Navigation in Outdoor Environments as an Embodied, Social, Cultural and Situated, Experience: an Empirical Study of Orienteering

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Abstract

This study investigated novices' "lived experiences" of navigation within the sport of orienteering from an enactive and phenomenological approach. The objective was to characterize qualitatively elements of task-related situations that were meaningful for orienteers. The results showed that the participants continuously made judgments about the reliability of their estimations about whether they were on "the right route" on the course. When the participants judged that they were only approximately on the right route or were unable to locate themselves, elements of the situation other than map and terrain features became meaningful for them. These results demonstrate that, for novice orienteers, navigation activity must extend beyond navigation as logical, computational way-finding problem to include embodied, social, cultural and situated dimensions.

Keywords: embodied cognition, enaction, navigation, orienteering, situated cognition, wayfinding.

1. Introduction

Every day we carry out navigation tasks to move from one location to another in large scale spatial environments; that is, environments that are too large to be perceived in full from a single point of view. When individuals undertake routine journeys in unfamiliar environments (e.g., the route between home and work), their navigation is relatively automatic. In contrast, when travelling through an unfamiliar environment, successful navigation requires more attention and often a navigational aid such as a map (Montello, 2005). The present study is focused on this second type of navigation.

Navigation refers to the combination of operations implemented to plan, conduct, and regulate one's movement on a course made up of different locations in the environment (Farrell & Barth, 1999). Most researchers have considered navigation as a task that includes two distinct processes: the cognitive process of finding one's way (wayfinding), and the motoric process of locomotion (Golledge, 1999; Montello, 2005). Wayfinding refers to the cognitive dimension of navigation, bringing into play planning and decision making processes. For example, Passini (1984) proposed that wayfinding decisions are hierarchically structured into plans. The initial, overall spatial goal (e.g., go to tourist center) resides at the top of the hierarchy. Intermediary decisions are made to help achieve the overall goal (e.g., obtain tourist center address), and then lower order decisions are made to help achieve the intermediary goals (e.g., go to information booth). Furthermore, wayfinding is classically associated with the concept of a cognitive map or mental map (Golledge, 1999). For example, Golledge, Ruggles, Pellegrino, and Gale (1993) investigated the "integration into cognitive maps" of acquired knowledge of two separate but partially overlapping routes in an unfamiliar environment.

Nonetheless, some authors have argued that the typical conception of cognition associated with wayfinding is too restrictive (e.g., Heft, 2013a, 2013b). To elaborate, from the traditional wayfinding perspective, locomotion is viewed as a behavioral consequence of algorithmic cognitive processes (Golledge, 1999); for example, Cornell, Heth, and Alberts (1994) proposed that a recognition-based algorithm is employed when reversing a recently walked route in unfamiliar environment. The distinction between wayfinding and locomotion reflects a dualistic conception of navigation (Lueg & Bidwell, 2005). In the environmental psychology literature, most studies have been focused on wayfinding rather than locomotion. When locomotion has been considered within these studies (e.g., movement on a treadmill during navigation in a virtual environment), it has featured only as an independent variable influencing mental representations (Lueg & Bidwell, 2005). Other studies within environmental psychology have been concerned with navigation in urban and suburban environments (e.g., Gopal & Smith, 1990) as well as inside complex buildings (e.g., Blajenkova, Motes & Kozhevnikov, 2005). In these studies, researchers have focused on identifying individual differences in spatial navigation ability. For example, researchers have studied how performance on spatial navigation tasks depends on specific spatial skills, gender, and self-reported good sense of direction (Wolbers & Hegarty, 2010).

Alongside these studies of navigation in different environments, researchers in the field of sport psychology have investigated cognition in orienteering, described as "the navigation sport with map and compass" (Boga, 1997, p. 29). Their aim in studying the navigation activity of these athletes has been to consider ways to accelerate skill acquisition in sports in which navigation plays central role (e.g., orienteering & mountaineering) as well as in professional settings (e.g., military field operations & taxi-driving) and more "everyday" settings (e.g., movement in a town center or museum) that require navigational skills (Eccles, Walsh & Ingledew, 2002a, 2002b). At a more theoretical level, Moran (2009)

showed how some research in sport psychology, in particular in navigation sports, has helped researchers to better understand various mental processes of interest in cognitive psychology and environmental psychology. For Moran, the sport domain offers researchers a "natural laboratory" and involves rich and dynamic environments ripe for the study of various aspects of human adaptation (p. 422).

The navigational problems that individuals face in daily life are different from the isolated and well-defined problems typically employed in experimental studies (Spiers & Maguire, 2007). Often, real-world navigational experiences are characterized by the complexity of the situation, and by navigational decisions limited by a variety of constraints (Spiers & Maguire, 2007). Thus, orienteering, in which performance depends on both cognitive and physical skills, constitutes an interesting field of study to better understand human navigational experiences in situations characterized by complexity, dynamism, uncertainty, and time-constraints (Eccles et al., 2002a; Mottet & Saury, 2013).

