Finding the Way

A Critical Discussion of Anthropological Theories of Human Spatial Orientation with Reference to Reindeer Herders of Northeastern Europe and Western Siberia

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In anthropology, research on human spatial orientation (wayfinding) has centered on two conflicting theories: the "mental map," whereby humans build abstract cognitive representations of the spatial relations between objects, and "practical mastery," which rejects the idea that such abstract representations exist and, in its most developed form, suggests that wayfinding is a process of moving from one recognized visual perspective (vista) to another (transitions between vistas). In this paper we reveal, on the basis of existing psychology and geography research, that both wayfinding theories are in fact complementary: humans rely on mental maps but also memorize vistas while navigating, and an individual's navigation method, ability, and the form of the mental map is likely to depend on a situation as well as on factors such as age, sex, familiarity with the environment, and life history. We demonstrate (using research material obtained during fieldwork carried out among Komi and Nenets reindeer herders) that anthropology can contribute to human spatial cognitive research, which has traditionally been an interdisciplinary endeavor, by identifying differences in spatial representation between different people and peoples. However, future contributions can be achieved only if anthropologists accept that mental maps and route knowledge (as advocated by practical mastery) are part and parcel of spatial cognition.

Statement of the Problem

Over the past century, anthropologists have shown interest in the methods of human spatial orientation. Many studies have focused on peoples who were thought to have extraordinary or even "superhuman" orientation skills: Micronesian mariners (Gladwin 1964, 1970; Lewis 1972), south African Bushmen-San (Porteus 1937; Reuning 1988; Widlok 1997), Australian aboriginals (Lewis 1976*a*, 1976*b*), and North American Inuit (Nelson 1969; Carpenter 1973; Aporta 2004; Aporta and Higgs 2005), to name just a few. These works greatly contributed to demystifying the capacities of human orientation, which have been perceived as being based on an instinctive "animal-like" sense of direction (Widlok 1997, 318; Hallpike 1979).

Theories of human orientation first emerged in psychology (Tolman 1948) and were later influenced by wayfinding studies made by geographers and urban planners (Lynch 1960; Appleyard 1970; Gould and White 1974; Downs and Stea 1977). At least historically, the endeavor was interdisciplinary. In anthropology, however, a coherent theory of human orientation began to emerge only over the past 2 decades and, as this paper will demonstrate, the interdisciplinary research tradition was not followed by anthropologists working outside the limited sphere of ethnolingusitics. Indeed, most recent anthropological contributions from outside this sphere show that communication between anthropologists and scientists from other disciplines has weakened. It appears that even when the results of psychological and geographical studies of human orientation are used by anthropologists, they are mostly selective and misrepresented. This, we would argue, seriously hinders the capacity of anthropology to make a potentially far-reaching contribution to the interdisciplinary research on human spatial cognition.

The principal aims of this paper are to (1) outline the recent anthropological debate of human orientation (over the past 2 decades), (2) evaluate this debate in relation to similar studies made in psychology and geography, and (3) demonstrate how anthropology can contribute to the ongoing interdisciplinary research on human orientation by using the theoret-

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ical approach to interpret wayfinding methods among reindeer-herding nomads of northeastern Russia and western Siberia.

The Anthropological Debate on Human Orientation

Over the last 20 or so years, the largest part of theoretical debate in anthropology over day-to-day wayfinding and the spatial orientation of humans has been based mainly on two rival theories, the "mental map" and the "practical mastery" theories (Gell 1985, 272). The former theory was inspired by the findings made in several disciplines after the pioneering experiments of Tolman (1948; cf. Ingold 2000, 220–222), mainly in the 1960s and 1970s (Lynch 1960; Downs and Stea 1973; Golledge and Spector 1978; Gould and White 1974). As Gell explained:

> This theory supposes that wayfinding is carried out in the light of stored spatial information in the form of a "mental map" of the terrain, plus, presumably, some inferential schemes of converting this information into suitable practical decisions and actions. (Gell 1985, 272)

In contrast, the practical-mastery theory, attributed by Gell to Bourdieu (Gell 1985, 272; Bourdieu 1977), denies the existence of mental maps. According to this theory, wayfinding, at least in its day-to-day form, is not based on "abstract representations of spatial relations" (i.e., mental maps) but rather on "habit and familiarity" linked to "activities, perceptions and the bodily attitude of the subject" (Gell 1985, 273). Gell maintains that, after Bourdieu, this perspective was adopted by Hallpike (1979) and was recently supported and further elaborated by Ingold (2000).

The central point of debate between these two theories is whether mental maps exist and, if they do, whether they explain human spatial orientation. Although definitions of the concept vary, both advocates and opponents of the mental-map theory appear to agree that the term "mental map" refers to a mental representation (model) of euclidian relations that exist between objects.[1] For example, for Ingold, a mental (cognitive) map is "a comprehensive description of objects, features and locations and the relations between them" (Ingold 2000, 220). According to anthropologist Gell, the essential features of mental maps are their relative stability and their "nonindexical" character,[2] with the latter meaning that the spatial relations modeled by the map reflect the objective spatial relations in a form independent of any localized point of view (Gell 1985). This notion of "nonindexicality," which roughly corresponds with the notion of an allocentric as opposed to egocentric frame of reference in psychology (Piaget and Inhelder 1967), forms an essential part of the definition of "mental map" in anthropology. Thus, Gell defined both cartographic and mental maps as "any system of spatial knowledge and/or beliefs which takes the form of non-token-indexical statements about the spatial locations of places and objects" (Gell 1985, 278). Here the term "non-token-indexical statements" refers to propositions that are true (or taken to be true) independent of how one is located in relation to the objects and places described by them. For example, the statement "King's Cross station is north of the London School of Economics" is non-token-indexical, because its validity is not conditional on the location in which it is uttered: the statement is true regardless of whether it is made when standing either north or south of King's Cross or even outside of London. In contrast, the statement "King's Cross station is to the left of the London Stock Exchange" is token-indexical. It is valid if it is made when standing west of King's Cross but not if one is to the east of it. It is this notion of "nonindexicality" that, according to Gell, differentiates maps from simple images (Gell 1985, 278–279). Therefore, the anthropological understanding of the term "mental (cognitive) map" resembles rather closely the original understanding of Tolman (1948), and it corresponds with what many psychologists would call survey, configurational, or layout knowledge as opposed to route or sequential knowledge (Shemyakin 1962; Appelyard 1970; Siegel and White 1975). This understanding of the term, as synonymous with survey knowledge, is known among psychologists and geographers (O'Kneefe and Nadel 1978; Allen 1999).

Advocates of the mental-map theory in anthropology believe that it is exactly its nonindexical character that allows the use of a mental map in spatial orientation and that the nonindexicality aspect ensures that once a position has been determined in relation to another encoded object in the map, one's position to all other objects also becomes automatically known. Therefore, wayfinding, according to this theory, consists of plotting a route in relation to the objects and places (landmarks or hallmarks) encoded in a mental map; during the course of a person's travel, movement is made from one landmark to another, the direction of this movement being made with reference to a mental map. Having arrived at a landmark, a person updates his/her position in space (position fixing) using this mental map and chooses the direction for further movement (Gell 1985, 176–178). It is evident that this process of wayfinding is not dissimilar to navigating with a cartographic map (Gell 1985, 286).

1. The term "mental map" has a number of synonyms. Among anthropologists, Ingold prefers the term "cognitive map." He indicates, however, that the terms "mental map" and "cognitive map" are synonymous (Ingold 2000, 219). Outside anthropology, the number of synonyms in use is much larger (Kitchen 1994; Golledge 1999*b*, xiii–xiv), while the term mental (cognitive) map itself can sometimes be used in a wider sense than in anthropology, that is, as the total representation of space in thought, which includes both euclidian relations between objects and visual memorization of routes (Golledge 1999*a*).

2. The claim to the contrary made by Oatley (1977, 546) was effectively rejected by Gell (1985, 274) and Ingold (2000, 224).

The advocates of the practical-mastery theory, on the other hand, deny the existence of such nonindexical mental maps. For example, Ingold states that "there is no such map, and belief in its existence is a consequence of the mistaken attribution to native people of a sense of what it means to know one's whereabouts that effectively treats them as strangers in their own country" (Ingold 2000, 219). Ingold's own explanation of wayfinding mechanisms derives from the works of psychologists Gibson (1979) and Heft (1996). He believes that everyday wayfinding is carried out in relation to the visual perspectives perceived by a moving organism (e.g., human). Following Gibson, Ingold names these perspectives "vistas" and cites his definition: "a semi-enclosure, a set of unhidden surfaces, . . . what is seen from here, with the proviso that 'here' is not a point but an extended region" (Gibson 1979, 98; quoted by Ingold 2000, 238). In the event of a change in visual perspective, for example, if a person moves from one direction to another, a transition would take place. Ingold states that "to travel from place to place involves the opening up and closing off of vistas, in a particular order, through a continuous series of reversible transitions" (Ingold 2000, 238). It is this sequence of temporally ordered vistas and transitions (rather than a model of spatial relations between objects and places) that people, according to Heft (1996), as quoted by Ingold, have in their heads and use for everyday wayfinding:

> As every path of travel gives rise to its own distinctive flow pattern, so every such pattern uniquely specifies a certain path. To find one's way, Heft argues, means to travel along a particular route so as to generate or recreate the flow of perspective structure peculiar to the path leading to one's destination (1996, 122). One remembers the route as a succession of vistas connected by transitions, rather as one might remember a piece of music as a series of thematic sections linked by bridge passages. Just as with musical performance, wayfinding has an essentially temporal character (1996, 112): "the path, like the musical melody, unfolds over time rather than across space." (Ingold 2000, 238)

Ingold, therefore, believes that people perceive and memorize space not as a set of spatially related objects and locations in euclidian space but rather as a set of routes encoded in temporally organized sequences of vistas and transitions. From this perspective, places (locations) are just "specific vortices in a current of movement, of innumerable journeys actually made" (Ingold 2000, 238). Within this model, human spatial cognition, as it is readily accepted by Ingold (2000), does not provide a traveler with any information on where he is (in euclidian space) or how other locations are situated in relation to him/her at any given moment of time. Instead, it tells him/her how it is possible to get from his/her current position to these locations. Therefore, using the terminology of psychology and behavioral geography, Ingold insists that humans have only route or sequential knowledge of large-scale environments. Ingold cites a number of ethnographies, including some studies of the sketch maps produced by informants, in support of this point (Ingold 2000, 228). He also points out that most of the sketch maps produced by aboriginal people from different parts of the world actually depict paths of journeys (represented in the form of lines) and that geographic objects are given in relation to these paths (Ingold 2000, 232–233). Finally, Ingold states that direction of movement is not determined before departure on the basis of a mental map but is rather as a result of the opening up of vistas: in his terms, "we know *as* we go, not *before* we go" (Ingold 2000, 239).

