HOW TO READ A MAP: REMARKS ON THE PRACTICAL LOGIC OF NAVIGATION

ALFRED GELL

London School of Economics & Political Science

Two theories of navigation are compared: first, the theory of *mental maps*, currently in use among psychologists and social geographers interested in problems of spatial cognition; and secondly the theory of 'practical mastery' deriving from P. Bourdieu. 'Mental maps' do not seem to resemble artefactual maps, or fulfil the same functions. Everyday navigation cannot, however, be understood as merely habitual. A new theory of navigation is proposed, based on the logical distinction between non-token-indexical 'maps' and token-indexical 'images'. It is argued that the function of a map is to generate images, and that the navigational utility of images arises because they are referrable to coordinates on a map. This theory is applied to Micronesian navigation and to the material presented by Frake in this issue. It is argued that all navigation, from the simplest to the most sophisticated, has a uniform logical basis.

The article by Professor Frake (this issue, pp. 252–68) demonstrates, in a most convincing way, the ingenuity of which the unlettered are capable in the performance of cognitively challenging tasks. He argues that the data he has unearthed on medieval navigation, like the better-known material provided by Gladwin (1970) and Lewis (1972) on Micronesian navigation, show that the 'primitive' mind cannot be contrasted to the modern one as 'dumb' versus 'smart', a position he attributes to Hallpike (1979) in particular. He believes that tasks performed by non-literate people in the course of their everyday lives 'can be seen as displays of high orders of cognitive ability' (p. 253). I concur emphatically with Frake's view, but I am not sure that the material he discusses is really very damaging to the Hallpike position, as spelled out in chapter 3 of *Foundations of primitive thought* (1979: 94 sqq.).

Hallpike is very explicit in stating that 'primitives' are not inferior in intelligence to 'modern' men, but that it is the nature of their technological milieu, which lacks the kind of 'challenges' which call forth the powers of 'operatory intelligence' in literate and/or technologically advanced societies, which is responsible for the prevalence of 'pre-operatory' modes of thought among them. In selecting the example of navigation in the tidal North Sea and the Atlantic seaboard Frake has focused attention on a set of environmental 'givens' offering the prospect of both enormous hazards and rich rewards —exactly the kind of situation which *would* challenge men to seek technical solutions to the technical problems involved.

Hallpike is perfectly prepared to concede that the Micronesian navigators use techniques which qualify as 'operational' in the Piagetian sense (1979: 309–11). I am sure that he would be equally ready to admit medieval navigators to this

category, given the material adduced by Frake. These facts support his basic contention that in order to perform cognitively complex tasks, Piagetian intelligence, up to the operatory stage, in necessary. This is also implicitly accepted by Frake.

The danger for the point of view which Frake is trying to sustain arises just here. Can one really assert that navigating a boat, without a chart or a magnetic compass, is really an 'everyday' task? Is is not rather a very special task, requiring long training, memorisation of a mass of detailed information, and considerable mental agility in applying this fund of information to the ever-changing circumstances of an actual sea voyage? The only weakness in Hallpike's argument exposed by Frake is its reliance on the rather tautologous principle that, other things being equal, primitive thought is primitive, except where it turns out that other things are *not* equal, and then primitive thought becomes non-primitive. And things are not equal when men are faced with difficult navigational tasks, which they must either solve or put their lives at very great risk.

I believe that, in order to establish the cognitivist or 'intellectualist' position espoused by Frake in his opening remarks, it is necessary to provide a more comprehensive account of 'everyday' navigation than either he himself provides, or is to be found in the writings of the cognitive psychologists on whom he bases himself. What needs to be shown is that everyday navigation, not of the kind seen as technically specialised or 'difficult', actually involves the same *logical operations* as are involved in the more spectacular navigational feats described by Frake, Gladwin, Lewis, etc.

Two approaches to everyday way-finding

The first question we can ask is what alternative theories can be proposed for everyday navigation or 'way-finding'? There appear to be two main possibilities. First of all there is the 'mental map' theory put forward by many scholars, including both geographers, anthropologists and cognitive psychologists. This theory supposes that way-finding 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 for converting this information into suitable practical decisions and actions.

Secondly there is what may perhaps be called the 'practical mastery' theory which can be exemplified best by the following passage from Bourdieu (1977: 2).

> It is significant that 'culture' is sometimes described as a map; it is the analogy which occurs to an outsider who has to find his way about in a foreign landscape and who compensates for his lack of practical mastery, the prerogative of the native, by the use of a model of all possible routes. The gulf between this potential, abstract, space, . . . devoid of landmarks or any priviledged centre . . . and the practical space of journeys actually made, or actually being made, can be seen from the difficulty we have in recognising familiar routes on a map or a town plan until we are able to bring together the axes of the field of potentialities and the 'system of axes linked unalterably to our own bodies, and carried about with us wherever we go' as Poincaré puts it which structures practical space into up and down, right and left, front and behind.

According to Bourdieu, mastery of the spatial environment arises through familiarity with 'practical' as opposed to 'Cartesian' space. Practical space is intrinsically linked to the activities, perceptions and bodily attitude of the subject. Cartesian space, by contrast, is not subject-centred. In Cartesian space, objects hold positions which are defined absolutely, not in relation to the presence, in the same space, of the epistemic subject. Maps ('models of all possible routes') show Cartesian space, but practical way-finding is mapless and conducted in terms of coordinates centring on the agent.