Orienteering involves an individual or team-based race in which the orienteer or teams of orienteers must, as rapidly as possible, find a series of control points in unfamiliar terrain with the help of a map and compass. The location of the control points is provided on an orienteering-specific map, which is made available to the orienteer only seconds before the race begins and is carried by the orienteer during the race. Each control is marked in the terrain by a brightly colored flag. Each control is equipped with a specific "punch", which the orienteer uses to leave a mark on his or her control card to record his or her visit to the control point. Orienteering maps contain five colors and range in scale from 1:4000 to 1:15000. They are designed specifically for the sport and contain information coded according to the official nomenclature of the International Orienteering Federation (e.g., human-made features, landforms, etc.). Orienteering is popular in Scandinavian countries and to a lesser extent in North America and in Western Europe. The sport is featuring more

frequently within school sports curricula in the west and its inclusion within these curricula is a rare example of the explicit teaching and learning of map-based navigation in western cultures (Heft, 2013a). Moreover, various countries teach orienteering within their armed forces (e.g., Malinowski & Gillespie, 2001). For example, orienteering is used as a task in the US army's Best Warrior competition (Ward et al., 2008).

Most studies concerned with this sport from a psychological perspective have been focused on understanding cognition in highly skilled orienteers (e.g., Eccles et al., 2002a; Seiler, 1996). By comparison, there has been little interest in the activity of novice orienteers. Moreover, prior studies of the sport have involved conditions of relatively low ecological validity (for a review, see Seiler, 1996). For example, Seiler (1990) showed that the route choices planned by elite orienteers in laboratory, within which the map is presented tachistoscopically, differ from those planned when these orienteers are in a real orienteering situation. In addition, following the example of research focused on wayfinding in environments outside the sport domain, most extant studies of orienteering have been framed by the computational cognitivist paradigm, in which orienteering is viewed as an algorithmic decision-making process (i.e., a computational cognitive process). According to this perspective, efficiency in orienteering lies in the orienteer's ability to select a good route, compare a mental image of the terrain constructed from the map with the real terrain to accurately locate himself or herself, and maintain an elevated running speed throughout the race (e.g., Hancock & McNaughton, 1986; Murakoshi, 1988; Pick, Heinrichs, Montello, Smith, Sullivan, & Thompson, 1995; Seiler, 1990). The expert orienteer differs from the novice by the quantity and quality of the items of information compared between the map and terrain (Seiler, 1996). These differences in information selected from the map and terrain for the purpose of navigation also depend on the extent to which the orienteer feels he or she is accurately located (Crampton, 1988).

Navigation in orienteering is consistently studied from the computational cognitivist perspective and as such involves concepts such as mental representations, short-term memory, and information storage and retrieval (for an exception, see Seiler, 1990). However, Ottosson (1996) and Johansen (1997) proposed an alternative to this traditional perspective that involves studying orienteers' activity from an experiential perspective; that is, by considering the individual's meaningful experiences in relation with their environment (Johansen, 1997; Ottoson, 1996). While being part of an extension of research on navigation in orienteering, the present study was conducted from a perspective inspired by the enaction paradigm (Stewart, Gapenne, & Di Paolo, 2010; Varela, Thompson, & Rosch, 1991). The aim here was to obtain insights into navigation in orienteering using a paradigm different from the computational cognitivist paradigm. According to the enaction paradigm, cognition is embodied; that is, cognition is based on perceptual, sensory, and motor processes, and expresses the history of the dynamic relations of an individual with his or her world. These dynamic relations are conceived as a structural coupling: The dynamics of actor/environment interactions specify both the actor's own organization and the environment with which he or she is interacting (Weber & Varela, 2002). The structural coupling is asymmetric because it is fundamentally oriented by the actor's perspective. Thus, actors are not subjected to the prescriptive force of environmental stimuli but instead seek to establish a state of equilibrium by selecting their own perturbations; that is, actors interact only with environmental elements that are sources of "perturbation" to the dynamics of their own activity.

The notion of asymmetric coupling takes into account the actor's capacity to "exist", affirm his or her autonomy, and continuously shape an ever-changing but meaningful and pertinent world (Maturana & Varela, 1992). Varela (1981) proposed that a "satisfactory explanation of the phenomenology of living systems" (p. 43) must consider this structural coupling from the actor's perspective. Thus, the focus within the enaction paradigm is the

actor's specific world (or *umwelt*) that is perceivable and experienced from the first-person point of view; that is, "from the inside" (Petitot, Varela, Pachoud, & Roy, 1999).

The specific theoretical and methodological approach used within this study was the course-of-action framework, which gives concrete expression to the enaction paradigm for use in the study of daily activities (Theureau, 2003, 2006). The framework mainly focuses on the subjective phenomena that constitute the actor's experience at each moment. This phenomenological level of activity refers to a form of consciousness termed the "pre-reflective self-consciousness". The pre-reflective self-consciousness is conceived as a permanent component of every human activity (Legrand, 2007; Sartre, 1943; Theureau, 1992, 2006; Varela & Shear, 1999) and reflects the phenomenological (or experienced) part of the structural coupling between actor and environment. From this perspective, the empirical description of the dynamics of the pre-reflective self-consciousness (i.e., the "course of experience") constitutes a description of the structural coupling that is partial but nonetheless offers a satisfactory explanation of the phenomenology of human activity.

The course-of-action framework allows one to finely analyze the components of human experience by means of a reconstruction, as accurately as possible, of the conditions of the situation in which an actor is engaged at each moment. Often, this reconstruction is made possible via video recordings of activities in natural settings, obtained by head-mounted cameras, and post-activity self-confrontation interview techniques that emphasize the actor's point of view (von Cranach & Harre, 1982).