Although it is intuitively difficult to deny that humans indeed often find their way using visual route memory, the practical-mastery theory with its explicit denial of nonindexical cognitive representations of euclidian relations between objects (survey knowledge or mental maps) cannot account for the whole range of wayfinding abilities that humans demonstrate. To prove this, let us make the following mental experiment. Imagine that a man attends a conference in a strange city and that accommodations and meals have been booked at a hotel and a restaurant (fig. 1). Suppose that the man has no cartographic map of the city and that the distance between all three locations (the hotel, conference venue, and restaurant) is fairly large; that is, one point is not visible from another.

On the first day of the conference, the man is guided to the conference venue along street 1. After the morning session, he is guided to the restaurant along street 2. After lunch he returns to the conference venue using street 2, and in the evening, he goes to his hotel using streets 1 and 4. The following morning, he would probably be able to find his way to the conference venue and then to the restaurant without assistance. This possibility is logical from both theoretical perspectives. Indeed, the mental-map theory would state that after being guided to the conference venue and then to the restaurant, the man would be able to compile a mental map registering the locations of all three places. From the viewpoint of Ingold's theory, the man would have acquired the sequence of vistas and transitions that determine the paths from the hotel to the venue and then from the venue to the restaurant.

Now suppose that the man decides to skip the next morning session. He is not prepared to skip lunch, however, and decides to go to the restaurant. Would he, without any assistance, be able to do this by taking the shortest route (i.e., by following street 3 and then turning into street 2)? From the viewpoint of the mental-map theory, he could well be able to do this. Indeed, since the man has already compiled a mental map of nonindexically registered spatial relations between the three objects (hotel, venue, and restaurant), it is now possible for him to work out that street 3 should lead in the direction of the restaurant. It is also possible for him to understand that the way to the restaurant would be shorter along this street compared with following streets 1 and 2. In contrast, from the viewpoint of Ingold's theory, the man would be unable to select the unknown route. Indeed, since

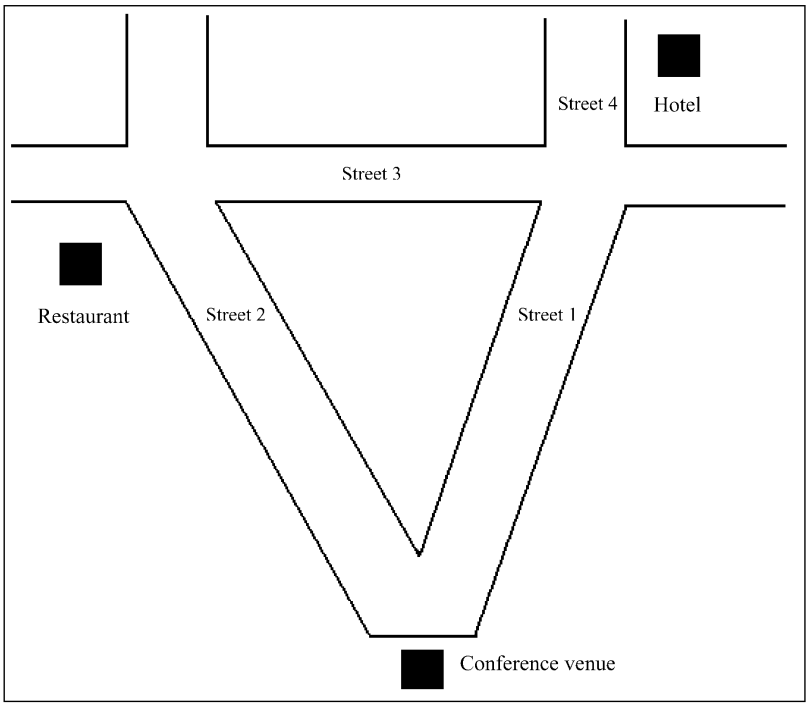

Figure 1. The mental map experiment.

Ingold believes that the man (like all humans) does not have a nonindexical model (mental map) in his head, the man cannot figure out that street 3 leads in the direction of the restaurant and, therefore, cannot know that it is the shortest route. Thus, in the absence of the appropriate sequence of vistas and transitions along street 3, the man cannot possibly know where this street leads. Hence, following this logic, the man would neither try to work out the direction nor estimate the distance since, as Ingold would have it, he knows *as* he goes, not *before* he goes. Therefore, the only possible way he could find the restaurant would be to follow streets 1 and 2.

This mental experiment demonstrates a fundamental feature of the mental map (survey knowledge) in contrast to route knowledge, the ability to "permit generalizations and inferences beyond the specific spatial information gained through direct experience" (Allen 1999, 71). These inferences enable a subject to find a novel and more economical route, such as a shortcut or detour; this ability would be absent if he/she had only route knowledge, as Ingold supposes. Since most human beings, aboriginal or otherwise, evidently have this ability, one has to agree with Golledge, Parincky, and Rayner (1980) that route knowledge as the primary or only mode of spatial cognition can be found exclusively among mildly or moderately retarded persons, while "locationally matched, low socioeconomic, mentally able persons quickly develop two-dimensional layout knowledge of both routes and surrounding environment" (Golledge 1999*a*, 10). In other words, in contrast to what Ingold maintains, humans do have what anthropologists consider to be mental maps.[3]

This statement, however, does not mean that the explanation of wayfinding proposed by the mental-map theory as accounted by Gell is necessarily correct; although humans have mental maps, reference to them need not be the only

3. It should be noted that apart from survey knowledge (mental maps) and route knowledge, the wayfinding process can be also based on so called path integration (more widely known as dead reckoning). Path integration is based on egocentric representations of euclidean spatial relations between a subject and the locations visited. These representations are constantly updated during travels by the subject's keeping of a list of turns he/she has made and distances he/she has traveled between turns. Reliance on path integration is currently believed to be the main method of wayfinding among insects and some rodents (Gallistel 1990; Etienne et al. 1999). Interestingly, all the cognitive abilities traditionally associated with mental maps (shortcuts, detours, ability to point to a location) can also be associated with using path integration (Gallistel 1990; Etienne et al. 1999; Collett and Graham 2004). It has, therefore, recently been proposed by Wang and Spelke (2002), that human wayfinding, like that of insects and rodents, is based (apart from survey knowledge) on path integration rather than mental maps. Unfortunately, their evidence is derived from studies of human pointing and moving in small-scale (room size) environments and the application of their model to wayfinding in large-scale environments can be problematic: it is believed, that human abilities for path integration in large-scale environment are modest (Loomis et al. 1993). In addition, as Collett and Graham recently demonstrated, the effective application of path integration in large-scale environments still requires the formation of a kind of mental map, even among animals (Collett and Graham 2004).

means of finding one's way. Indeed, the existence of route knowledge is undeniable. Therefore, Ingold's statements could still be true to the extent that reliance on route knowledge represents the only form of wayfinding in familiar environments, while mental maps, despite their existence, are used mostly in environments that are more or less novel. With this change, we believe Ingold's argument corresponds much better with practical mastery seen as an intellectual tradition. Indeed, the fundamental assumption behind this tradition, as we understand it, is that a significant portion of day-to-day human activity does not result from calculations about or formal inferences from cognitive representations of the environment but rather from a habitual or even automotized response to it—"habitus," according to Bourdieu (1977), or "skill," according to Ingold (2000). To the best of our knowledge, however, no advocates of practical mastery (apart from Ingold in this case) have denied that humans possess the means and ability for such calculation and inference. In light of this, to paraphrase the statement of Ingold, what makes native people feel they are strangers in their own land is not the belief that they possess mental maps (they surely do) but rather the belief that they rely on these maps during the course of their day-to-day actions. Ingold may have had this possibility in mind when he stated,

> The novice becomes skilled not through the acquisition of rules and representations but at the point where he or she is able to dispense with them. . . . The map can be a help in the beginning to know the country, but the aim is to learn the country, not the map. (Ingold 2000, 415)

If the practical-mastery arguments are interpreted in this way, the debate over the two theories switches from a discussion about the existence of mental maps to the question of how they are used in wayfinding. We believe this makes the debate much more interesting, but unfortunately, it is no less futile. To prove this, in the following sections we review the relevant anthropological (ethnolinguistics), psychological, and geographical findings before discussing our fieldwork material. This review will demonstrate that anthropology can contribute to the ongoing interdisciplinary research on human spatial cognition and orientation but only if it goes beyond the debate described above.

The Debate Reevaluated

Ethnolinguistic Studies

An important contribution to the research on human spatial cognition and orientation that has an explicit focus on cultural differences was recently made within the field of ethnolinguistics. This research concerned the probable effects of the predominant linguistic frames of reference used for expressing spatial relations between objects in a particular language (Levinson 1992, 1996, 2003; Brown and Levinson 1993; Widlok 1997; Wassmann and Dasen 1998). It has long been known (see Levinson 2003, 25–34, for a review) that linguistic expressions of spatial relations between objects can be given in either relative or absolute frames of reference. Using the English language for our example, in a relative frame of reference, the meaning of the expression "the glass is to the left of the bottle" depends on the position and orientation of the speaker relative to the objects. In an absolute frame of reference, the expression "the glass is north of the bottle" has no such dependency (cf. Gell's notions of indexicality and nonindexicality, above). As Levinson (2003) explains, there can also be a third frame of reference—intrinsic—exemplified by "the tree is in front of the house." In an intrinsic frame of reference, this expression's meaning does not derive from the speaker's position unless the position of the object is described in relation to him/her ("the tree is in front of me").