The 'mental map' theory suggests that technically sophisticated navigation using maps, and everyday way-finding using 'mental' maps, are essentially similar, the difference lying in the contrast between a mental and an artefactual map, while the 'practical mastery' theory suggests that the two are wholly different from one another, and indeed take place in a different kind of 'space'. The practical mastery theory is, clearly, the one compatible with Hallpike's approach, drawing a sharp distinction between technologically advanced kinds of way-finding which involve abstract representation of spatial relations, versus practical way-finding which is informal, subjective, and based on habit and familiarity. In fact, both Hallpike and Bourdieu converge towards an essentially behaviourist view of spatio-temporal behaviour in pre-technological conditions. Bourdieu does so because the *Theory of practice* bears many resemblances, despite Bourdieu's overt Marxism, to Meadian social behaviourism, Hallpike because early pre-operatory thought in Piagetian theory is essentially reflex/habitual thought, which is gradually superseded as operatory thought develops. Since Hallpike's primitive thinkers never get to the stage of formal operations, behaviouristic interpretations remain descriptively adequate to account for their responses. I cannot, for lack of space, defend these provocative utterances as they should be defended, though it is worth underlining the fact that Bourdieu's most notable conceptual innovation in anthropology, the 'habitus' (the set of inculcated dispositions to respond to situations in an unreflective, socially patterned way) is a clear attempt to reinstate behaviouristic arguments in sociology, whence they had been more-or-less banished since the rise of structuralism in the period since 1950.

Mental maps

In what follows I wish to defend a version of the mental map theory against the (behaviouristic) practical mastery theory. But I also wish to point out certain ambiguities in the currently accepted notion of 'mental maps' which have been invoked very freely, and perhaps rather uncritically, by cognitive psychologists and geographers (Lynch 1960; Downs & Stea 1977; Gould & White 1974; Canter 1977; Oatley 1977; Neisser 1976). Is the idea of a mental map to be taken seriously, or is it a vague metaphor? If mental maps really exist, are they like non-mental maps? Oatley, a psychologist, is at pains to stress that mental maps are not 'static' like artefactual maps, but dynamic: 'the navigator's mental map is a process, not a picture' (546). Lewis, speaking of the mental maps presumed to underly the navigational prowess of the desert Aborigines, describes the 'map' as a continually updated 'image' of the territory:

> It would appear then, that the essential psychophysical mechanism was some kind of dynamic
> image or mental 'map', which was continually updated in terms of time, distance, and bearing,
> and more radically realigned at each change of direction, so that hunters remained at all times
> aware of the precise direction of their base and/or objective (1976: 262).

Such remarks are confusing if one wishes to take the 'map' notion at all seriously, since the objects we have in our possession, and refer to as 'maps', have none of these characteristics and would be quite useless to us if they did. How would we fare if the trusty *London A to Z* in the glove compartment of the car insidiously metamorphosed into a different edition, showing all the familiar places in new locations, every time we undertook a journey from Piccadilly to Marble Arch? We only update maps when the geography of the world changes, not whenever we move about ourselves. Whatever Oatley and Lewis are talking about when they invoke the idea of a mental map, it is clearly not anything like an artefactual map, and does not deserve to be known by the same name.

Quite apart from the instances in which mental maps are given attributes totally at variance with ordinary maps, there is a more basic problem with mental map theory, even when mental maps are understood, as they generally are by geographers, to have the features normally associated with non-mental maps (e.g. Lynch 1960; Downs & Stea 1977). Mental map theorists assume that just having a map is sufficient to ensure navigational success, and therefore attribute instances of successful navigation to the possession of such maps. But this is not very true to our experience of actual map use. In real life the question of map use only arises when we do *not* know how to accomplish a journey or find a location. Our criterion for claiming that we 'know the way' between A and B is that we have no need for maps, or other directions, in order to make that journey. Does this mean that we have a mental map which *shows* the way between A and B and that we 'consult' this map in order to find the way? Surely not. If mental maps are the mental equivalents of artefactual maps (a memorised replica of the relevant artefactual map) then if we 'know the way' between A and B we will not need to consult our mental map in order to get there, just as we would not have needed to consult our artefactual map, if we had one. Therefore it cannot be true that 'knowing the way between A and B' is the same as 'having a mental map which shows, *inter alia*, the route between A and B'. We appear to be on the horns of a dilemma. Either mental maps are so unlike artefactual maps as to fail to qualify as 'maps' at all, or if mental maps are really like maps, then they cannot be invoked in the explanation of spatially knowledgeable way-finding performances which, by definition, occur without the assistance of maps.

Let us turn to the alternative theory, mapless practical mastery. We can suppose that practical mastery of the environment consists of possessing complete knowledge of what the environment looks like from all practically-available points of view (which would not include the view from the horizontal plane of projection of a standard map, since the world never appears to anybody as it does in a map). Way-finding is carried out as follows; the subject identifies his position by matching the landscape image which opens up around him with one previously filed. In order to proceed towards a chosen destination he moves so as to create around himself a chain of linked landscape images corresponding

to an image of higher order, extended in time as well as in space, which is, roughly, 'the view throughout the journey from A to B'. The sequence of landscape images form a series of sub-goals which are reinforced if the journey is successfully accomplished, extinguished if it is not. In this manner one can account for quotidian way-finding without invoking maps at all, nor the idea of an absolute concept of space, as opposed to a subject-centred one. This seems to be the theory of navigation implied by Hallpike and Bourdieu. To be sure, it would hardly work at sea, but that does not matter; if this theory is correct, then one can certainly drive a wedge between 'everyday' way-finding and technically sophisticated way-finding. Practical way-finding is based on images reinforced by habit and familiarity, technical way-finding is based on maps and algorithms. And this would seriously endanger Frake's claim that the performance of 'everyday tasks' involves 'displays of high orders of cognitive ability'. Can we mount a rescue operation?

However different the performances of the experienced native, effortlessly making his way about in a familiar environment, and the efforts of a map-using stranger, the distinction between them can be minimised if one takes the following considerations into account.