The course-of-action theoretical framework has been employed in empirical studies within ergonomics (e.g., Theureau, 2003) and sport psychology (e.g., Bourbousson, Poizat, Saury & Sève, 2012; Mottet & Saury, 2013; Poizat, Bourbousson, Saury, & Sève, 2009, 2012). Of these studies, Mottet and Saury's (2013) research concerned orienteering and

involved a comparison of two different orienteering tasks in terms of novice orienteers' experience of spatial navigation. The study revealed differences between the tasks in the organization of the orienteers' activity, which was explained by differences in the constraints of the tasks on the orienteers' use of "fast-and-frugal-heuristics" (Gigerenzer & Goldstein, 1996; Seiler, 1990). Also revealed was that orienteers adopted different modes of map-based navigation as a function of their "location judgments"; location judgments were defined as an orienteer's judgments about the reliability of their estimations about whether (or not) they are on "the right route" on the course. Mottet and Saury (2013) hypothesized that orienteers constantly "build" location judgments as they navigate through an orienteering course. The aim of the present study was to characterize novice orienteers' location judgements. More specifically, the study was concerned with: (a) describing location judgments made by novice participants as they completed several orienteering courses; and (b) identifying and characterizing qualitatively the elements of the situation that are meaningful for the orienteers during the completion of those courses, that is to say the resources for actors that they can use to act (Theureau, 2006). From the results of the studies by Mottet and Saury (2013) and Crampton (1988), it was expected that, for novice orienteers, the nature of these meaningful elements would depend on their location judgments.

2. Method

2.1 Participants

Participants were eight male undergraduate students (M_{age} = 19.7 years, SD = 0.7) who had chosen to learn orienteering as part of a sports science degree. They had never participated in orienteering and thus were novices but were motivated to learn to orienteer. Research has revealed sex-based differences in novice orienteering performance (Malinowski

& Gillespie, 2001); these differences were avoided here by including participants of only one sex.

2.2 Procedure

The study had ethical approval from the host institution, informed consent was obtained, and participants were informed their data would be kept confidential. Participants undertook instructor-led orienteering training sessions of 1 h 30 min once per week for 12 weeks. The instructor was an experienced coach. During each session, participants were asked by the instructor to undertake traditional tasks used to teach orienteering that require navigational problem solving (e.g., Boga, 1997). Prior to the first session, the researchers met the participants and informed them about what would be asked of them during the study. Participants' activity was only studied during sessions held on weeks 2, 7, 10 and 12 of training. During these sessions, participants were asked to complete an orienteering course in an unfamiliar area of terrain (e.g., wooded parks). The course completed was different and thus novel on each of the four occasions. Nonetheless, the courses were similar in terms of distance (i.e., 1800 m), amount of controls (i.e., 6), and navigational difficulty (i.e., a "blue level" of difficulty according to the French Orienteering Federation). As with all traditional orienteering courses, participants were asked to find the course controls, in a specified order, as quickly as possible. Participants were provided with a compass, control card, stopwatch, and a 1:5000 scale orienteering map aligned to magnetic north and displaying a map symbol key. For each course, participants' start times were staggered as in a real orienteering race. On average, course completion time was 28.8 min (SD = 9.1).

2.2.1 Data Collection

Two types of data were gathered according to the method associated with course-of-action theory (Theureau, 2006). These data types included an audiovisual record of activity

during the tasks obtained via a head-mounted video camera and post-task verbalization data obtained via self-confrontation interviews. These methods of data collection have been used successfully in a previous study of orienteering (Omodei & McLennan, 1994).

2.2.1.1 Audiovisual record of activity during the tasks

A complete audiovisual record of activity during the task was obtained using camera-equipped glasses with an integrated microphone, which afforded capture of the participant's approximate visual field as well as his spontaneous verbal comments.

2.2.1.2 Post-task verbalization data

Verbalization data were obtained via a self-confrontation interview with each participant within 48 h after each task. During each interview, the participant was provided with the equipment they used during the task (i.e., map, compass, control card, & stopwatch) and shown, via a display monitor, the audiovisual recording of his activity during that task. During the film, the participant was asked to comment step-by-step on his activity, as seen on the film; specifically, he was asked to comment about what he was doing, feeling, thinking, and observing during the task. The researcher used prompts (e.g., "And here, what are you doing?") to help the participant to make explicit what was meaningful for him in the situation observed on the film. Interviews were recorded using a camera with audio microphone that captured the film being shown and the researcher's and the participant's verbalizations. Interviews lasted 34.5 min (*SD* = 8.0) on average.

2.2.2 Data Processing

Data analysis consisted of reconstructing, for each task, each participant's course of experience with reference to the course-of-action framework. The course of experience is defined as "the activity of a given actor engaged in a given physical and social environment,

where the activity is meaningful for that actor; that is, he [sic] can show it, tell it and comment upon it to an observer-listener at any instant during its unfolding" (Theureau & Jeffroy, 1994, p. 19). The course of experience is, by hypothesis, a chain of signs that are meaningful units of activity from the participant's point of view, and that emerge from the interaction between the participant and his or her environment. Each sign consists of six components: the unit of the course of experience, the representamen, the involvement in the situation, the potential actuality, the referential, and the interpretant (a description of each component is beyond the scope of this study; see Theureau, 2006). The aims of the present study required an analysis of only two of these components: the units of the course of experience, which corresponded to the participant's location judgments; and the representamens associated with these judgments, which corresponded to the elements of the situation perceived as meaningful by the participant at each moment. Six steps were involved in the reconstruction of a participant's course of experience, which are described as follows.

2.2.2.1 Transcription of audiovisual activity record and of self-confrontation interview data.

Transana® 2.42 software was used to transcribe verbatim the audio recordings of participants' spontaneous verbalizations during actual task performance, and the self-confrontation interview data. Overt behaviors and elements of the context were systematically described by the researcher (e.g., "At time 08:04, Participant 1 manipulates the compass"). A time stamp was recorded for each event within the course of activity.