The meaning in these expressions depends on the orientation of one of the objects in space and, most important, on the shared conventions of speech of the speaker and the addressee on how sides (front, back, left, and right) should be assigned to this object. Thus, for an English speaker, a shared convention is that a house's front door is situated on the front side of the house. In contrast, in a relative frame of reference, there is no similar convention regarding the sides of trees or bottles, and so the meaning of "the glass is in front of the bottle" depends on the position of the speaker. Other peoples may have different conventions about the assignments of sides to objects (see Levinson 2003, 76–79, for examples).

Although most languages seem to allow expressions in all three (or at least more than one) frames of reference, not all linguistic frames of reference are used equally in everyday speech. For example, among all European peoples, the relative and intrinsic frames clearly prevail in everyday conversations, while the absolute frame is reserved for a limited type of situation. The great contribution that recent ethnolinguistic research has made is in demonstrating that this is not universal. There are a number of groups whose representatives make spatial expressions predominantly in the absolute frame of reference. Furthermore, in some languages (e.g., the Australian language Guugu Yimithirr, studied by Levinson [2003]), this is the only linguistic frame of reference available due to the absence of concepts that in English correspond to "left," "right," back," and "front." The representatives of these groups, therefore, routinely use expressions such as "take a cup from the southernmost box," "you have a fly on the eastern side of your face," or "put your signature in the northwestern corner of this document."[4]

4. It should be made clear that an absolute frame of reference would not necessarily be based on geographic bearings (east, west, north, and south), although this type of absolute frame is probably the most widely spread. For example, the absolute frame of reference used in Bali Island is based on directions called *kangin*, *kauh*, *kaja*, and *kelod*. While *kangin* and *kauh* more or less correspond to east and west, *kaja* signifies the direction toward the mountains (away from the sea), while *kelod* is the direction toward the sea. Therefore, the geographic direction of the *kaja-kelod* axis is different in different parts of the island (Wassmann and Dasen 1998; see Levinson 2003 for further discussion).

These groups have recently been the object of intensive research (Widlok 1997; Wassmann and Dasen 1998; Levinson 2003). The results from these studies have led some researchers to claim that the reliance on the absolute linguistic frame of reference reflects or even creates certain differences in spatial cognition between these groups and the other groups that predominantly rely on intrinsic and relative linguistic frames of reference (Brown and Levinson 1993; Wassmann and Dasen 1998; Levinson 2003). Some of the findings that led to these claims are reviewed below.

First it should be noted that relying on absolute linguistic frames of reference in everyday speech logically presupposes the possession and reliance on nonindexical mental maps, as understood by Gell. Indeed, the equivalent of English phrases such as "the school is to the left of the supermarket" or "turn right from here to get to the town hall" would be coded in this frame as something like "school is to the north of supermarket" or "go south from here to get to the town hall." As Levinson pointed out,

> To achieve such descriptions one will need to know, or able to recover, the angles subtended between any two places. In that sense a mental map of one's world with accurate absolute angles must be accessible. One place in that map that will be especially important will be the location of speaking (necessary to create phrases such as "the city hall is south from here"—K.V.I., M.J.D.). As the speaker moves, his angular position vis-à-vis other places will change. (Levinson 2003, 125)

In other words, in order to rely on the absolute linguistic frame of reference, one needs to know at any moment how one is situated in relation to any object to which one wishes to refer, as well as how these objects are situated in relation to each other in euclidian space. In short, one always needs to know where one is, not only where one should go.

A number of experiments performed with people relying on the absolute linguistic frame of reference (e.g., Lewis 1976*a*; Levinson 1992, 2003; Haviland 1993, 2000) demonstrated the empirical validity of this logical conclusion. In most of these experiments, people were asked to point to different locations and the accuracy of their pointing was estimated by using a magnetic compass, a geographic map, or the global positioning system. Thus, Levinson (1992, 2003), in his study of spatial orientation among the Guugu Yimithirr people of Northern Queensland asked the people to point to the same distant places (situated up to 350 km away) while located at their "base" (Hopeavalle) and at stops on trips between different places; the experiments took place in open space, providing good vision in all directions, as well as in the bush or forest, where vision was limited. The informants were asked to imagine they were located in various distant places ("hypothetical locations") and to point to different places (including the one where they were actually located) from there; the time the informants took to make this gesture was estimated (Levinson 2003, 125–127). The list of places the informants were asked to point to included some they had never visited and some they had never approached from their current location. It was observed that the average deviation of the direction pointed out by the informants from the location azimuth taken from a map ranged from 12.6° (when pointing from their base) to 19° (when pointing from hypothetical locations; Levinson 2003, 126–127). Essentially similar results were obtained by Lewis in his (1976*a*) study of the Western Desert peoples of Australia (average deviation: 13.71°) and in Widlok's (1997) study of the Hai‖om of South Africa (16.40°).

These studies confirm that people relying on the absolute linguistic frame of reference in their everyday speech do have extensive layout knowledge (mental maps) of their environment and constantly update their position in relation to the landmarks encoded in it. In contrast with the claims by advocates of the practical-mastery theory, these people cannot "dispose" of their mental maps, whatever may be their familiarity with their environment. Quite the reverse, they rely on them every time they need to make a spatial statement relating to the environment. It should to be accepted, however, that the ethnolinguistic studies described do not by themselves confirm that the people actually use their mental maps for routine wayfinding. It could be argued that despite having mental maps and being constantly aware of their euclidian position in relation to objects, they still do not base their wayfinding on this knowledge (despite its being adequate for the task) but always use route knowledge (vistas and transitions) instead. Although we accept that this possibility cannot be excluded on the basis of existing research, credible evidence should be presented in order to prove it. Since we are unaware of any such credible evidence, it is likely that these people use mental maps.

The question remains of how far the described results can be extrapolated to people who do not rely on the absolute frame of reference. The pointing experiments, when used with other people (mostly Europeans), regularly gave less impressive results than those described so far. For example, among Britons led in a zigzag trajectory through a wood and then asked to point back to their starting point, the average deviation was found to be as much as 54° among males and even more so among females (Baker 1989, 35–45). The same experiments made by Pederson among the members of a Dutch mushroom-picker's club revealed a comparable deviation (49°; quoted in Levinson 2003, 242). This fact and others are used to support the claims that there is a fundamental difference in the spatial cognition of people who rely predominantly on absolute frames of reference and that of those who rely on relative and intrinsic linguistic frames of reference Thus, based on these results, Levinson (2003) argues that "absolute" people are likely to have "oriented survey maps" (i.e., mental maps that encode relative positions of objects in euclidian space using a general geocentric system of coordinate axes; e.g., geographic bearings). "Relative" and "intrinsic" people, on the other hand, rely predominantly on route knowledge or nonoriented mental maps (i.e., mental maps

that do not employ any general system of coordinate axes; Levinson 2003, 273–275). However, Levinson points out, referring to McNaughton, Chen, and Markus (1990), that there is a serious problem with the latter since they do not have an established grid of directions, and adding a new place (landmark) to them would necessitate establishing and recording spatial relations between this place (landmark) and every other place (landmark) already on the map. Therefore, Levinson believes that these maps, being limited in size, do not play an important role in wayfinding.

If this assertion is correct, then the mental-map theory of Gell is likely to present a correct account of "absolute" people wayfinding, while the practical-mastery theory could be correct for "intrinsic and relative" people. However, findings in psychology and geography seem to suggest that things are actually much more complicated.

Psychological and Geographic Studies of Human Orientation

Psychological and geographical literature on spatial cognition (in relation to large-scale environments) is extensive, and its complete review is impossible here. In this paper, therefore, only the main methodologies used and conclusions reached are outlined below.

Toward the end of the 1960s and the beginning of the 1970s, the main method used in psychological and geographic studies on the topic was the "mapping exercise" (Appleyard 1970; Craik 1970; Pocock 1976); by the middle of the 1970s, a number of mapping exercise studies were made in different areas of Europe (Spencer and Lloyd 1974; Pocock 1976) and America (Appleyard 1970). During these studies, groups of people were asked to sketch a map of a certain area with which they were familiar (usually a town or city). The sketch maps obtained could be clearly divided into two groups: those tending to emphasize the connecting lines—notably roads and streets ("sequential" maps)—and those in which the elements representing different places (e.g., buildings, parks, mountains, etc.) were scattered over the sketch and where the connections between them (e.g., streets and roads) appeared to be incidental ("spatial" maps: Appelyard 1970; Pocock 1976; Murray and Spencer 1979 or "survey" maps: MacEachren 1992; Golledge, Dougherty, and Bell 1995). Following logic similar to that recently used by Ingold to prove his theory, it was initially supposed that the sketch styles reflected the type of spatial knowledge of their authors: sequential maps were believed to represent route knowledge and survey maps to represent survey knowledge (or mental maps, in Gell's terms). It was soon recognized, however, that the style of sketch maps depended more on the purpose (implicit or explicit) of producing them. Thus, a person having good survey knowledge of an area could still depict it in the form of a sequential sketch. He/she was especially likely to do this if the sketch was made with the purpose of recounting journeys or explaining the way to particular points (Spencer and Weetman 1981). Since most sketch maps in everyday life are made for exactly these purposes, sequential maps are very likely to predominate. It is important to bear this in mind while evaluating the data on the aboriginal peoples' sketches referred to by Ingold (2000), since, as he correctly points out, these maps depict routes. However, the aboriginal peoples in question were probably innocently sketching their most frequent routes rather than portraying their route knowledge per se. Importantly, in the mapping exercise studies, where informants had no clues about the purpose of their sketching, the percentage of sequential maps obtained was usually only marginally larger than those of the spatial or survey maps (Pocock 1976; Murray and Spencer 1979; Spencer and Weetman 1981). Whatever the case may be, the mapping exercises are now believed to be an appropriate method for studying the content rather than the form of of territory-related knowledge. Pointing experiments such as those described in the previous section are thus believed to be a much better indicator of survey knowledge than the sketches. As pointed out by Golledge, "pointing accuracy is usually a good indicator of whether or not layout understanding has been achieved" (Golledge 1999*a*, 41).

It would appear that almost all researchers in psychology and geography agree that humans can have both route knowledge and survey knowledge of large-scale environments (see MacEachren 1992; Golledge, Dougherty, and Bell 1995; Kulhavy and Stock 1996; Montello et al. 1999 for literature reviews). Even Gibson (1979), who demonstrated how certain behavior believed to be based on mental representation of euclidian relations (mental maps) could be produced without reference to them, never appeared to insist that his ecological vision was the only basis for explaining spatial behavior among humans. Certain results of the pointing experiments simply excluded this possibility.