1. It is not likely that all the journeys made even by the most experienced native are likely to be wholly unproblematic from the navigational point of view. However familiar he may be with his environment, there will undoubtedly be moments when he has to stop and think about where he is, and which is the best way to go. If predominantly habitual navigation is occasionally supplemented by more careful navigational deliberation, there may be grounds for supposing that a mental map is present, even though it is only 'consulted' occasionally, at moments of dubiety. If the mental map is there when it is needed, then it is presumably there all the time.

2. There are good reasons for believing that much significant cognitive activity is un-attended to (Bateson 1972). The absence of conscious deliberation on the part of an agent is not evidence that such deliberation is not taking place. It may be that, subliminally, information is being recorded, processed, and manipulated in complicated ways even though the forefront of consciousness may be occupied with quite extraneous thoughts. When we undertake quotidian journeys we do so on the mental equivalent of autopilot. But if we look at real flight controllers installed in aircraft we note two things. First, flight controllers are programmed with maps and with instructions to follow the same search and decision strategies as would be followed by a novice pilot flying that route for the very first time. Second, we note that there is nothing about such machines which corresponds to 'habit'. The same meticulous navigational performance is repeated on every occasion. It would be theoretically feasible to programme an aircraft with 'habits' by feeding the contents of the onboard flight recorder into the flight controls, with instructions to repeat yesterday's flight from Heathrow to Kennedy International airport exactly as before. But an aircraft programmed to repeat actions on the basis of previous 'rewards' would soon crash.

Automated devices such as flight controllers are not 'conscious'; nor is the native always conscious of the skilled character of his way-finding, which does not for that reason cease to be skilled. Navigating in a familiar environment is

not more subjectively burdensome than speaking one's native tongue. Since Chomsky's demolition of Skinner's *Verbal behavior*, linguists have abandoned habit-formation, dispositions to respond, conditioning, etc. as explanatory concepts in accounting for linguistic performance, and perhaps there is no better reason for retaining them in the explanation of navigational performance either (Chomsky 1959).

Seen in this light, the apparent dissimilarity between the experienced native and the map-using stranger has diminished somewhat, but has hardly been eliminated altogether. What we have to show is that native and stranger perform an essentially similar task in an essentially similar way, but that the process takes place subliminally and inaccessibly in the instance of the experienced native, whereas the stranger is obliged to wrestle with his navigational problems in public.

If we confine our attention to the native we can hardly expect to make much progress, since he himself does not know how he does it, and all we know is that he can do it; how, we are unable to say. The only way in which we can reconstruct the unobservable mental processes underlying effortless navigation is to look more closely at the relatively accessible mental processes of the map-user who, on the language-use analogy, is in the position of a non-speaker of a language who uses a published grammar and vocabulary laboriously to create sentences which would come effortlessly to the lips of a native speaker.

Navigation using an artefactual map

We know little of the process which enables us to convert the squiggly lines, colours and written inscriptions on a published map into covert or overt practical instructions for way-finding . . . 'wait for the right turn after the railway-bridge, go down there till you pass the cemetery and then half-left at the roundabout . . .' Treatises on map reading, mostly the work of military men and schoolmasters, are not written with the problems of cognitive psychology in mind. Let me give an account of roughly what seems to happen. Take the terrain mapped in fig. 1 (adapted from the Ordinance Survey of India).

Suppose I want to get from Narainpur to Dugabengal, not a place I have ever visited before. I am sitting in the tea-shop in Narainpur, studying the map and planning my trip. The map tells me that a couple of kilometres from Narainpur I will see a road, off to the left, which should look as if it deserved the characterisation 'motorable in the dry season'. Taking this, I will pass by the scattered houses of Bakhrupara, then a small tank, after which I will reach the margin of the forest. Once inside the forest I will see a small track leading off to the left. This will continue through the forest. Emerging from the forest, I will see standing stones (graves) on the left, and then Dugabengal village. In my preliminary communings with the map I produce a series of predictions in the form of mental images of what I am likely to encounter at particular places along my projected route. I have travelled to Dugabengal in my imagination before ever setting out. Utilising a combination of my knowledge of cartographic conventions and my fund of background knowledge of the appearance of roads,
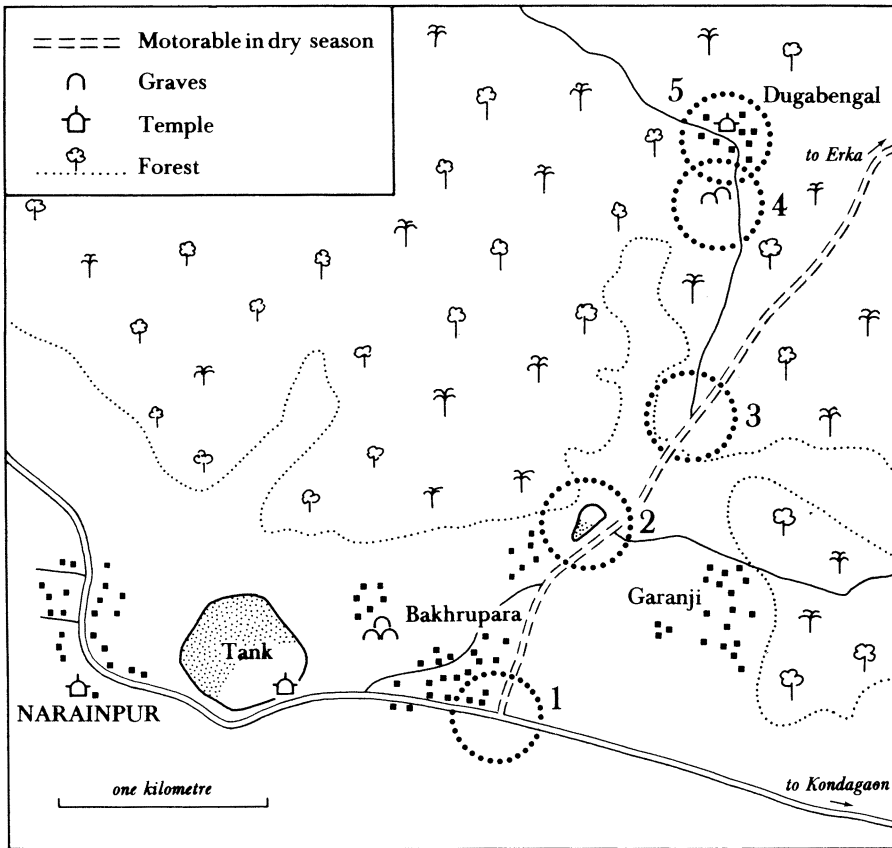
FIGURE I.   The way from Narainpur to Dugabengal.

