runner*, and the *Kairos runner*. Below, we describe one case per pattern.

3.1 The Economical Runner

This pattern was characterized by one MS: "maintaining a very slow running speed, using each life base for recuperation" (200.3 km). The MS's involvement was

Table 1 Characteristics of economical runner macrosequence

	Self-assessment				Involvement	Representamen
	E	T	D	WB		
Maintaining a very slow running speed, using each life base for recuperation	3.8	3.6	3	5	Be careful about the pace, preserve oneself, save energy, do not get hurt	Acceptable levels of pain and fatigue, pleasure running, absence of physical pain

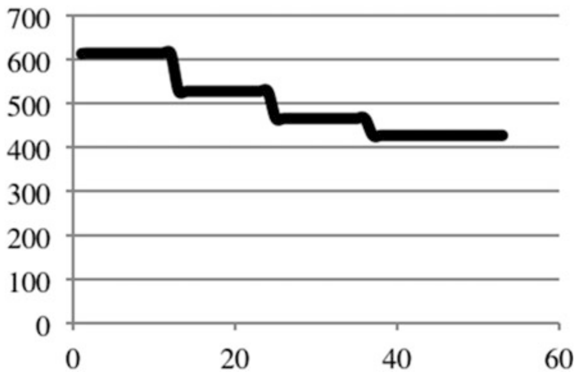

Fig. 1 The *black line* represents the evolution of the average elevation velocity between life bases for an *economical runner* (m/h) during the race

"save energy" or "preserve oneself", combined with the representamen of an absence of physical pain and an acceptable level of fatigue during the race. The *economical runner*'s self-assessment was one of feeling relatively comfortable as the race unfolded (see Table 1).

This pattern was also characterized by a progressive decrease in the average elevation velocity during the race, as shown in Fig. 1. This decreased from 614.90 m/h at the beginning of the race to 427.29 m/h when the race was suspended.

3.2 The Explorer Runner

This pattern was characterized by three MSs: "running without discomfort" (102.1 km); "running with sudden, extreme fatigue" (46.6 km); and "running at the best possible pace" (134.8 km) (see Table 2).

In the "running without discomfort" MS, runner tried to maintain a good pace without exhausting him/herself. Self-assessment revealed that this runner felt relatively comfortable. The "running with sudden, extreme fatigue" MS involved struggling to go on while feeling extreme fatigue. Self-assessment showed that this runner felt uncomfortable. The "running at a the best possible pace" MS consisted in giving one's best during the ascent and letting gravity take over in the descents.

Table 2 Characteristics of explorer runner macrosequences

	Self-assessment				Involvement	Representamen
	E	T	D	WB		
Running without discomfort	4.3	3.6	3	4.7	Do not blow out too early, try to maintain rhythm	Running feels easy, pleasurable, or really good, pacing oneself
Running with sudden, extreme fatigue	7	5	5	4	Hold on, struggle to go on	The cold is affecting me, not feeling well, feeling hot, suffering, legs hurting
Running at the best possible pace	6.2	4.5	4	3	Do the best I can on ascents, let gravity take over on descents	Struggling but running, feeling better, feel like I'm moving forward

Self-assessment revealed that this runner still felt uncomfortable even if some improvements emerged.

These macrosequences were also characterized using the average elevation velocity, as shown in Fig. 2. The "running without discomfort" MS was characterized by a high elevation velocity (M = 757.89 m/h). The "running with sudden, extreme fatigue" MS was characterized by a strong decrease in elevation velocity (M = 491.93 m/h). Finally, the "running at the best possible pace" MS was characterized by a weak, insignificant increase in elevation velocity in comparison to the previous one (M = 545.61 m/h).

The present results showed no significant difference between the average elevation velocity of the "running with sudden, extreme fatigue" and "running at the best possible pace" (491.93 vs. 545.61 m/h), so the average ascent and descent velocities were calculated (Table 3). Results indicated an increase in descent velocity and a decrease in ascent velocity for the "running at the best possible pace" MS compared with the "running with sudden, extreme fatigue" MS.

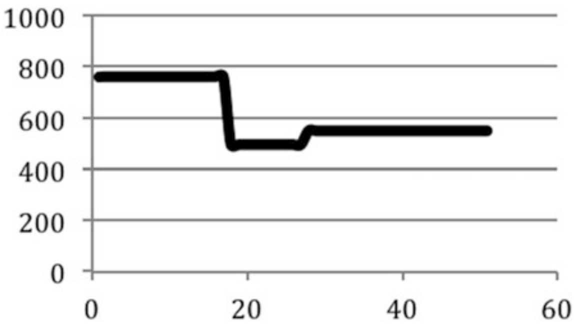

Fig. 2 The *black line* represents the evolution of the average elevation velocity between life bases for an *explorer runner* (m/h) during the race

Table 3 The ascent and descent velocities for the "running with sudden, extreme fatigue" and "running at the best possible pace" macrosequences of an explorer runner

Macrosequences	Ascent velocity (m/h)	Descent velocity (m/h)
Running with sudden, extreme fatigue	453.78	549.24
Running at the best possible pace	389.45	626.7

3.3 The Kairos Runner

This pattern was characterized by two MSs: "controlling the pace as the race unfolded" (271 km) and "accelerating to finish the race" (12.5 km). In the "controlling the pace as the race unfolded" MS runner tried to maintain a good running pace without exhaust themselves. Self-assessment showed that Kairos runner felt in a relatively comfortable zone. The "accelerating to finish the race" MS consisted in an abrupt change to the way in which the runner engaged in the situation to get ahead of his opponents and get back up the ranking. Self-assessment showed that *Kairos runner* made great efforts, however, the others elements of experience were rated at reasonable levels (Table 4).