2.2.2.2 Integration of data sets

Transcriptions of the audiovisual activity record and the self-confrontation interview data were synchronized using the time stamps recorded during the transcription of each data set, which resulted in one integrated data set.

2.2.2.3 Identification of units of the course of experience corresponding to participants' location judgments

According to Theureau (2006), units of the course of experience may be actions, emotions, communications, feelings or interpretations that are meaningful for the actor. In this study, the focus is on units of the course of experience concerned with interpretations and, more specifically, participants' location judgments. Locations judgements were defined as participants' judgements of the reliability of their estimations about whether (or not) they were on "the right route" on the course. Units concerned with location judgements were identified by asking the following about the data set obtained in the previous step: What are the participant's thoughts about the reliability of their estimations about whether (or not) they are on "the right route" on the course? How confident does he appear to be about the reliability of such estimations?

2.2.2.4 Identification of the representamen associated with each unit of the course of experience

According to Theureau (2006), the representamen refers to the assumption that activity is an adaptation to an environment containing meaningful elements, where these elements are resources for actors that they can use to act. At any given instant, the representamen is comprised of the elements of the situation that are meaningful for the actor. These elements may be perceptive representamens ("I perceive this"), mnemonic representamens ("I remember this") or proprioceptive representamens ("I am doing this"). In the present study, the representamens associated with each unit of the course of experience (identified in the previous step) were identified and labeled by the researchers in relation to answers to the following questions about the data: For this participant, what is the meaningful element in this situation? What element of this situation is the participant considering? What

element is being remembered, perceived, or interpreted by the participant? (See section 2.2.3 for details about coding procedures used to enhance the credibility of the analysis). For example, during the self-confrontation interview, a participant observed, on the film of his orienteering activity, that he stopped running and looked to the left in the terrain. On the basis of this observation, the participant verbalized: "And there, I stop dead because I think can see a mark on the left". The representamen within this verbalization was identified by the researcher as "a mark on the left". On average, 48.8 representamens (*SD* = 21.4) were identified per task (where a task was one completed orienteering course).

2.2.2.5 Thematic categorization of units of course of experience and of representamens

Units of the course of experience were categorized as a function of the orienteer's strength of his feeling that he was able to locate himself precisely on the course. At each moment this feeling was assessed on an continuum limited a priori by the certain feeling of locating himself precisely on the right route on the course on the one hand, and on the other hand the feeling of being lost and unable to locate himself on the course. Representamens were systematically compared and categorized using an iterative procedure according to the inductive categorization principles proposed by Strauss and Corbin (1990). Representamens were grouped in the same category whenever they pertained to the same general type of representamen and each category was labelled as a "typical representamen". For example, the two representamens "legs scratched by prickly brambles" and "wet feet" were classified in the category of typical representamen labelled "body comfort".

2.2.2.6 Identifying occurrences of typical representamen concerning location judgments

Frequency counts of each different general type of representamens (e.g., body comfort) were obtained for each type of location judgment. The relative share of each general type of representamen for each type of location judgment was then calculated. Simple

descriptive statistics were computed in favor of inferential statistics because the sample size was small.

2.2.3 Maximizing the credibility of the qualitative analysis

Several procedures were used to enhance the credibility of the data (Lincoln & Guba, 1985). First, the familiarization phase of the study (see above) was included to help build the participant's trust, with a view to enhancing the credibility of the self-confrontation interview data. Second, two researchers independently conducted the three main steps involved in the analysis of each participant's data (i.e., identification of units of the course of experience; identification of the representamens; thematic categorization of units of course of experience and of representamens) and discussed any initial disagreement about the categorization of a given datum until a consensus was reached. Third, in line with Strauss and Corbin (1990), a saturation criterion was adopted during the categorization process; this criterion was considered to be met when no new categories of representamens and location judgments emerged during the analysis of the data.

3. Results

In this section, we first present results that illustrate the variation in participants' location judgments during the orienteering tasks. Following this, we present results that show how elements of the situation that were meaningful for participants at a given moment were related to their location judgment within that moment.

3.1 Variations in location judgments

During the tasks, the participant continuously made judgments about the reliability of his estimation about whether (or not) he was on "the right route". These judgments varied

from a feeling of being perfectly on "the right route" to one of being completely lost. Nonetheless, three typical experiences were identified and are described as follows.

3.1.1 The typical experience of being on the right route

The first typical experience corresponded to moments when the participant thought he was on the right route; that is, the route he had planned from the map to try to follow during the course. In these moments, he judged himself capable of locating himself on the map, given what he could see of the surrounding terrain, with certainty either: (a) at that very moment; or (b) within a short period of time. Participant 7 provides evidence of such a judgment made at that very moment: "There I say to myself it's good, I'm exactly there [points to his location on the map] because everything matches". Participant 4 provides evidence of such a judgment made within a short period of time: "There I'm around there [points to his location on the map] on the path but I know I must continue until the intersection with the river".

3.1.2 The typical experience of being approximately on the right route

The second typical experience corresponded to moments when the participant judged that he was near the route that he had planned from the map to try to follow but also expressed doubts about the reliability of his estimation of his position on the course. For example, Participant 4 stated: "There, I'm not really sure where I am but I think it must be there so I keep moving forward".

3.1.3 The typical experience of being unable to locate oneself

The third typical experience corresponded to moments in which the participant judged he was unable to locate himself on the map from what he could see of the surrounding terrain. At these moments, the participant judged himself "lost". For example, Participant 8 stated:

"There I am totally lost, in fact; I don't know at all where I have gone and there I think I'm definitely not in the right direction."