houses, forests, tanks, and graves in this part of India I can use the map to reconstruct vicarious experiences of this and, indefinitely, many other journeys around the district. But I must set out, since it is a real experience of travelling to Dugabengal that I seek, not a vicarious one. I get to location (1). There is my road, which I remember having noticed before, though I then had no idea where it led. When I get to (2) I am in *terra incognita* so far as my personal experience is concerned; but I am prepared for the tank and the right fork to Garanji, which I avoid. Location (3) is a problem; I can easily get lost here because there are more tracks leading off to the left than are marked on the map and the edge of the forest has retreated since the surveying was done. Left into the forest, taking what seems the most likely-looking track. Increasing tension: watch out for the graves. More forest. Ah!—graves in view (4). The village beyond must be Dugabengal (5), not quite as pictured but recognisable enough.

Let this suffice as an account of how a map is actually used. The question I can now ask is how this differs, if at all, from the account previously given of mapless way-finding by the experienced native who knows the locality 'like the back of his hand' and who navigates by matching up his current visual impressions with a file of remembered landscapes identified with particular

places along a projected route. Clearly he is not really doing anything radically different from the map-using stranger, who also matches up his current visual impressions with landscape-images at each stage of the journey. The stranger has constructed these images from a map, while the native derives them from personal experience, but otherwise their mental processes are identical. In particular, it cannot be said that the stranger navigates in a different kind of 'space'—Cartesian as opposed to practical—since both stranger and native can be seen to rely on matching up a series of 'expected landscapes' seen from a particular set of subject-centred coordinates, with the world as perceived. This is so despite the fact that the map-user's expectations are *derived* from a map which knows nothing of such subjective coordinates and which represents the world from everybody's and nobody's point of view.

The gap between the experienced native and the map-using stranger seems to have narrowed considerably, but the most difficult and contentious part of the argument is still to be accomplished. I have so far only succeeded in showing that the map-user makes up for his deficit in prior experience of the landscape, which otherwise sets him apart from the experienced native, by the use of an artefact, a map. But it has yet to be shown that the experienced native makes use of a 'mental map'; all that has so far been attributed to him is the possession of a complete series of partial views, in the form of accumulated images of what the world looks like seen from points A, B, C, D, along the route A → B → C → D. This multiplicity of partial views does not add up to a map, which is a perspectiveless, synoptic whole encompassing all locations and all routes between these locations. But this is just what is presupposed by the theory of mental maps, if the notion of a mental map is to be taken seriously. It must now be demonstrated that the experienced native must refer to a *map* in order to evaluate the spatial significance of the concordance between a filed image of a landscape and his current perception of his surroundings. I must show that in order for practical navigation to take place, it is not merely sufficient that a landscape-image be matched to a perceived landscape, but that the landscape-image must be identified with coordinates on a mental map.

Non-token-indexical versus *token-indexical spatial propositions*

In order to do this it is necessary to find an adequate way of defining a map. What makes a map different from an 'image'—a perspective view of the landscape? Maps often look like pictures (resembling the terrain viewed from above, but without a horizon), but there is nothing intrinsically pictorial about maps, since their information content can be encoded in words and numbers. There need be nothing sensory about a map, whereas an 'image' always has sensory form. I define a map as any system of spatial knowledge and/or belief which takes the form of non-token-indexical statements about the spatial locations of places and objects. A page of the Ordinance survey is such a statement (or a large collection of such statements) encoded graphically, but equally the line from the Gazeteer at the back of the Atlas which tells me that Medicine Rock, Montana, is at 46° N 105° W is also a map, in the sense that if I know this I can be said to know

where Medicine Rock is, and moreover, if I am standing in front of a sign saying 'Welcome to Medicine Rock' I know where I am, too.

The defining property of maps is that they consist of one or more spatial propositions with non-token-indexical truth conditions (Mellor 1981). By non-token-indexical is meant that tokens of these propositions are true independently of the spatial coordinates in which they are uttered or entertained as beliefs. Saying 'King's Cross station is north of the LSE' is to utter a token of the proposition-type which is true if King's Cross station and the LSE are where the proposition in question asserts. If this proposition is true, all its tokens will be true, wherever they are uttered. On the other hand, saying 'King's Cross station is north of here' is to say something which is true only if said south, and not too far west or east of King's Cross. It is true if uttered in the LSE, or in Croydon, or in Ouagadougou, but not true if uttered in Oslo, Cambridge, or Islington. Tokens of this spatial proposition have truth values which vary according to the spatial coordinates (or index) at which they are uttered, and for this reason it is a token-indexical spatial proposition. The essential point, however, is that the truth value of a token-indexical spatial proposition is logically dependent on the truth-value of an underlying non-token-indexical spatial proposition. Thus the truth value of 'King's Cross station is north of here' uttered in Ouagadougou, is dependent on the truth of the proposition 'Ouagadougou is south of King's Cross'. But the truth values of non-token-indexical spatial propositions are not logically dependent on the truth values of any token-indexical spatial propositions.