It is commonly believed that route knowledge is qualitatively a simpler form of spatial representation than survey knowledge (Shemyakin 1962; Siegel and White 1975). Indeed, both learning it and using it for retracing learned routes can be easily modeled with reference to the classic stimulus-response chain, whereas survey knowledge is both acquired from direct experience of the environment and used for wayfinding by means of mental inference (Tolman 1948). Therefore, until recently, it was believed that route knowledge precedes survey knowledge both in ontogenesis (during the course of human development) and in microgenesis (during the course of learning a particular environment; Shemyakin 1962; Hart and Moore 1973; Siegel and White 1975; Moore 1976; MacEachren 1992; Kulhavy and Stock 1996). Although both beliefs have recently been challenged by empirical studies, we consider their brief review to be worthwhile.

The belief that route knowledge precedes survey knowledge in ontogenesis is based mainly on the Piagetian assumption that the capacity for abstract operations on mental representations is formed relatively late in a human's life (Piaget and Inheldr 1967). This assumption is now challenged by empirical studies (Acredolo 1981; Newcombe 1997; Newcombe and Huttenlocher 2003) that suggest that babies and young chil-

dren can possess both route and survey knowledge of the environment. The belief that people who start to learn a novel environment acquire route knowledge first, while survey knowledge develops much later as their experience of their environment increases (Hart and Moore 1973; Siegel and White 1975; Devlin 1976; Garling et al. 1981), is based on the assumption that route knowledge is a necessary prerequisite for the formation of survey knowledge (Shemyakin 1962; Siegel and White 1975). At least two theoretical models explaining the formation of survey knowledge based on route knowledge have been proposed (Siegel and White 1975; Golledge and Spector 1978). Both state that the cognition of a new space (territory) starts with learning routes (building route knowledge) between a set of objects or places. As the number of known places and routes increases, people start to retrieve the relative euclidean position between them and, therefore, form survey knowledge (mental maps). These models have, however, also been recently challenged by experimental studies (Foo et al. 2005; Ishikawa and Montello 2006; Brunye and Taylor 2008), which demonstrate that route knowledge does not necessarily precede survey knowledge, nor does it necessarily lead to the formation of survey knowledge. Rather, both forms of knowledge can be acquired independently of one another at the very beginning of the learning process.

The capacity to acquire each form of knowledge, as well as the speed of this acquisition, seems to depend on a number of idiosyncratic and social factors that differ between each individual (Ishikawa and Montello 2006). First, it depends on a person's exposure to the environment and the extent to which he/she engages with it; general traveling experience would seem to further facilitate the process (Spencer and Weetman 1981). Second, it was demonstrated that the formation of survey knowledge is likely to depend on sex. Women required a significantly longer time to form a mental map (Montello et al. 1999; Prestopnik and Roskos-Ewoldsen 2000; Lawton and Callai 2002). Indeed, according to Silverman and Eals (1992), the difference between the mental mapping abilities of men and women is related to the division of labor between them during the Pleistocene period; with men being involved in hunting and women in gathering.

These data suggest that survey knowledge (mental maps) is not something that is used exclusively by strangers and disposed of when the environment becomes familiar, as the "soft" variant of the practical-mastery theory would suggest. If the accumulation of experience with the territory indeed produces any qualitative change in the forms of spatial knowledge (as the older models of spatial knowledge acquisition suggest), this change is quite the reverse: survey knowledge develops only when the environment becomes familiar. In the light of recent studies, however, it seems more likely that no such change takes place either in ontogenesis or in microgenesis but rather that both forms of knowledge are available to people at the very beginning of the learning process and remain so as experience with the environment grows. More importantly, no form of spatial knowledge is ever disposed of. There is a good deal of evidence to support that people rely on both forms (Spencer and Weetman 1981; Golledge, Dougherty, and Bell 1995; McNamara and Shelton 2003). Again, the relative reliance on the two kinds of knowledge during wayfinding is a rather different question. However, it would appear that people visually remember only a limited number of routes, which are mainly those that are used most frequently (such as the routes from home to work and from home to a supermarket; Spencer and Weetman 1981). In fact, it is much more likely that one of the important functions of survey knowledge is that it allows disposing of the necessity to visually remember a growing number of routes (Garling et al. 1981). Therefore, it can be assumed that the more routes a person uses during the course of his/her everyday movement, the more he/she will rely on survey knowledge.

Finally, some studies focused on the structure of mental maps, which resulted in an important discovery of their hierarchical structure (Stevens and Coupe 1978; Lieser and Zilbershatz 1989; McNamara, Hardy, and Hirtle 1989). MacEachren (1992, 249) observed, "People seem to know the relative position of places within a region and relative positions of regions, but not the position of locations within different regions." In other words, mental maps are not continuous; people know, for example, the positions of places A, B, and C in relation to each other and the positions of places α, β, and γ also in relation to each other. However, they do not necessarily know the positions of places A and α or A and β in relation to each other. Instead, they are likely to know the relative position of a whole cluster of places ABC and $\alpha\beta\gamma$ (regions) to each other. This means that to travel from place A to place α, people take a course to the cluster (region) $\alpha\beta\gamma$, rather than to a particular place α within it. It is only after their arrival in this region that they can find the particular place α. The size of regions and their structure also seem to vary depending on the life history of an individual.

To sum up, the findings presented in this section suggest that the mental map/practical mastery theoretical debate, even if it is understood as a debate about using different kinds of knowledge rather than their existence, is futile. Human wayfinding is based on both mental maps and the temporarily ordered sequences of vistas and linkages. It appears that this fact is global and depends on neither culture nor language. However, another important message that geographical and psychological studies send to anthropology is that one can expect considerable differences in size, hierarchical structure, and extensiveness of the use of mental maps vis-à-vis route knowledge between different people and peoples. This expectation is based on the finding that all these parameters appear to depend on sex, travel experience, and the life history of individuals, which, in turn, depend on an individual's way of life (e.g., settled vs. nomadic peoples). However, what remains unclear is the exact nature of this dependency. It seems that studying it will constitute one of the main directions of interdisciplinary research on human orientation in the near

future, and it appears that anthropologists can contribute by providing comparative research on the orientation skills and mental maps of various peoples.

In the following section, we shall commence this endeavor by presenting comparative anthropological material with aim to ascertain the similarities and differences in mental map structures between two nomadic reindeer-herding peoples. This material is by no means complete and exhaustive, since the main purpose of this exercise is to provide an example of how anthropology can contribute to the ongoing interdisciplinary research on human orientation by taking note of the results of psychological and geographical studies discussed above.

Methodology

The empirical ethnographic material used in this paper was collected during successive periods of fieldwork in the Inta region of the Komi Republic and the Nenets Autonomous Okrug (northeast of the European part of the Russian Federation) as well as in the Yamalo-Nenets Autonomous Okrug (northern part of western Siberia). Three expeditions took place with brigades[5] of the Komi *Sovkhoz* (reindeer-herding enterprise) Bol'shaya Inta, who migrate mostly in the territory of the Nenets Autonomous Okrug. The first expedition took place in 2001 (September–November), the second in 2002 (June–December), and the third in 2003 (January–February). During these expeditions, 9 months were spent with the second and third brigades, 1 month with the first and fourth brigades, and 1 month with the fifth brigade. During various intervals between August 2001 and February 2003, a period of more than 1 month was spent interviewing retired reindeer herders in small remote villages: Nenets herders in the village of Kharuta (3 days); Komi herders in the villages of Adzvavom (2 weeks), Kocyuvom (1 week), Petrun' (3 weeks), and Rogovoy (3 days). Two further expeditions took place in the autumn/winter of 2005 and the summer of 2006 in the southern part of the Gydan peninsula, the Tazovsky district of the Yamalo-Nenets Autonomous Okrug. These expeditions were focused on the Taz group of Nenets reindeer herders. During these expeditions, one and one-half months were spent with the fifth brigade (November–December 2005), and four and one-half months were spent with the first brigade of the Sovkhoz Tazovsky. About 4 weeks were spent interviewing retired reindeer herders in the village of Tazovsky (October–November 2005).

The research included participant observation and interviews that were conducted in the Komi and Russian languages. Most informants were male reindeer herders over 15 years old. The interviews were informal, and no specially designed questionnaires were used. The standard techniques of cognitive anthropological research were used during the interviews (Michrina and Richards 1996). The interviews typically started with a question that led to a discussion. Translations of Komi and Nenets terms into Russian and English were carried out for the purpose of analysis. The interviewing process was repeated several times with different individuals and groups of herders in order to cross reference data.

5. The Russian term used to designate an individual reindeer-herding unit working for a reindeer-herding enterprise.

The Mental Maps of Komi and Nenets Reindeer Herders

Both the Komi and the Taz Nenets reindeer herders lead a very mobile way of life, moving hundreds of kilometers between seasonal pastures. The Komi appropriated the reindeer-herding techniques of the Nenets some 300 years ago, and in many respects, their material culture and living conditions are similar to those of the Nenets (construction and organization of the nomadic tent, means of transport, etc.). However, their patterns of movement and land use are remarkably different, making a comparative study of their method of orientation quite interesting. The Komi have long linear migration routes with winter pastures located in the forest-tundra and summer routes near the Barents and Kara seas, some 400–500 km farther north. When moving, the Komi follow well-established migration routes (*vörga*), which have remained relatively unchanged for centuries (Dwyer and Istomin 2008*a*). A migration route is shared by two reindeer-herding brigades who pasture their animals on opposite sides of it; the distance between migration routes is around 5–10 km, which means that the Komi have long narrow corridors in which to pasture their herds. In contrast, each brigade of Taz Nenets exploits its own plot of land of about 60 km^2. Its movements within this plot are circular rather than linear, with no established migration routes. A Taz Nenets brigade changes the plots it uses around every 5 years and can sometimes move to a new plot situated as far as several hundred kilometers away.