3.1.4 Dynamics of location judgments

At the beginning of each task (i.e., orienteering course), the participants were provided with the appropriate course map, on which the course start location was shown as a triangle. Also, the course start was marked in the actual terrain by a "start" flag. As a result, the participants were able to easily locate themselves precisely on the map. Thus, at this moment, participants' convictions of being correctly located were at their peak: "There, as soon as he [the instructor] gives us the map, I immediately look for the start. I want to be sure I have located myself correctly before starting, and so there it's fine, I know it's like that" (Participant 3). Beyond the start, no participant managed to maintain a state whereby he always judged himself to be in the right location. Nonetheless, typically, this state was experienced occasionally at various points within the course. Thus, participants' experienced fluctuations in their location judgments. For example, after 2 min 43 s of engaging in the orienteering task during his second training session (i.e., the first testing session), Participant 5 made the following comments about his activity: "I had a good start and there I begin to doubt as I wonder if I haven't gone too far". At 5 min 48 s, he comments: "There, I am lost; I don't know at all where I am". As an example, Figure 1 illustrates the fluctuations in location judgments experienced by Participant 5 as he completed the orienteering task during his second training session.

Please insert Figure 1 about here

3.2 Analysis of meaningful elements for orienteers in connection with the three typical location judgments

The qualitative analysis of the participants' courses of experience revealed that participants took into account different categories of meaningful elements (i.e., representamens) as they completed their tasks (see Table 1). The quantitative analysis of the frequency of representamens belonging to each location judgment category revealed that the participants took into account different configurations of meaningful elements depending on their location judgment (see Table 2).

Please insert Table 1 and Table 2 about here

3.2.1 Meaningful elements related to the typical experience of being on the right route

When the participants judged they were on the right route, the elements of the situation that were meaningful for them were primarily map features and terrain features. The category "Map and terrain features" represented 82.3% (*SD= 14.7*) of representamens concerned with the typical experience of being on the right route. Participants' activity was characterized by map reading, within which specific types of map features were selected as a priority (e.g., human-made features). When the participants were moving through the terrain (as opposed to stopped to read the map), meaningful elements included features of the terrain that they had anticipated observing based on their reading of the map. Accordingly, their feeling of confidence was strengthened in terms of the reliability of the relations they were making between the terrain and the map, allowing them to effectively navigate and thus proceed through the orienteering course. For example, Participant 5 stated: "So there I have spotted a dotted line on the map; therefore, I expect to come across a ditch on the right […] and there bing! I see the ditch in the terrain; so there I say to myself it's great, I'm sure of myself because everything matches". Occasionally, participants were surprised by features they observed in terrain because they had not anticipated these features based on their reading of the map. If they were able to quickly match these terrain features with the appropriate map

features, the judgment they made about the precision of their navigation was not affected by the features that were not anticipated. During this type of experience, navigational activity was characterized by a logical line of reasoning, which is reflected by comments made by Participant 4: “There I say to myself, it is not difficult, I have to be lucid and logical; hyperlogical if I want it [the terrain features and the map features] to fit”.

3.2.2 Meaningful elements related to the typical experience of being approximately on the right route

There were two types of cases in which the participants judged they were only approximately on the right route. The first case was one in which the participants were surprised that their anticipations about how the upcoming terrain should look were not realized. Specifically, elements of the terrain that were anticipated based on the participant’s reading of the map were not encountered as they moved through the terrain; and/or elements of the terrain that the participant “met” as they moved through the terrain were not anticipated from the map and/or could not be located on the map. For example, Participant 1 stated “And there I say myself it is strange because normally there is a cross on the map so I should have met… something but I can’t see it”. In the second case, elements other than terrain features and map features became meaningful for the participants in the situation, and led them to think that there might be problems with their navigation. These other typical meaningful elements were: (a) congruence of the orienteer’s activity with that of other orienteers observed in the surrounding terrain; (b) a feeling of moving forward through the terrain too much or not enough; (c) unmapped human-made clues; (d) passing time; (e) body comfort; (f) past experiences; (g) the compass and control flag; and (h) other various minor elements; see Table 1 for descriptions of these elements. When the participant had an experience in which he judged that he was only approximately on the right route, map and terrain features accounted for 44.3% (*SD=16.9*) of the total number of representamens related

to this experience (see Table 2). Thus, the frequency of representamens was greater for each of the remaining element types (e.g., passing time) in comparison to the experience of being on the right route.

3.2.3 Meaningful elements associated with the typical experience of being unable to locate oneself

Terrain and map features had relatively little meaning when participants judged that they were unable to locate themselves on the map from what they saw of the terrain around them: Only 9.0% (*SD=9.3*) of the map and terrain representamens were related to this typical experience (see Table 2). Typically, participants felt that they had no meaningful feature in the environment that could help them to locate themselves on the map, as expressed by Participant 7: "There I have no landmark; I have a feeling everything looks the same […]. I no longer look at the map because I have no idea where I am". Within this type of experience, participants' interpretations of their navigation often involved instant reactions to a series of events that were unexpected within their course of experience. For example, Participant 6 met another orienteer running in the opposite direction, which led him to believe he was not on the right route. Participants' activity typically involved looking for opportunities to once again locate their position on the map, as Participant 2 explained:

> I begin to get a little panicky; I try to hang on to everything I can. I can see the others but they go in all directions. I say to myself I'm losing too much time but at the same time I don't know what to do […]. I try to move forward instinctively because maybe I can see something […]. Then, I see Bastien [another orienteer]; he tells me it is this way but I think he was lost too so, well, I decide to take my compass to see where I am… but I don't manage [to do that].