Spatial knowledge-systems consist, therefore, of compendia of non-token-indexical spatial beliefs. It is only on the basis provided by non-token-indexical spatial beliefs that the agent can derive token-indexical beliefs about his current location in space. This is the fundamental reason why the notion advanced by Bourdieu, that 'practical' space is ego-centric, defined exclusively by the coordinates which meet at the agent's own body, must be rejected as logically unsound. We are obliged at all times to locate our bodies in relation to external coordinates which are unaffected as we move about, and it is in relation to these coordinates that we entertain token-indexical beliefs as to our current location in space, and the locations of other places relative to ourselves. It is only on these logical rather than psychological grounds that the theory of 'mental maps' can finally be defended. We have mental maps, not as a matter of contingent fact, but as a matter of logical necessity, because the logical form of spatial knowledge is non-token-indexical. If we entertained only token-indexical spatial propositions, which could not be reduced to non-token-indexical spatial propositions, we should be logically debarred from possessing spatial knowledge or coherent spatial beliefs of any kind at all.

I will now explore this idea in a little more detail. The points to bear in mind are i) that token-indexical and non-token-indexical spatial beliefs have different kinds of logical truth conditions; ii) spatial knowledge is grounded in non-token-indexical (map) beliefs, and iii) that perceptually based judgements as to the agent's *own* position in space always take the form of token-indexical spatial beliefs. Point iii) is a new element in the argument so far. Very schematically, *all* perceptual judgements are token-indexical beliefs, beliefs which have transitory

truth conditions which are dependent on them being held just when the target object of perception is being perceived. Thus, perception consists of making judgements such as 'this is a crow', a judgement which remains true just as long as the crow sits there and allows itself to be perceived; when the crow takes to the air and flies away, goodbye to that particular perceptual belief.

   Thus the agent, perceiving himself (by matching images) to be at a particular location, utters the perceptual judgement 'Ah! Here we are at Marble Arch,' a token whose truth conditions are bound up with its being uttered at Marble Arch, and not anywhere else. On the other hand, knowing where Marble Arch is (and hence where the agent is, as he utters his token indexical judgement) depends on the availability of non-token-indexical propositional knowledge about the location of Marble Arch in space.

The territory, maps, and images

In constructing a workable theory of navigation, one must make a three-fold distinction between 1) The territory, 2) the map of the territory, and 3) images of the territory. The territory is the real world, consisting of objects and places in spatial locations in the light of which non-token-indexical spatial beliefs are true or false. Maps are compendia of non-token-indexical spatial beliefs. Images are perceptually based beliefs about what is where in relation to a percipient subject, i.e. token-indexical spatial beliefs. If we return to the discussion of the journey to Dugabengal we can see that the utility of a map resides in the fact that it *generates images* of the landscape at any given set of coordinates in the territory it covers. These landscape images, derived from the map, can then be matched with the perceived landscape in order to monitor navigational progress and/or motivate navigational decisions. Conversely, the navigational utility of an image resides in the fact that it can be identified with a set of coordinates on a map, the coordinates at which that image has token-indexically true truth conditions. 'Navigation' consists of a cyclic process whereby images generated from maps are matched up against perceptual information, and perceptual images are identified with the equivalent coordinates on a map.

   Fig. 2a is a map of Pitcairn island. Fig. 2b is an 'image' of Pitcairn island, a 'landfall sketch' of the kind provided by maritime explorers for the assistance of others who might sail the same waters later and to whom it would be useful to have a means of checking the identity of the islands they sighted. This landfall sketch is an 'image' which is token-indexical in the sense that the sketch 'becomes true' as a depiction of the landscape only when the world is viewed from the point marked 'X' on the map of Pitcairn Island. If the world ever comes to look to you as it does in fig. 2b, that means you have arrived north-east of Pitcairn island. On the other hand, the landfall sketch is of no use in getting you to Pitcairn Island in the first place; it only tells you that you are there if you are there already. And it will not even do this if you happen to approach Pitcairn island from some other direction.