Both the Komi and the Nenets languages belong to different branches (Finno-Ugric and Samoyedic, respectively) of the same (Uralic) linguistic family. In both languages, spatial relations between objects are expressed by means of localizing cases of nouns (encoded by nouns' suffixes) and postpositions. The latter also acquire the localizing cases's suffixes. The localizing cases of nouns express mostly the relations of inclusiveness (something being inside something) and contact between objects. For example, "inside a nomadic tent" is *chomyyn* (komi) = *chom* (nomadic tent) + −*yn* (inessive suffix) and *makona* (nenets) = *ma'* (nomadic tent) + −*hana* (inessive suffix; rules of phonetic assimilation apply). The spatial relations other than those of inclusiveness and contact are designated mostly by postpositions. Thus, "behind a nomadic tent" is *chom sayyn* (komi) = *chom* (nomadic tent), *say* (space behind) + −*yn* (inessive suffix) and *ma' pun'ana* (nenets) = *ma'* (nomadic tent), *pun'* (space behind) +

−*hana* (inessive suffix). Although some of the postpositions in both languages semantically express spatial relations in the absolute frame of reference—Komi: *chom katyn* (upstream from a nomadic tent); Nenets: *sale-khard ngermhana* (to the north of Sale-Khard city)—their use seems to be restricted to a limited number of situations. For example, the postpositions *kat* (space upstream) and *kyvt* (space downstream) in Komi are used only when speaking about objects situated on a bank of a river or stream. Most spatial expressions involving postpositions in both languages clearly use both the relative and intrinsic frames of reference. In the Komi language, two verbs describing movement in the absolute frame of reference were observed: *kayny* (to move toward a watershed) and *löchchyny* (to move away from a watershed). These verbs are frequently used to describe movement on both macro- and microscales, even when no watershed is visible: *löchchy rösshaas da pes kayöd!* (go [away from the watershed] to the bush stand and bring [toward the watershed] firewood!), can be used only when the speakers are situated between the watershed and the bush stand. However, these verbs coexist with equally frequently used verbs describing movement in the intrinsic frame of reference. In the Nenets language, only "intrinsic" verbs were recorded, although our familiarity with this language is much more limited than with that of Komi. Nevertheless, it can be supposed that both peoples rely predominantly on intrinsic and relative frames of reference in their speech.

Both groups of herders frequently stressed the importance of "knowing the land," and even the younger herders had detailed knowledge of their territory. For example, while working with Komi duty herders (i.e., those responsible for the herd at a given time), we often asked them to describe their land. The herders always produced a detailed description by listing rivers, streams, lakes, ponds, bogs, *tabey* (thermokast),[6] willow stands, hills, and hill ranges (*musur*), areas with specific vegetation (e.g., *pacha*, an area covered with dwarf birch; *yarey*, a lichen area; and *nyar*, an area without vegetation). The description was almost always accompanied by pointing gestures meant to identify the direction in which these landscape features were situated and sometimes their approximate distances from any given point. The informants also often provided details of the relief of the terrain they described. A peculiar gesture was uniformly used for this: an informant moved his finger along the line of horizon following the stream of the river situated behind it; while doing so, he also moved his finger closer to and farther from his body describing the zigzags of the riverbed. Most of the features described by the informants were out of the line of view from the place where the description was given.

This behavior signifies that the Komi informants had a very clear idea about how the various features they listed were situated in relation to each other at any given moment in time. In other words, they possessed a mental map (survey knowledge) of the environment. Such a map is indeed necessary for successful reindeer pasturing, which is based on the herder's ability to envisage and react to the movement of the reindeer herd and to guide its movement in an appropriate direction in order to ensure herd cohesion and avoid dangerous terrain. This means that a Komi herder must be able to envisage and predict aspects such as how the animals move and at what speed, when and where they split into groups and how these groups behave, and which places are associated with reindeer mortality (Dwyer and Istomin 2008*b*). These skills require a clear idea of the spatial structure of the landscape—that is, a map or "the model of all possible routes" (Bourdieu 1977, 2)—and it would appear that no limited network of routes remembered as sequences of vistas and linkages would suffice.

Further investigation into the mental maps of Komi reindeer herders revealed the existence of clear spatial limits, since all male informants could provide a very detailed account of the position of various landscape features situated on both sides of their migration path (*vörga*) at a distance of up to around 15 km away. However, the territory beyond this limit was accounted for in much less detail. It was noted, for example, that while speaking about territory close to their path, the herders could tell about and point to areas with specific vegetation, bogs, and *tabey*. In more distant territory, only the objects distinctly standing out from their environment and visible from far away—landmarks such as large rivers, lakes, high mountains, and villages—were named and pointed to. The size of the territory these semidetailed mental maps covered (i.e., from 20 to about 80 km from either side of the migration route) seemed to vary greatly from one reindeer herder to another. The territory beyond this distance seemed to be almost completely unknown to the herders and was referred to as "unknown land" (*tödtöm mu*). Interestingly, the herders have detailed mental maps of the landscape that is immediately adjacent to the migration route (i.e., around 10 km from either side of it), which is necessary to successfully pasture one's herd. For example, when a herder was asked whether he was afraid to let reindeer go farther than about 10 km away from the migration route, he answered that he was not because he knew the land sufficiently well to return to the tent encampment, but not well enough to pasture his herd. This shows that the mental maps of Komi reindeer herders cover a long and relatively narrow strip of land (situated on both sides of their migration routes) and that these have different levels of detail; they are elaborate in areas adjacent to the migration route (i.e., the core map) but gradually

6. A komi term for what is probably known as thermocarst; a common natural phenomenon caused by the thawing of permafrost, which renders the ground unstable when walked on, moving and shaking like jelly. *Tabey* is rather dangerous both for people and reindeer, because one can easily fall through the thin layer of soil into the wet mud. It is sometimes very difficult for people and almost impossible for reindeer to get out of it without assistance. The same phenomenon is called *il'a ya* (literally "alive land") by the Nenets.

become vague and not sufficiently detailed to easily pasture reindeer the farther one moves away from it (i.e., the "periphery" map). Although, the periphery mental maps of reindeer herders seem to be insufficiently detailed for successful reindeer pasturing, they are still detailed enough for wayfinding. Finally, no evidence was found concerning the hierarchical structure of the Komi herders' mental maps. It would appear that these maps represent a continuous survey of the territory along the migration path.

The mental maps of the Taz Nenets reindeer herders, who do not have migration routes, appear to be different. In the same way as the Komi, the Nenets herders, at any time, could list a great number of landscape features that surrounded their territory, including rivers, bogs, forested patches, willow stands, lakes, hills, ponds, areas with specific soil type (*yum*: permafrost polygons; *il'a ya*: the same as *tabey* among the Komi) that surrounded their territory. Directions to these features were pointed to and, in the same way as the Komi, some informants provided an approximate distance to them. The Nenets informants could usually name and point to landscape features situated as far as about 25–30 km away in any direction from their location. Beyond this distance their knowledge of the terrain became less detailed in the same way as that of the Komi. Their detailed mental maps, therefore, seem to cover a circular piece of territory with a diameter of 25–30 km.

The most important difference between the mental maps of the Komi and those of the Taz Nenets reindeer herders, however, is that the mental maps of the Taz Nenets seem to have a much more complicated structure. It was revealed that the Nenets conceptualize their territory as a set of regions (named *ya*),[7] each of them having its own name and relatively clear borders that mostly coincide with watersheds (the ridges of land that separate two adjacent drainage basins). These regions are relatively small in size and cover a territory of approximately 25 km × 25 km. A reindeer-herding brigade usually visits three to four regions during the course of its annual migrations.

It was soon discovered that all the Nenets male informants could easily point to any place in a region where they were currently situated, while most of them had significant problems with pointing to places situated in neighboring regions when they were asked to do so. For example, during the entire period that the camp of the first brigade was situated in the region called *Lutsa yaha' mal*, its members could point to all the places in this region with high precision. However, most of them had problems with pointing to the old drilling tower near the N'ado (*Ngado*) yakha. Usually, they simply pointed in a northern direction and said that the tower was in *Ngado-yakha ya* (the region of the N'ado River). Once the brigade crossed the watershed between the basins of the Russian and N'ado rivers, the informants were able to point to the tower with much greater precision even though the distance to it had actually increased. On the other hand, many informants could no longer point to the places near the Russian River despite the fact that the distance to some of those places was less than that of those objects in the N'ado River region, to which they could point from their new location. They accounted for this by saying that the brigade was in "another land" (*ya*) now. Therefore, their ability to point to a location depended on the region in which they were situated rather than on the actual distance to those objects. This effectively rules out the possibility that their willingness or refusal to point to the locations reflected their awareness of limited precision of pointing gestures in the case of distant objects or their interpretation of the task (i.e., detailed spatial answers only make navigational sense for a limited area). Rather, the data show that in contrast to the Komi, the mental maps of the Nenets have a hierarchical structure as described in the previous section.

The following description provided by one of the informants explains both the organization of Nenets mental maps and their hierarchical structure more precisely. One can see that what the informant refers to are non-token indexical statements:

> The land between the Vyder-yakha and Limb'a-yakha (names of rivers) is the one I know best. When I was young, I used to "live" (meaning "to move") there for a long time. There I can point you to every tussock. There, I can point to everything and from everywhere. I also know the land down from the village (of Tazovsky), between Vesako-yakha and Koptan (names of rivers). We "lived" there for a long time as well and I know every tussock there also. But I cannot show the direction to them from here. If we were there I could, but not from here.

This quotation—one of several comments of this sort obtained during interviews—reveals that the Nenets' knowledge of land is uneven. Every Nenets herder possesses a more detailed knowledge of some regions than others due to his personal life history. The more detailed the knowledge is, the more detailed the mental map of the region appears to be. The important point, however, is that the detailed mental maps of the regions are independent from each other—the informants insisted that once inside the region they can point to "every tussock" from any given point. However, they were unable to tell how most of the places inside the region were situated in relation to their position outside of it. This falls in line with the psychologists' and geographers' argument about the hierarchical structure of mental maps.