Table 2 shows that, as the participants became less certain in their location judgments, the percentage of representamens in the map and terrain features decreased and the percentage of representamens in the remaining categories increased.

4. Discussion

In the present study, we aimed to characterize the experiences of novice orienteers engaged in orienteering tasks by focusing on meaningful elements of their navigation activity. The study revealed two phenomena inherent to the navigation activity of novices in orienteering. First, novices' activity is underpinned by continuous judgments of the reliability of their estimations about whether (or not) they are on "the right route" on the course. These judgments generate three types of experiences that the orienteer fluctuates between during the ongoing orienteering task: a typical experience of being on the right route, a typical experience of being approximately on the right route, and a typical experience of being unable to locate oneself. Second, the nature of elements of the situation taken into account in a meaningful way by novices during their navigation activity differs as a function of their typical experience at a given moment within an orienteering course. These results highlight that orienteers' *umwelten* (Petitot et al., 1999), which is defined as the actor's meaningful and pertinent world from his or her own point of view, varies within an orienteering course. Specifically, the orienteers' *umwelten* varies according to the extent to which they feel able to locate themselves precisely on the course from the connection they make between the features on the map and the features in the terrain. Some dimensions of novice orienteers' activity are brought to light only when they feel only approximately (i.e., vs. certainly) on the right route or when they are unable to locate their position on the map. Elements other than map and terrain features, such as body comfort, then become meaningful and constitute additional resources for coping with the task so that the orienteer can succeed in a satisficing way in view of the complexity of the problem (Simon, 1955). Such elements underline the

embodied, social, cultural, and physically and materially situated dimensions of the experience of navigation in orienteering.

4.1 The embodied dimension of the spatial navigation experience

The embodied dimension of the orienteers' courses of experience is evidenced within the meaningful element *Feeling of moving forward too much or not enough*. Navigating consists of moving in space from one point to another, which gives navigation a fundamentally physical dimension. However, analyzing the "lived experience" of the novice orienteers reveals that their navigational activity is not based on a rational and Euclidean assessment of distances afforded by the use of the scale of the map and/or pace counting, a strategy often used by skilled orienteers that involves counting one's running paces to measure distance (Eccles et al., 2002b). Our results suggest that the navigational space meaningful for these participants is a "lived", perceptible, and sensorial space, constructed from judgments that can include distortions of distance and direction (Tversky, 2003a). Previous research on such distortions might afford us an understanding of the mistakes made by novice orienteers. For example, distance judgments for routes are judged longer when the route has many turns (Sadalla & Magel, 1980), landmarks (Thorndyke, 1981), intersections (Sadalla & Staplin, 1980), or barriers (Newcombe & Liben, 1982).

From the orienteers' point of view, navigating consists of attempting to stay on the right route (i.e., to advance toward an objective with a location that is more or less defined), rather than locating oneself precisely on the map at each moment. This experience is lived (i.e., experienced) by the orienteers as a continuous fluctuation of judgments about the reliability of their estimation of whether (or not) they are on "the right route". Thus, the experience of navigation does not consist for the orienteers of finding their way step-by-step in a static environment. Instead, the experience involves moving and finding one's position at

the same time in a changing environment and exploiting in particular sensations of the speed and direction of movement (Spiers & Maguire, 2008).

The meaningful element *Body comfort* also evidences the embodied dimension of navigation. According to Tversky (2003b), every human activity takes place in a vast number of spaces, which present specific frames of reference including the space of the body, the space immediately around the body, and the space of navigation. The meanings constructed here by the novice orienteers as they engaged in the navigation tasks show that their navigation experience is closely related to a global and embodied *umwelt* in which the distinction among the different spaces suggested by Tversky (2003b) is not meaningful. We hypothesize that the novice orienteers had difficulties apprehending navigation in a large scale space independently of the space of their body. When their Body comfort was under threat, due to "aggression" from vegetation (e.g., brambles), the novice orienteers often had doubts about being on the right route and experienced negative emotions that led them to question the reliability of their estimations of their position on the course. These results contrast with those obtained for expert orienteers; for experts, vegetation, for example, constitutes a mere hindrance to their ability to "optimize running pace throughout the race", which is a key performance-related objective (Macquet, Eccles, & Barraux, 2012).

4.2 The social dimension of the spatial navigation experience

The social dimension of the orienteers' courses of experience is typically illustrated by the categories of meaningful elements entitled *Level of congruence of the orienteer's activity with that of other orienteers* and *Unmapped human-made clues*. Some researchers have proposed that any human experience cannot be completely understood without considering the social context in which it emerges (De Jaegher, Di Paolo, & Gallagher, 2010). In the present study, the orienteering tasks were undertaken by individual participants

performing alone; that is, the tasks were not group tasks. Nonetheless, as they undertook their orienteering tasks, the participants sometimes observed other orienteers undertaking their own tasks. These observations were taken into account and interpreted as meaningful elements by the participants as they undertook their orienteering tasks (Maturana & Varela, 1992). Level of congruence with other orienteers' activity constituted the second largest category of meaningful elements for the novice orienteers as they undertook the navigation tasks. This social dimension of navigation was expressed at different levels. First, on the occasions when orienteer "A" saw orienteer "B", the sighting was meaningful to orienteer A because it conveyed information to him that he was moving in the right direction and more specifically that might be nearing a control flag. Tversky and Hard's study (2009) suggests that from the point of view of spatial cognition, other people would also participate in the construction of spatial relations between the different features of an environment.