Table 4 Characteristics of Kairos runner macrosequences

	Self-assessment				Involvement	Representamen
	E	T	D	WB		
Controlling the pace as the race unfolded	5.3	3	3	5.4	Energy to spare, do not get hurt	Running feels easy, acceptable fatigue, pleasure, absence of physical pain
Accelerating to finish the race	8	5	4	2	Lead the race, get further ahead, increase lead	Feeling of having lots of energy, very challenging weather conditions

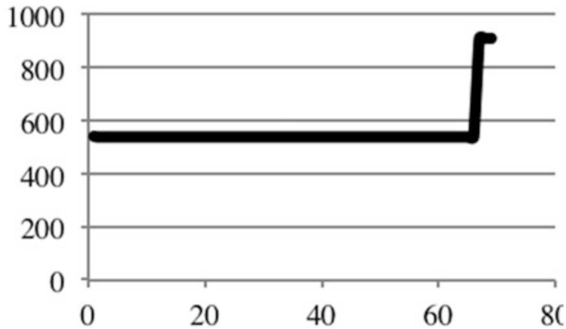

Fig. 3 The *black line* represents the evolution of the average elevation velocity between life bases for a Kairos runner (m/h) during the race

These macrosequences were characterized using the average elevation velocities (Fig. 3). The "controlling the pace as the race unfolded" MS was characterized by a stable elevation velocity (M = 535 m/h), whereas the "accelerating to finish the race" MS was characterized by a great increase in velocity values (M = 906 m/h).

4 Discussion

The different patterns presented here can be associated with various ways of managing the efforts required to complete an ultra-trail depending on the runner's expected performance. Clearly, the first pattern corresponded to amateur runners aiming simply to participate in and finish the race. The other two patterns, however, could be associated with more competitive runners aiming for a good personal performances or a strong ranking. These results confirmed the importance of accurately managing one's efforts and energies during such races [2, 4, 6]. They also revealed new ways of doing this.

Results showed that these means of managing effort could be organized into different sequences of experiences represented by macrosequences: these corresponded to specific types of involvement linked to the specific feelings associated with the runner's current situation. In macrosequences, the phenomenological *thickness* of the runner's stream of experience during the race is concentrated into a form of awareness of the situated activity or timely sense of agency [1, 11]—that is, the moment-by-moment feeling of being a runner competing in the race.

Three of the macro-sequences appeared to correlate with the values of the overall elevation velocities (including ascent and descent velocities). When runners characterized their perception of their pattern of running activity as *economical*, elevation velocity was relatively low and progressively decreased during the race. These runners were thus sensitive to the perceptual information of a low velocity, and a slow, step-by-step decrease in velocity (a decrease of 200 m/h over more than 50 h) did not affect this perception. The runners who described the feeling that activity accelerated towards the end the race saw their elevation velocity increase overall. Runners' awareness of the current situation appeared to be linked to the same overall increase in velocity with a value that was almost a 400 m/h for a short duration. For runners who described their feeling of activity as being one of extreme fatigue, the elevation velocity showed a great decrease compared to the previous state (almost 300 m/h lower). Once again, runners' awareness of the situation appeared to be linked to the value of the elevation velocity.

Thus, we can argue that ultra-trail runners' awareness of their race activity is made up of the perceptual information related to the average elevation velocity that afford them during different parts of the race. The runners constructed a situational awareness in which their elevation velocities informed them about the activity state in which they were running. These results add to our understanding of the three activity states that ultra-runners experience during a race [6]. When elevation velocity values are progressively decreasing within a low range, runners' awareness of being in a preservation state remain constant. In contrast, when elevation velocity values increased or decrease strongly, they informed runners of whether they were in revival or survival states.

The present results also revealed a fourth macrosequence labeled "running at the best possible pace." This activity awareness emerged when runners were able to go out from a loss activity state. In this macrosequence, mean elevation velocities did not seem significantly different from the previous macrosequence in which runners felt they were in a survival state. However, a closer look at the data showed that mean ascent velocities had decreased (by 60 m/h) whereas mean descent velocities had increased in the second one (by 70 m/h). Thus, we can argue that this awareness of "running at the best possible pace" was linked to the distinction between the two types of elevation velocity—ascent (managing a relative decrease in speed) and descent (running faster). Runners' awareness of being in a better state, of feeling better, was informed by this distinction between velocities. This result can be interpreted by saying that after being in a state of difficulty, runners had to enact a more accurate world. By trying to enact it, they used the possibilities offered by the situation (ascent and descent). These ascents and descents velocities constituted affordances and informed runners about the new states that finally makes emerging this sense.

These results are congruent with the enactive conception of human activity in which (a) routines (corresponding to the three first macrosequences, and frequently observed in trail running, e.g., [2–4]) makes emerging a global sense of activity and (b) disruptions, in order to be absorbed implies to create a new world of actions by increasing level of attention and distinguishing more and at finer grain elements available in the environment [12, 13].

To conclude, the original way in which first- and third-person data were aggregated in this study have enriched our understanding of the components of activity state awareness during an ultra-trail race. The present findings suggest the potential heuristic value of this method for future studies in sports-oriented situated activity.

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