   The map of Pitcairn island does not look like any view of the island a mariner approaching it would obtain, but it alone provides the information needed to get there (via latitude and longitude) and moreover, while not being an image in
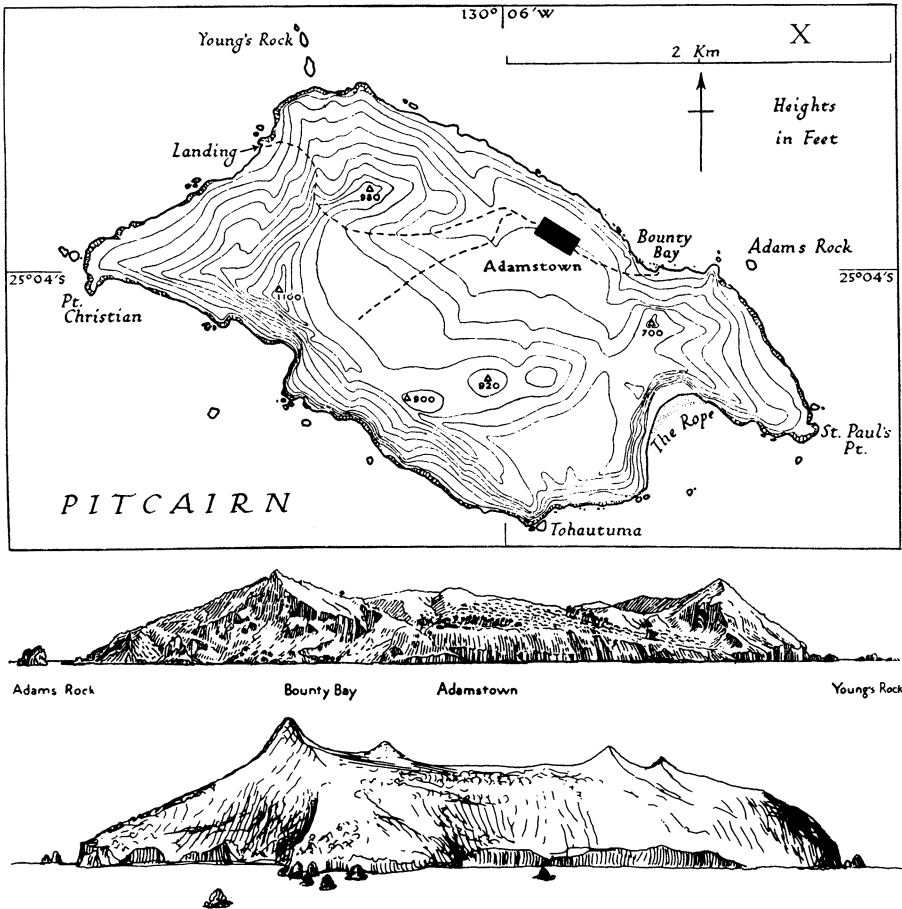
FIGURE 2.   *a*. Map of Pitcairn Island.
            b. Landfall sketch of Pitcairn from the northeast.
            c. Landfall sketch of Pitcairn from the southwest (reconstructed by the
            author from 2*a*).

itself, it can be used to generate images of Pitcairn seen from all possible points of
view. Thus, suppose we are approaching Pitcairn not from the Bounty Bay side,
but from the opposite side. Consultation of the map will generate an image of
what we should see if we are correct in our supposition that we are approaching
Pitcairn from the south-west. I have drawn this image in fig. 2*c*.

It is essential to the theory of navigation that I am putting forward here that,
just as images (like landfall sketches) are of no use to the mariner unless he has a
map at his disposal which generates, at specific coordinates, just that token-
indexical image, so non-token-indexical maps are of no use unless they gener-
ate, at any given set of coordinates, a unique image. For it is only in the light of
token-indexical judgements (noticing, for instance, that the world has come to
look like fig. 2*b* or 2*c*) that navigational decisions can be formulated. Such
decisions are attended with navigational success only if they are based on a
correct identification of the current position of the navigator. Thus, in fig. 3, it is

of no use to the mariner that his map-belief that A, his target, is due north of B, his estimated position, is true, if he has misidentified his current position and is actually at C. It is not the intrinsic correctness of our non-token-indexical map beliefs which determines whether or not our navigational decisions are successful. Success is dependent on our deriving only true token-indexical beliefs about our own position and the relative positions of target objects from the maps in our possession, and correctly identifying perceptual images with the appropriate map coordinates. It is beliefs with transitory truth-conditions, not map beliefs, which are permanently true or false, which provide the spur for action.
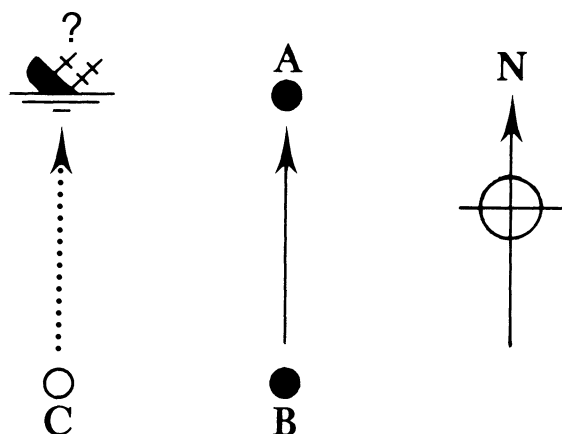

FIGURE 3. Misidentified coordinates.

Dynamic versus static mental maps: the etak *system*

My overall argument, therefore, is that mental maps consist of compendia of non-token-indexical spatial beliefs, and that in the absence of such beliefs it is impossible to formulate navigational decisions; on the other hand, in order to employ a map it is necessary to match the images produced at particular map-coordinates with perceptual images of the surrounding terrain. Subliminal way-finding consists of a two-way process of generating images from a mental map and matching these images with perceptual input. I might add, here, that 'perception' need not be purely visual; it is quite likely that human beings are sensitive to the earth's magnetic field, as are other living species, and that this information is combined with other clues as to cardinal directions, such as visual sightings of the Pole star, the track of the sun, etc. (Baker 1981). The point I wish to emphasise is that maps and images are logically distinct and that both are equally essential to the process of navigation. So in a sense the 'mental map' theory and the image-based practical mastery theory are both right, if they are taken in conjuction, and both wrong if they are taken separately.