The mental maps of the territory outside these regions seem to be much less detailed. The interviews showed that the Nenets included only basic landmarks, among which rivers

7. The word *ya* has many meanings for the Nenets. The most general of them are "land," "ground," and "earth" (as opposed to the sky—*num*). In the few Nenets radio broadcasts and the newspaper in Nenets language published in the Yamal-Nenets autonomous area, this word is also used in the sense of state or country (e.g., Russia; *Lutsa' Ya* literally means "the land of Russians").

were the most common. Indeed, when asked to describe the territory outside their pasturing region, the Nenets typically listed rivers by pointing to the direction in which they were situated and specifying the direction of their stream. The area covered by these "hydrosystem" mental maps was difficult to determine, especially because the names of the rivers the informants used were often different from the Russian equivalents on the maps. Informants admitted that the area known to them varied significantly depending on the age and experience of a herder; older herders generally knew a larger territory than younger ones. However, even the nondetailed mental maps of younger herders seemed to cover surprisingly vast areas. For example, one 16-year-old reindeer herder managed to list the rivers to the east of his current location up to the Yenisey (about 300 km away). He stated that the Yenisey River had several large interconnected branches and was located in a huge valley. He also described the river's eastern tributaries and showed by gesture both directions in which the Yenisey and Kheta rivers flowed and the point at which they met.

It seems probable that rivers represent the main axes of Nenets mental maps. The position of every location is made with reference to a particular section of a river (e.g., low, middle, and upper). The locations of regions for which the Nenets had detailed mental maps were typically described as being between such and such rivers. Furthermore, any movement outside the brigade was referred to as descending or ascending relative to a river running nearby, even one that may be some distance away and often out of sight. Therefore, the mental maps of the Taz Nenets reindeer herders apparently have two hierarchical levels. The upper level consists of the hydrosystem map, which means that regions are known in relation to the relative locations of rivers. The lower level consists of detailed mental maps of some of these regions. It seems that the Nenets are quite aware of the existence of these two levels of knowing the territory, which is indicated in the following interview:

> (Informant) It would be nice to go and live on Luts'a-yakha, it is a good place. There is plenty of lichen, a lot of fish, many animals and no Russians there. No Russians on Luts'a-yakha.[8] However, we cannot go and live there alone, we would need someone with us who knew the land there. (Anthropologist) You do not know the way to get there? (Informant) Why, yes we do. Of course, we do not know all the hills, bogs and lakes! But we still can find our way there. We could travel from one river to another and eventually get there. Everybody knows rivers, right? But to live in a place one has to know the land and not just the rivers. You need to know all bogs, lichen places, where to pasture reindeer. To know the land, we need an old man (vesako) to go there.

This interview shows the conceptual difference the Taz Nenets made between knowing the rivers and knowing the land. "Knowing the rivers" seems to refer to having the upper-level mental maps, which, the informant believed, everyone has.'"Knowing the land" refers to the detailed lower-level maps. Apparently, as described in the latter interview, nobody in the brigade had these detailed maps, and this prevented this particular group of Nenets from moving into the territory.

All information regarding the reindeer herders' mental maps was obtained from males aged 15 years of age or older. Unfortunately, little information could be collected on the methods of spatial orientation used by either female informants or other age groups, but the empirical studies described in the previous section indicated that these could be quite different. Indeed, the difference in the methods and capacities of spatial orientation between children and adults as well as between sexes was, on many occasions, mentioned by the informants. For example, the Komi made comments that support the theory that children rely mostly on route-based orientation:

> (Anthropologist) Children remember the way better than grown-ups, do they not? (Informant) I could forget the way, but they would not. They do not know the land, they do not know where different places are, but if they were shown a route they would remember it and could always come back.

Both the Komi and the Nenets have a common belief that women are less apt than men as far as wayfinding is concerned. Women themselves especially stress this view. For example, two young Komi females in the eastern part of the Bol'shezemel'skaya tundra mentioned that they had never been to the sea coast (situated about 15 km to the north from the northernmost point of their migration route), since the males did not take them there. When asked if they could not go there by themselves, the girls answered, "We would probably end up in Vorkuta[9] if we tried." Similarly, Nenets women stated that they would never go anywhere without men because they could not orient themselves and, therefore, would get lost. Furthermore, both the Komi and the Nenets females gave much poorer descriptions of their territory, listed fewer features, and almost never pointed in their direction. It should be noted that the Nenets women performed much better in this respect than the Komi women, who were unable to name and point to landscape features situated even a few kilometers from the brigade's location.

It would definitely be misleading, however, to rely on this evidence to support the hypothesis that women have worse spatial orientation abilities than men. As was pointed out by Habeck (2005), among Komi adults, women are much more limited in their mobility than men. In fact, their mobility is restricted by driving a caravan of sledges along a migration route when movements take place (Habeck 2005, 36–37) and is related to the traditional division of labor between the sexes,

8. *Luts'a-yaha* literally means "Russian River."

9. A city in the Bol'shezemel'skaya tundra situated about 300 km away.

whereby women carry out mostly domestic duties. Habeck noted that younger girls, who had not yet assumed the full responsibilities of tent workers, enjoyed a much higher degree of mobility than elder women. This statement is supported by our observations: the mobility of young girls was observed to be quite high and essentially similar to that of boys of the same age, and no difference in their spatial performance was noted. The comment of an older reindeer herder on the spatial abilities of children, as quoted above, referred to both boys and girls. Therefore, the difference in the wayfinding abilities between older men and women can probably be explained by the different degree of their mobility rather than by any differences between the sexes per se. The same is true for Nenets women whose mobility is similarly (if not more)[10] restricted. On the other hand, since the Nenets do not follow established migration routes, their women probably become familiar with a larger territory during the course of their seasonal movements. This could explain their greater ability to describe their territory. These findings appear to support some psychological and geographical studies (e.g., Kitchin 1996) that argue that differences in cognitive map knowledge and abilities between the two sexes is equivalent and that any differences are likely to be socially and culturally produced, greatly influenced by gender constricting roles and reinforced by stereotyping.

Conclusions

The material presented indicates that the debate between the mental-map and practical-mastery theories, which has been dominating the theoretical study of human orientation in anthropology for a considerable length of time, is pointless, since rather than being conflicting, the theories are in fact complementary. It has been demonstrated in other disciplines that human beings have and use both mental maps and visually remember routes (vistas) while navigating. Both the degree to which they rely on each of these and the characteristics of the mental maps they use depend on an individual's personal history and way of life. It is likely that the language an individual speaks also plays an important role. However, not enough is known about how these characteristics affect a person's spatial representations and wayfinding capacities, and anthropology could potentially contribute by providing examples of how different peoples perceive their environment and navigate around it.

The analysis of wayfinding among the Komi and the Nenets reindeer herders carried out in this paper demonstrates that the methods of orientation and the characteristics of mental maps can be remarkably different even among people who have similar nomadic ways of life and rely on the relative/intrinsic linguistic frames of reference in their speech. Factors such as the flexibility of movement between herding groups (linear as opposite to circular) seem to create differences in the structure and form of mental maps. The Komi, who use established migration paths and pasture reindeer along them, were found to have detailed and continuous mental maps of these areas. In contrast, the Nenets, who do not have established migration paths and often change the territory of their seasonal migrations, have detailed mental maps of only relatively small and discrete regions. The Nenets do, however, have an additional level of more general mental maps, consisting of only basic landscape hallmarks (mostly rivers), which can be spatially related to one another. This finding confirms the ideas of a hierarchy of mental maps and its dependence on a way of life proposed by geographers and psychologists.

Importantly, this material seems to demonstrate that relying on relative/intrinsic linguistic frames of reference does not prevent people from developing extensive survey knowledge (mental maps). Our material does not allow for determining whether these mental maps are oriented or nonoriented, and therefore, it cannot prove or disprove Levinson's claim that "relative" and "intrinsic" people are likely to have nonoriented mental maps. It is worth noting, however, that the hierarchical structure and regionalization observed in the Nenets' mental maps could hardly be expected among "absolute" people. Indeed, such a structure would make it impossible for them to speak about spatial relations between objects from different regions. Therefore, it seems logical for us to conclude that relative and intrinsic and absolute peoples are likely to be different in the degree to which their mental maps are hierarchical and divided into regions. Incidentally, the high regionalization of mental maps, given that they are nonoriented, can explain how new landmarks can be easily added to them; encoding of a new landmark in this case demands encoding its angular relations only with landmarks inside its region rather than all the landmarks encoded by the map.

The correctness and universality of these findings evidently still need to be cross referenced using a comparative quantitative approach; however, it would appear that anthropology can make an important contribution to the interdisciplinary study of human spatial cognition and orientation by studying how these differ between people and peoples. However, for anthropologists to continue this endeavor, the existence of mental maps has to be accepted and the futile debate between the mental map (cognitive map) and practical-mastery camps abandoned.

Acknowledgments

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10. Among Taz Nenets, women should not even touch (let alone sit on) male transport sledges, while big and heavy sledges for women, particularly in winter, are poorly suited to traveling anywhere other than on established paths, as they sink into the snow.

edged. The fieldwork undertaken among Komi and Nenets herders in the Bol'shezemel'skaya tundra was financed by a joint interdisciplinary research scholarship from the British Natural Environment Research Council and the British Economic and Social Research Council (ESRC). The writing of this paper was also made possible thanks to a Postdoctoral Research Fellowship funded by the ESRC for Dr. Mark J. Dwyer. The authors wish to thank their numerous Russian, Komi, and Nenets collaborators, in particular, the Yangasov, Shurakov, Alekseevich, Larionov, Filippov, Kanev, and Semyashkin extended families (Komi) and the Salinder, Khudi, and Tyseda extended families (Nenets) for their assistance, patience, and extraordinary generosity. We should also acknowledge A. Makarchuk from the Bol'shaya Inta Sovkhoz and A. Kaplun from the Tazovsky Agricultural Cooperative for their assistance and cooperation. Finally, we wish to thank our colleagues Günther Schlee, Tim Bayliss-Smith, Brian Donahoe, Joachim Otto Habeck and William Seager for their suggestions and criticisms, and also Mrs. Eileen Dwyer for assisting with editorial tasks so tirelessly. We dedicate this manuscript to Serafim Feoktistovich Yangasov (1926–2008); a remarkable herder, close friend, and relative to whom we owe much of our knowledge.

Comments

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I highly welcome the publication of Istomin and Dwyer's article, as it discusses a topic of high importance (spatial cognition) that is only marginally treated in anthropology. The article does a very good job at describing and linking different theoretical models coming from a variety of disciplines (principally psychology and geography) with anthropological studies of space.

The article states that most theories of spatial cognition rely on two opposing theoretical approaches: the mental-map approach and the practical-mastery approach. In the authors' view, a debate between these two theories is "pointless," since according to the authors both theories are in fact complementary. Although I enjoyed reading the article and I found the descriptions of its ethnographic cases fascinating, I do not believe that the evidence presented here was conclusive in solving the theoretical debate. In fact, I do not believe that the debate is pointless or futile but, on the contrary, necessary if we are ever to understand the complex relationships between people and the environment where they live.