Second, on some occasions when orienteer A had an experience of being unable to locate himself, a meeting with another orienteer was seen as an opportunity to get help, even if orienteering regulations forbid competitors to communicate with one another during a race. Third, the novice orienteers attended to all available navigational cues in their environment including those not present on the map and that were more discreet, where an example was footprints. Footprints were typically interpreted by orienteer A as clues indicating that other orienteers had passed by, which strengthened orienteer A's feeling that he was moving in the right direction. This finding contrasts with expert orienteers' activity since experts typically do not heed the activity of other orienteers observed within a race, judging this activity to be an unreliable source of navigation-related information (Macquet et al., 2012).

4.3 The cultural dimension of the spatial navigation experience

The cultural dimension of the orienteers' courses of experiences is typically illustrated by the categories entitled *Memories of past experiences* and *Unmapped human-made clues*. The novice orienteers' navigation activity in the specific context of the training they received from the instructor testifies to their belonging to a community and expresses some shared social and cultural standards, which are the product of a common culture and part of an individual and collective history (Lave & Wenger, 1991). An example of the influence of common culture in the present study is as follows. A novice orienteer reported recognizing a configuration of the terrain during an orienteering course that was similar to the type of terrain within which the instructor had often positioned control flags during earlier training sessions. This result accords with the findings of a study by Eccles et al. (2009), within which expert orienteers reported immersing themselves in the culture of countries hosting upcoming competitions to acquire knowledge of the local terrain types and mapping methods and styles.

Furthermore, it is likely that there were deeper socio-cultural influences on the novice orienteers' activity that must be considered "as constitutive influences at the level of individual experience" (Heft, 2013a, p. 14). That orienteering takes place in forest distinguishes this task from navigation tasks in urban environments such as cities or buildings. It is likely that the dark, wooded environments that characterize orienteering do not merely affect the actor's ability to see clearly, for example; they also constitute a culturally meaningful environment (Nassauer, 1995). In urban western societies in particular, many people report feelings of fear when imaging being alone in woods, which researchers have proposed arises because people are socialized as children to perceive forests as potentially dangerous places (Hart, 1979; Vogt et al., 2006). For novices, orienteering can be experienced as an "ordeal" (Jeu, 1977); that is, the novice is to some extent engulfed in the forest world and later returns to the "world of the living" (p. 33). This cultural context could explain why the participants in the present study sought out signs of other people (e.g.,

footprints or waste). Specifically, these signs might have functioned as a reassurance to the novice orienteers when they experienced being unable to locate themselves.

4.4 The physically and materially situated dimension of the spatial navigation experience

Finally, the physically and materially situated dimensions of the orienteers' courses of experience is typically reflected in the category entitled *Compass and control flag*. After the map, the compass is the object of navigational equipment used most frequently, at least by expert orienteers (Eccles et al., 2002a). The compass allows the orienteer to keep the map set (i.e., rotated so that it is aligned with the terrain) during a race, which effectively avoids the cognitive cost associated with mentally rotating the map and/or the terrain (Eccles, 2006). Keeping the map set with the help of the compass is one of the first navigational skills taught to novices in orienteering (Boga, 1997). However, the use of the compass to set the map is paradoxically especially meaningful for novice orienteers when they experience being unable to locate themselves on the map. We hypothesized that novices consider the compass as a "last resort" artifact, allowing them to undertake a concrete action in a situation of doubt (Norman, 1993).

As for the control flag, it constitutes an artifact that materializes physically the goal of navigation (Mottet & Saury, 2013). When the participants performed an orienteering task, their primary goal is not to get to different geographical points or solve the navigation problems with which they are presented but to find the control flags that comprise the task. Being bright colored, the control flag may constitute a "real-world" featural singleton (Eccles, 2006), which is easily perceived in a forest environment and on which novice orienteers can rely to find anew their position after losing it. Moreover, the control flag constitutes a socially recognized object with which the orienteer can provide physical evidence of his or her visit via the mark left by the punch on his control card. This kind of

materially and socially situated navigation can be compared with observations made in quite a different field by the anthropologist Widlok (1997). Widlok showed that the Bushmen of Namibia do not navigate to get to geographical points but to accomplish at these points something materially and socially recognized (e.g., collecting a particular fruit). These observations accord with our results, giving substance to the hypothesis that an individual's knowledge about locations is not functionally independent of goal-directed action in a specific spatial and material context (Heft, 2013a; Widlok, 1997).

This study has important limitations that must be considered when interpreting the results. First, as with all self-report methods (Eccles, 2012; Ericsson & Simon, 1993), the self-report method employed here was able to capture only the conscious verbalizable experiences of navigation during orienteering by the participants. Invariably, human behaviour within and beyond navigation is also partly mediated by non-conscious, non-verbalizable cognitive processes that self-report methods are unable to capture. Thus, we were unable here to account for the structural coupling between an individual and his environment in its entirety (i.e., including both conscious and non-conscious processes) and yet a comprehensive understanding of navigation requires capturing non-conscious processes in addition to conscious ones. Alternative research methods, such as experimental methods, are required to identify these non-conscious processes. Nonetheless, we believe that our findings constitute a "satisfactory explanation of the phenomenology" of our participants' activity (Varela, 1981, p. 43) and serve as at least indirect clues about the embodied, social, cultural, and physically and materially situated dimensions of navigation in orienteering.