Finally, I should like to return to the question of the supposedly 'dynamic' characteristics of mental maps indicated by Oatley and Lewis (above p. 271). According to my account of navigation, the one characteristic maps clearly cannot have is mutability, except when the territory itself is subject to change,

which I have tacitly assumed is not the case. But readers of Frake's article, and the accounts of Micronesian navigation given by Gladwin and Lewis will be inclined to contest this stipulation. Frake's lunar/solar/tidal mental maps of medieval seamen clearly exist in order to codify a process of systematic change in the territory—at certain moments in time harbours are full and sandbanks well covered, at others they are empty and their approaches are made hazardous by low water. My answer to this would be that the tidal compass described by Frake is a means of providing *temporal indices* for a 'file' of maps, maps which are spatially non-token-indexical but temporally token-indexical, i.e. true at some times and not at others. The mariner's problem is to decide which of his maps is true 'now'; that is, to arrive at a token-indexical temporal belief about which set of non-token-indexical spatial beliefs to entertain, since his beliefs about which ports are tidally safe or hazardous do not depend on where he is, spatially, in relation to them. He achieves this by making use of a time-map of lunar/solar correlations; i.e. he derives a temporal 'image' (a 'now'-fix) from his set of non-token-indexical temporal map beliefs. The tidal compass is the set of non-token-indexical temporal beliefs whose token-indexical images determine which non-token-indexical spatial beliefs he will entertain, spatial beliefs whose token-indexical images will in turn motivate his final navigational decisions. What we have is a two-stage process instead of the one-stage process normally encountered in navigation away from the sea. But the two stages, the first temporal, the second spatial, have identical logical attributes. In neither case are the maps themselves 'dynamic', since the truth conditions for the tidal compass are independent of the passage of time; the mariner's time map is true at all times, not at particular times. And similarly, the file of temporally indexed spatial maps as a whole does not change in truth value because of the fact that, depending on the temporal index, at a given moment only one of the file of maps is *currently* true. It is *true at all times* that a map, indexed as 'true at T_1' according to the tidal compass, is true at that temporal index. We can therefore rigorously distinguish between spatial/temporal map beliefs which, true or not in reality, at least aim at 'timeless' truth, from the dynamic token indexical beliefs which map users hold about the current truth-value of particular images derived from such maps.

The same kind of considerations can be applied to the Micronesian *etak* system, which has been described over and over again in the psychological literature, but which may still not be sufficiently familiar to anthropological readers to make a brief summary of the facts inappropriate. Micronesians have been accustomed to make voyages in small canoes over distances of 400 miles and more, aiming at targets not more than a few miles across. These extraordinary feats are achieved by a combination of techniques involving dead reckoning, following the stars at night, and making use of a detailed knowledge of conditions encountered at sea (wave patterns, bird movements, cloud formations, winds, etc.). Navigational lore is passed on by master navigators as a theoretical discipline, on land rather than at sea, and the effectiveness of the system can be gauged by the fact that properly instructed individuals think nothing of attempting voyages to distant islands where neither they themselves nor their instructors have ever sailed.

The non-token-indexical 'map' of the Pacific ocean passed on to each generation of navigators consists not of a picture of the ocean but a listing of all the relevant pairs of islands plus so called 'star courses' between these islands. A star course is a list of stars, which, rising and setting at different times of night, are to be aimed towards or away from in order to reach one island or another. Actually, it is a misnomer to call these lists 'courses', since the actual course sailed will not correspond to the star course, but will be modified by a number of additional factors (the prevailing wind, which may necessitate tacking, compensation for the natural tendency of canoes to drift to leeward when the wind is on the beam, compensation for oceanic currents, etc.). Moreover, the navigator aims not for his target, but for a region close to his target which will maximise his chances of making his distant landfall. The star-course system is not therefore a set of sailing-directions for getting from island A to island B, but an abstract representation of *where these islands are* in relation to each other, expressed in terms of the bearings followed by an 'ideal' canoe.

Star courses, though not in any way resembling Admiralty charts, do have the essential map-property of non-token-indexicality; they do not change truth value according to where they are uttered. Thus, if island B is due east of island A, the star course 'A→ B = Altair Rising/Altair setting' is true wherever on the surface of the ocean a canoe in transit between A and B may be located. The trouble is that the map 'A→ B = Altair rising/Altair setting' does not generate images of the perceptual surroundings of a canoe on course between A and B which can be discriminated from the perceptual surroundings of a canoe which is *not* on course between A and B. Star courses do not generate navigationally useful images, since the image from the star course map of an ideal canoe prow aligned, in this case, with Altair, corresponds to an infinitely large set of possible perceptual images, not exclusively ones which would be encountered on the seaway between A and B.

The *etak* system is the means whereby Micronesian navigators contrive to make star course maps generate token-indexical images. Lacking instruments such as chronometers and sextants, as well as charts, Micronesians use dead-reckoning to estimate their whereabouts on the ocean, by continuously monitoring their speed through the water and their heading. These dead-reckoning 'fixes' are not directly identifiable with images from star course maps because, as we have seen, star course maps do not generate locationally specific images. Instead, token-indexical beliefs, arrived at by dead reckoning, are cognitively encoded as 'sightings' of an *etak* ('refuge') island lying perpendicularly to one side of the desired inter-island course, so as to form the apex of an imaginary triangle. Fig. 4 shows the *etak* (Faraulep) for a journey between Woleai and Olimarao. The Woleai—Olimarao run is memorised, prior to departure, as the star course giving the bearing between the starting point and the destination, plus a series of additional star courses between points along the route and the *etak* island Faraulep. While sailing, the navigator makes imaginary sightings of the *etak* island—which is always invisible below the horizon—in order to formulate token-indexical beliefs, arrived at by dead reckoning, as to his current position. Thus at Woleai, Faraulep is under 'Great Bear rising'. Some time later, if the canoe is still on course, Faraulep is under 'Kochab rising', and later still 'Polaris'
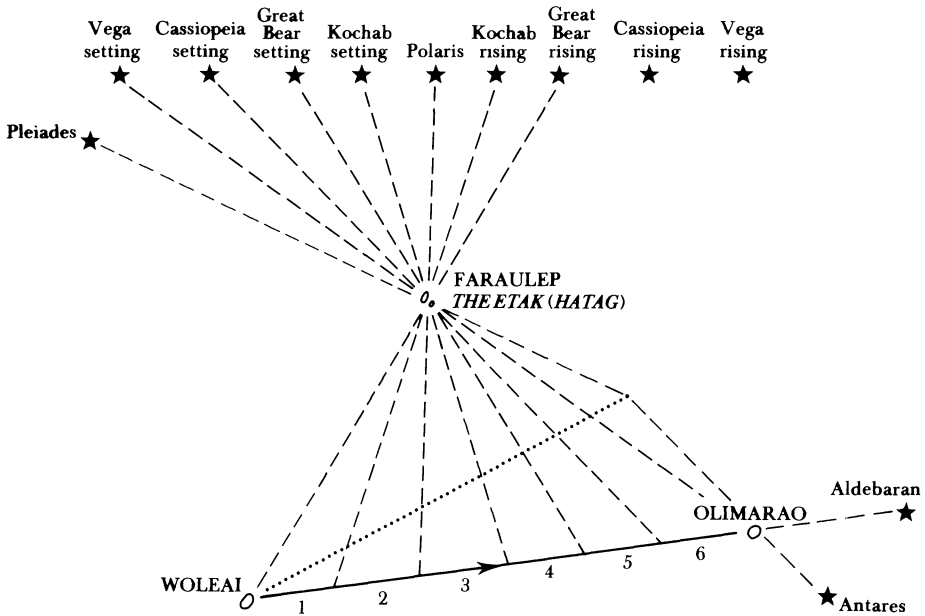
FIGURE 4.   The *etak*.