In their desire to reconcile the two conflicting theories, the authors accept the notion of a mental map, but I found their evidence inconclusive. In "The Anthropological Debate on Human Orientation," they propose a mental experiment that helps them support the idea of mental map. They then proceed to criticize Ingold's argument of route-based spatial cognition (what they call the practical-mastery approach). In my view, the authors' understanding of Ingold's theory is limited and, to some degree, misleading. Ingold never actually states that humans are incapable of spatial abstraction. What Ingold suggests is that locations (in the euclidian sense) do not really exist (or matter) beyond the concrete experience in which humans and the environment interact (through dwelling or traveling). Humans may not need a mental map to make spatial decisions such us the one presented by the authors in their exercise. They do need, however, an understanding of their own place in space.

I am not necessarily contesting the existence of mental maps but only the authors' claim that both approaches are not conflicting.

Inuit of the Canadian Arctic (my area of expertise) rely heavily on routes for their perception of and their interaction with their environment. In a culture that did not use maps until recently, Inuit hunters describe the territory in terms of vistas and remember large extents of territory. They always describe routes as a succession of vistas (see Aporta 2004) that a traveler (or a narrator) updates as he/she moves (physically or figuratively in a narrative). There are two important points I would like to highlight here: (1) This route knowledge does not require actual travel of the routes; the journey of the route can be entirely constructed discursively (orally) through a narrative, and the land can be imagined by an interlocutor. (2) This approach does not prevent Inuit from using shortcuts or improvising new routes. This is not the result of an abstract mental map but of their own ability to relate concrete features to larger spatial frameworks. That an individual remembers the territory does not necessarily mean that he/she is using a mental map, as it could be argued that he/she is in fact remembering the experience of being there and seeing particular vistas. Hence, the difference between mental map and mental mapping.

One of the main contributions of this article is the section "The Debate Reevaluated," as it presents us with a comprehensive account of the treatment of space by ethnolinguistics. One notable absence in their account is Fortescue's seminal study of winds and Eskimos' spatial terms of reference (1988) as well as MacDonald's description of how Inuit use the wind axis (1998). These studies show an interesting case where an absolute frame of reference (to use the authors' language) is based on humans' concrete perception of the winds. In other words, to the Inuit, the wind directions replace magnetic cardinal points but in a complex way. Although the wind directions exist independent of the fact that the winds are blowing at a given time, this spatial framework is connected to the individuals' experience of the winds. This spatial framework is, therefore, both abstract and experiential.

The other omission of literature relating to ethnographic/

anthropological studies of space is Hutchins's book *Cognition in the wild* (1995).

Regardless of my differences of opinion (or maybe because of them), I welcome this article by Istomin and Dwyer. I do not think that it will resolve the conflict between two important theoretical views of space. On the contrary, it may bring the issue to the front for some new debates, which is why I believe this is an important contribution to the development of the discipline.

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The paper touches a vital capacity to code the "living space," to find one's proper way in any environment, whether urban jungle or uncharted desert, using innate intuition or acquired knowledge. This issue may seem to be just a speculative matter, but it could be vital for someone who becomes hopelessly lost or for a researcher who encounters a cultural scenario in which spatial orientation plays crucial role.

The authors provide an overview of two spatial orientation models, "mental map" and "practical mastery" (temporarily ordered sequences of vistas and linkages), which are discussed in anthropology, psychology, and geography and are seen as in opposition. They conclude that people of various cultures and languages commonly use both of them. In practice, these tools are more complementary than contradictory.

Case studies of the east European Komi-Zyryans and the west Siberian Nenets show that both groups are heavily dependent in their everyday activity on spatial mobility and land knowledge. The difference between Komi and Nenets spatial mapping stems from the contrast between stable linear (Komi *vörga*) and variable circular (Nenets *ya*) migration patterns, where actors should recognize either a narrow strip of land or many usable areas. However, the hierarchy of conceptualized territory in the Nenets' case might be a manner of sequential focusing rather than a structure of mapping.

A hierarchical mental map of the Taz Nenets, with its upper level consisting of the rivers, may vary according to other locales. The Nenets living in the taiga area (Pyan-Khasava) have as the main axes the big lakes and high-ground woods; the "'Stone" Nenets carefully list in their descriptions the (Ural) mountain peaks and valleys; the coastal (arctic) Nenets first of all have in mind the capes. Besides, everywhere in the tundra, hills (*seda*) of a particular shape and sacred meaning used to be the key landmarks. The latest contributions to this mapped environment are the oil and gas rigs as well as all-terrain-vehicle roads. In everyday practice, herders also point "roads," or tracks of their previous migrations (*nedarma*) as elements on the topographic grid.

The elaborated visual map of paths and pastures gives Nenets a field for maneuvers: the herders in Yamal Peninsula told me how they "play chess" with one another on migration routes, searching for better pastures and determining the sequence of migratory moves (especially during rapid spring migration, when dozens of caravans are racing along the central Yamal watershed to the calving areas). The person who knows the path well (*yasavei*, or navigator) is of particular value and is respected. Sad or comic stories result when a brigade migrates without a *yasavei*, which happened several years ago in the "Big-Land" tundra, where the eleventh brigade was compelled to use the seventh brigade's route.

Nenets describe their style of wayfinding as different from that of neighbors, for example, the taiga Khanty people. One experienced Nenets gave me his interpretation of this difference: "Nenets keeping way watches himself like from the sky as a moving dot on the map. On the contrary, wayfaring Khanty recognizes a tree and follows this direction, then he notices a hill and goes toward this point; thus, he remembers every hummock of his hunting ground." He continued, "Similarly, they repair an outboard engine. Nenets starts by sitting in front of the engine and mentally screwing nuts; after imagined fixing, he does it by hands. Khanty immediately begins to screw nuts since his hands remember every detail of engine."

The Nenets' watching from the sky is not an echo of modernization. The same vision could be traced in archaic folktales, which sometimes begin with flight of the dumb man-bird Myniku, who observes the valleys, reindeer herds, and nomad camps; he then sits on the top of a tent and sees through the smoke window what is going on inside. Like the director of a film sequence, the storyteller begins with a panoramic long shot from the sky and then zooms down for details.

A peculiarity of the Nenets "map" is its ability to move according to rotation of the sky-picture. At night, a herder starts a journey by directing reindeer toward a certain star. After an initial run (*nedalava*, about 7–10 km), he shifts his sight to the next star on the left, and so on. It means that Nenets keep in memory two layers of map, sky and land, and can orient them them as needed during their travels. Moreover, travelers also keep in mind the "wind map" (memory of the wind's last directions) and correlate it with snow surface patterns.

Wayfinding methods vary widely to suit spatially different schemes of behavior, from "close-up" methods, such as those used by Komi or Russian women concentrated in a domestic niche, to methods employing a broad panorama, such as the Nenets herder's method or the Russian Pomor navigator's space perception (the latter includes a large-scale graphic chart with a coastal silhouette, memorial crosses, chapels, and churches). Istomin and Dwyer's study illustrates the vast range of human orientation methods and different spatial designs in various cultural and ecological contexts.

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In this interesting paper, Istomin and Dwyer address a theoretical debate within anthropology concerning how people from technologically undeveloped cultures (and, presumably, the rest of us) orient themselves while navigating. The debate is cast as a contest between those who advocate a "mental map" and those who advocate "practical mastery." The authors are right—this is a poorly framed debate for which the answer, on empirical and common-sense grounds, is "both." Or I suppose you could say it was "neither." Either way, as it appears it has been framed in anthropology, this is indeed a straw-man debate between two positions that are largely untenable on their own. The practical-mastery theory explains wayfinding as a sense of "knowing the land" that results from experience moving through it. But, cartographic maps aside, how would a person acquire a mental map if not through experience moving through the landscape? And what would it mean to "know the land" if not to form representations of it in the mind? Do proponents of practical mastery think "knowing" is stored in muscles or bones? The practical-mastery position is quite reminiscent of the theory of direct ecological perception expounded by Gibson (1979), whom the authors cite. Although Gibson—or at least his followers—offered an alternative to mental maps, I think almost no one takes direct perception too seriously as a viable model of skills such as orienting to distant landmarks. (An aside: the authors write that "[e]ven Gibson . . . never appeared to insist that his ecological vision was the only basis for explaining spatial behavior among humans. Certain results of the pointing experiments simply excluded this possibility." I do not believe that J. J. Gibson read papers about cognitive maps or pointing experiments of the kind to which the authors refer, but he and his followers certainly did believe that ecological theory was the explanation for spatial behavior. They did allow for cartographic maps but not cognitive ones.) The important work by Hutchins (1995) on situated cognition deserves consideration here as well. Hutchins made highly relevant observations about the situated nature of navigation and orientation, but as with Gibson's ideas, few people would accept it as a complete alternative to mental maps.

Questions about the "nonindexical" quality of mental maps, their dimensionality (1 or 2), their geometric sophistication, and the reference systems used in their organization and expression in language are interesting and important issues. In fact, they constitute much of the deepest theoretical debates and fundamental research questions across the disciplines that study spatial cognition. Researchers in geography and human psychology generally do not reserve the term "mental map" or "cognitive map" only for two-dimensional, nonindexical, metric survey knowledge; a mental map is one's internal representation of the environment, whatever its form and specific content (Downs and Stea 1973). Yes, there is extensive discussion in the literature about the constructs of "route maps" and "survey maps," but both are internal representations of the environment that may be referred to metaphorically as internal "maps." Researchers in biology and animal psychology, in contrast, more or less do reserve the concept of mental maps for two-dimensional, nonindexical survey knowledge. Having said this, I doubt that you could find many proponents of mental maps, including myself, who would claim that they are fully nonindexical, representing all of the Earth surface equivalently and allowing access from any point to any other point with equal speed and accuracy. So if that's what you think a mental map is, you are right—they do not exist.