Second, the size of our study sample was small (n = 8), which did not permit the use of inferential statistical analyses. Future research should involve larger samples to afford the use of such analytical approaches. Third, the research design employed here did not afford identification of the sequence of cognitions involved in navigation. For example, we were

unable to identify whether the thoughts and percepts verbalized by the participants caused, or were caused by feelings of being oriented in the terrain. More controlled research designs allowing control and manipulation of study variables are required to identify such sequences of cognitions, although this may necessitate the use of a less ecologically valid study environment than the one involved in the present study.

To conclude, this field study of novice orienteer's experiences of orienteering tasks contributes, beyond the specific domain of orienteering, to a better understanding of map-based navigation in unfamiliar environments (Moran, 2009). However, the map is only one means, among a whole of potential resources for navigation, especially when the navigator is not entirely sure of his or her position, which is often true for the novice. By studying navigation activity as it is experienced, this research shows the dynamic nature of embodied cognition (Spiers & Maguire, 2008) and, in addition, how "the environment is composed of meaningful objects, meaningful events, meaningful places…" for individuals during a navigation task (Heft, 2001, p. 329).

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Table 1. Categories of representamens.

Meaningful Element	Description	Examples of verbalizations during self-confrontation interviews
Map and terrain features	Mapped elements of the terrain that are meaningful to orienteers, where these elements depend on the orienteer's ability to decode the map symbol (knowledge of the legend) and to identify the feature symbolized on the map in the actual terrain .	*"I've spotted a blue spot (on the map), so I should see a pond or something like that [in the terrain]". (Participant 1)*
Congruence of the orienteer's activity with that of other orienteers	Elements allowing the orienteer to assess his own activity in relation to his assessment of other orienteers' activity (e.g., not seeing another orienteer in an area of terrain, following another orienteer, and being followed by another orienteer).	*"There I look, I try to see, and then here I see no one, I see no one running; it's strange". (Participant 3)* *"And there Boris turns right, so I am more in doubt [...] because for me it's straight on". (Participant 1)* *"I ask him [another Participant] where we are; he tells me near there [points to map] but in fact I think he is also a bit lost". (Participant 8)*
Feeling of moving forward through the terrain too much or not enough	Estimations of progress in space based on subjective body sensations and not from more objective indicators like pace counting (i.e., counting one's running paces to measure distance)	*"There I stop as I feel I have moved forward far too much". (Participant 3)*
Unmapped human-made clues	Navigational clues visible in the terrain but that are not mapped (footprints, waste, hikers' behavior, etc.) which indicate a potentially useful route.	*"There I say there are footprints, so, well, I say to myself, it's ok, the teacher must have been around there". (Participant 3)* *"There I can see people with a broad smile, so I said to myself there must be something around there". (Participant 7)*
Passing time	The feeling that it is taking longer than it should to complete a given part of the course.	*"There I say to myself at a rough guess, I'd better move forward because I've already lost quite a lot of time and I have a feeling I've been there for a long time, but I'm definitely not sure it's this way". (Participant 4)*
Body comfort	Sensations of body comfort or discomfort (pain, etc.) in relation to causes (rain, brambles, fatigue, temperature, etc.).	*"So there, I get through all these trees that prick you; my objective is to get out of these [...] and there I don't understand, I say to myself it mustn't be there". (Participant 6)*

Memories of past experiences	Memories of strong emotional experiences (of orienteering or other activities), places already visited, discrepancy or conformity with setting configurations (i.e., the nature of the design of the leg) already experienced, etc.	*"I no longer want to go in this place because I think it's a bit creepy". (Participant 7)* *"There I'm thinking it's a good place to locate the control flag in comparison to what happens usually; it looks a little bit like the second session". (Participant 2)* *"There it gets on my nerves because I feel I'm back in the same situation where I had stayed for ten minutes in the wooded area but I was not in the right place at all". (Participant 1)*
Compass and control flag	Compass and control flag are considered by the orienteers as material objects with which it is possible to act (move dial of compass, use control punch, etc.).	*"There I look all around, and there I think I can see an orange thing... I was hoping it was one [a control flag] but it wasn't!". (Participant 4)* *"At that time, I had no clue what to do! I keep checking north with the compass to see where I am; I try to reassure myself in fact". (Participant 5)*
Other	Other trivial elements involved in navigation activity.	*"And then here I can see loads of mushrooms on the ground". (Participant 8)*

Table 2.

Means and standard deviations of percentages of categories of representamens as a function of the type of the location judgment made.

Type of location judgement	Map and terrain features		Congruence of orienteer's activity with that of other orienteers		Feeling of moving forward through the terrain too much or not enough		Unmapped human-made clues		Passing time		Body comfort		Memories of past experiences		Compass and control flag		Other	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Being on the right route	82.3	14.7	7.3	4.7	1.2	2.0	1.9	4.3	1.7	2.9	1.0	2.3	2.6	4.7	1.2	3.1	0.2	0.8
Being approximately on the right route	44.3	16.9	16.4	13.3	10.1	7.6	5.6	5.1	6.1	7.9	7.8	8.9	5.7	6.9	4.5	6.8	0.4	1.6
Being unable to locate oneself	9.0	9.3	13.0	16.5	18.4	17.4	8.3	11.0	9.7	12.8	5.9	13.5	4.8	13.8	11.5	13.0	5.2	14.4
Total	46.9	32.9	12.2	12.7	9.9	12.8	5.2	7.6	5.7	9.3	4.9	9.7	4.4	9.1	5.7	9.4	2.0	8.5

Note. $n = 8$ in each cell

Figure 1. Dynamics of location judgments during orienteering made by Participant 5 during the second session of the orienteering task.