I agree with the authors that research on cultural variations is valuable and intriguing, even fascinating, but I wonder how far ethnographic unstructured interviews and sketch mapping can go to adjudicate the theoretical issues the authors discuss. There is no way, for example, to sketch or otherwise make a map from scratch, whether with sticks, paper, or computers, except by employing a sequential process. This in no way proves that the underlying representation is necessarily routelike. On the other hand, being able to sketch a two-dimensional configuration does not prove that one has an underlying survey map. I could turn an internal list of places along a route into an accurate survey map during the drawing process, as long as the list included at least approximate information about metric distances and directions between some of the places. The ability to accurately sketch maps is probably needed if one is to make the case for a completely "nonindexical" survey map, but it in no way suffices to prove the case.

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This is a most welcome continuation of a discussion that tackles the intriguing problem of understanding not only human orientation but also how cognitive processes work more generally. In my first contribution to this topic I had concluded that "both practice theories and mental-map theories fail to account for all skilled and habitual forms of orientation" (Widlok 1997, 328). I am therefore very pleased to see this conclusion replicated by interdisciplinary research based on a very different set of empirical data. It is in the framework of this general appreciation of the work by Istomin and Dwyer that I offer these critical comments for further thought and research.

A weak reading of my earlier conclusion was that practice theory and mental-map theory, each taken by itself, do not explain orientation. However, this does not necessarily imply

that we should call it a futile debate, because it is through this discussion that we were led to make distinctions that went unnoticed previously. Gell and Ingold highlighted that different purposes and backgrounds (e.g., that of a mapmaker, in contrast to a person habitually moving around) also have to be considered when designing our methods. Ingold's emphasis on practice is strategically important because it is a corrective to our dominant default model to treat all knowledge as if it was maplike. Finally, Levinson et al.'s work of different frames of references convinced researchers across disciplinary boundaries that there is more than one human frame of reference for orientation available. In the meantime, we now have not only case studies and positions from the extremes of the spectrum that initially fired the debate but also many more "mixed results" that have emerged, for instance, when frames of reference are combined in the way that one axis is predominantly absolute and the other axis is relative (see Widlok 2007). What I take Istomin and Dwyer to mean is that the combination of what appeared to be exclusive alternatives is probably the normal state of affairs. But does it follow that we should simply subscribe to both models? Do humans switch between two modes of cognition depending on cultural contexts and situations because two of our models (practice and mental maps) each appear to be half-true?

There is also a strong reading of my earlier conclusion that I would like the authors to consider, namely, that both models fail to account for the orientation skills we are dealing with, even when they are taken together as a duality. I am not so much concerned about the general point that an explanation that is based on a single model is in terms of theory to be preferred to one based on a duality of models but rather about unresolved contradictions surrounding the notion of mental representation in the mental-map model and about the notion that we are faced with two clearly separable systems (organism and environment) interacting with one another. I shall refer to these points in reaction to recent developments in neuroscience, another source of information that we as anthropologists need to be able to deal with. These new developments were succinctly summarized in a recent monograph (Fuchs 2008) but are reflected also by other attempts to confront ecological psychology and phenomenological approaches with the neurosciences.

Unless we want to assume that cognitive maps are stored in a completely immaterial and noncorporeal entity called "culture" (which I suggest we should not, for its obvious problems) neuroscientists suggest that cognitive maps are mental representations, nowadays equated with more or less localized patterns of neural activity. In our case of orientation, this would mean that a certain pattern of neural activity (the mental map) is triggered once a certain situational stimulus is received, for example, crossing the river and getting to the country where one knows one's way. Fuchs argues that the notion of representation (or map) in such a context would be flawed. While representations always refer to an image of something for someone, this subjective someone is being glossed over by most neuroscientists and mental-map modelers. In other words, he argues that environmental information is not stored as a representation in the brain, and mental states are not descriptions of the landscape, but they only participate in the situations from which corporeal agents are able to derive the relevant contents (Fuchs 2008, 146). We, as situated human beings (and not the brain by itself), generate representations based on implicit and incomplete knowledge that "only" provides options for acting in a certain way. And since our particular perspectives as corporeal beings differ because of our experiences and positions in society, there is variation to be found within and between groups. This is not to say that there is no physiological basis for orientation knowledge; rather, it is not the brain alone that creates this basis but a larger system of the organism in its environment. Mental maps therefore do not contain meaningful information, but as patterns of neural activity, they participate in situations where agents create contents and skill. It is not about retrieving memory but about providing "open loops" for experience in the sense of a readiness to act in anticipation of certain situations (like having crossed a certain river).

As long as the implicit or explicit notion of the mental map is as problematic as that of "retrieving" representational contents from the brain, anthropologists should continue looking for a better model to explain orientation.

Reply

We wish to thank the numerous reviewers for providing, throughout the publication process, suggestions and comments that we generally found very useful, insightful, and at times, challenging.

Aporta has four main issues with our paper. First, he disagrees that route-based spatial cognition and mental maps do not conflict, which, therefore, implies that human spatial orientation can be based strictly on either visual memorization of routes or mental maps. He opts for route-based spatial cognition, which despite not "necessar(il)y contesting the existence of mental maps," leaves us wondering about the mysterious process and conditions under which humans would select one method rather than the other?

Second, according to Aporta, our understanding of Ingold's ideas is "limited and . . . misleading," since Ingold "never actually states that humans are incapable of spatial abstraction." To address this comment, we first need to quote a section of Ingold's work.

"For the map-using stranger, making his way in unfamiliar country, 'being here' or 'going there' generally entails the ability to identify one's current or intended future position with a certain spatial or geographic location, defined by the

intersection of particular coordinates on the map. But a person who has grown up in a country . . . knows quite well where he is, or in what direction to go, without having to consult an artefactual map. What, then, does he have that the stranger lacks? According to a view that has found wide support in the literatures of geography and psychology, there is no difference in principle between them. Both are map-users. For both, knowing where one is means identifying one's position in the world with a location on the map. The difference is just that the native inhabitant's map is held not in the hand but in the head, preserved not on paper but in memory, in the form of a comprehensive spatial representation of his usual surroundings. At any moment, it is supposed, he can access this mental map or 'cognitive' map, and determine his location in terms of it" (2000, 219). Ingold continues, "There is no such map, and that the belief in its existence is a consequence of the mistaken attribution to native people of a sense of what it means to know one's whereabouts that effectively treats them as strangers in their own country" (2000, 219).

Although Ingold does not state that humans are incapable of spatial abstraction, he denies the very concept of a mental or cognitive map and never explains how spatial abstraction is achieved. We object to being accused of ignorance, when in fact Ingold's position is clear, and we wish to refer Aporta back to Montello et al.'s (1999) excellent and decisive comments as well as to the vast body of existing literature outside of anthropology, which has mostly been ignored.

Third, Aporta claims that Arctic Canadian natives "rely heavily on routes for their perception of and their interaction with their environment." He then goes on to say that "route knowledge does not require actual travel of the routes," since journeys can be constructed through narrative, which does not prevent the Inuit from using shortcuts or improvising new routes. Indeed, he claims that this approach is not the result of an abstract mental map but of their ability to relate concrete features to larger spatial frameworks. "That an individual remembers the territory does not necessarily mean that he/she is using a mental map, as it could be argued that he/she is in fact remembering the experience of being there and seeing particular vistas."

With respect, it would appear that Aporta has missed the point. We agree that humans can remember territory (in various ways) and navigate by following a sequence of vistas, all of which, incidentally, are stored in the brain. However, we are at a loss to understand how he supposes a Canadian native is capable of taking a shortcut between routes (by treading a new sequence of vistas) without having a cognitive mental representation, in whatever form, in order to do so. Not only is this statement contradictory, it is, once more, at odds with all empirical studies outside anthropology and appears to defy common sense.

Fourth, Aporta expressed concern that we have failed to incorporate information on the wind-based design of the allocentric/geocentric (absolute) frame of reference among Inuit. We would like to point out that the same concern could be expressed by other regional specialists, since there must be countless ways to design the absolute frame of reference. A description of each and every one is neither possible nor necessary in the context of this paper.

Widlok argues that rather than being partially right (as we insist), both models of spatial orientation could be wrong, which suggests that a third unknown cognitive process exists. He then states, in agreement with the view of Hutchins (1995), that in order to understand this process we should focus on the "larger system of the organism in its environment" ("cognitive system," as Hutchins puts it), which includes not only the brain but a number of other natural as well as social elements. We agree with this suggestion, and indeed, our forthcoming works on this very topic are based on the ideas of Hutchins. However, we would like to point out that this paper is focused on just one element of the cognitive system—the human brain. One should indeed assume that there are different ways of encoding and using spatial information. It is important to stress, however, that any new "third way" model, as suggested by Widlok, would have to be one based on the cognitive system per se rather than on the human brain.

We thank Golovnev for his ethnographic contribution, which largely supports our arguments. We wish to point out, however, that stars and winds cannot represent an additional layer of mental maps, given that they help a traveler to select and maintain a certain direction during a journey in a way similar to the use of a compass. A compass cannot be treated as a part of the map, and neither can the stars and winds. The reliance on stars and winds during a journey is revealing, however, because it effectively proves the usage of mental maps rather than route-based orientation; a person who remembers a route visually as a sequence of vistas does not need to consult the ever-changing sky or wind in order to select or maintain his course.

Finally, we would like to stress that a scientific debate can be fruitful only if new empirical data are analyzed in relation to previous works. In the context of this paper, Ingold's anti-cognitive grand theory, of which spatial cognition is an inherent part, was destined to fail; not only was it based on Gibson's ideas, which were published 20 years before Ingold's *The perception of the environment* (2000), but his theory ignored all the criticisms that were leveled against Gibsonianism. Why else was Gibsonianism rejected as the mainstream theoretical approach in cognitive psychology? Our great concern is that too many anthropological debates are of the kind we address in this paper. More worrisome is that many colleagues believe this situation to be normal. As a result, cultural/social anthropology is becoming increasingly fragmented, and many anthropologists not only accept but take pride in this deplorable state of affairs. We believe that if this situation endures, colleagues from other disciplines will simply cease to take anthropology seriously; this evidently is already occurring. We believe that reliance on interpretation

rather than explanation effectively prevents any interdisciplinary cooperation (including spatial cognitive research), which seriously limits the scope, usefulness, and influence of our discipline. Indeed, our fieldwork methodology could be greatly enriched by the adoption of new methods (including quantitative ones), as proposed by Montello.

—Mark J. Dwyer and Kirill V. Istomin

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