and 'Kochab setting' etc., until, on arrival at Olimarao, it is under 'Vega setting'.

This overcomes the problem of the locational nonspecificity of images from star course maps because if the canoe has diverged from the seaway between Woleai and Olimarao, the 'sightings' between the canoe and the *etak* will no longer correspond to the previously memorised ideal scheme. By sector 6, Faraulep will be under the Pleiades, instead of under Cassiopeia, where it should be. Olimarao will also have shifted; instead of being under Aldebaran, it will be under Antares. In fact, for purposes of formulating token-indexical fixes, navigators conceptualise the canoe as stationary, and the islands, particularly the *etak* island, as moving. The destination moves steadily towards the canoe, the starting point recedes, and the *etak* island moves in a circular path around the horizon.

The point to emphasise, however, is that the *etak* system is a system of images from a map, not a 'dynamic' map which redraws the arrangement of Pacific islands for each location the canoe momentarily occupies. That is to say, the star-course 'map' is made to produce images which take the form of imaginary sightings of islands which shift around the perimeter of the horizon. But if the Micronesians entertained the idea that islands really moved about in this way they would never be tempted to put to sea. On the surface, a belief about the position of the *etak* looks to have the logical form of a straightforwardly non-token-indexical spatial proposition. 'Faraulep lies under Polaris' sounds logically identical to 'Brighton is south of London'; but it is not, because the *etak* position applies only in the token-indexical context of its utterance at sector 3 of the Woleai—Olimarao run, and not otherwise. Moreover, the *etak* position is ultimately derived from the non-token indexical set of beliefs about inter-island

star courses, a system of spatial beliefs which does not alter according to the location of the canoe.

The *etak* system, therefore, though of extraordinary refinement, is a system of images derived from a map and is logically on a par with the cognitive processes which underly the most elementary kinds of way-finding in everyday contexts. And this is the general point that I should like to end with. We can distinguish among navigational techniques from the standpoint of their complexity and the amount of information they may involve, which in the case of Micronesian navigation is very great indeed. We can also distinguish between those systems which rely on published information, such as charts and tables giving the times of high and low tides, combined with standard algorithms which can be performed with paper and pencil etc. versus systems which rely on extensive rote memorisation and involve mental calculations of a greater or lesser degree of difficulty. There can be no doubt, as Frake suggests, that medieval navigational techniques would weed out the duffers much more effectively than the systems in use nowadays, and that from the point of view of the intellectual demands made on them, the mariners of earlier times are in a class apart from their present-day counterparts. All this should not be allowed to obscure the fact, however, that the essential logical processes involved in all way-finding, from the most elementary and subliminal, to the most complex and laborious, are identical. And it is on these grounds that we should seek to justify the thesis of the universality of human cognitive processes against opponents, such as Hallpike, who maintain that there are cognitive sheep and goats. Frake has shown that there are sheep among the goats: I want to go further and deny the existence of goats altogether.

REFERENCES

Baker, R. R. 1981. *Human navigation and the sixth sense*. London: Hodder & Stoughton.
Bateson, G. 1972. *Steps to an ecology of mind*. London: Paladın.
Bourdieu, P. 1977. *Towards a theory of practice*. Cambridge: Univ. Press.
Canter, D. 1977. *The psychology of place*. London: Architectural Press.
Chomsky, N. 1959. Review of 'Verbal behavior', by B. F. Skinner. *Language*. **35**, 26–58.
Downs, R. & D. Stea 1977. *Maps in minds*. New York: Harper & Row.
Gould, R. & P. White 1974. *Mental maps*. Harmondsworth: Pelican.
Gladwin, T. 1970. *The past is a big bird*. Cambridge, Mass: Harvard Univ. Press.
Hallpike, C. 1979. *The foundations of primitive thought*. Oxford: Clarendon Press.
Lewis, D. 1972. *We the navigators*. Canberra. Australian National Univ. Press.
——— Observations on route-finding and spatial orientation among the Aboriginal peoples of the
    western desert region of central Australia. *Oceania*, **46** (4), 249–82.
Lynch, K. 1960. *The image of the city*. Cambridge, Mass.: M.I.T. Press.
Mellor, D. 1981. *Real time*. Cambridge. Univ. Press.
Neisser, U. 1976. *Cognition and reality*. San Francisco: W. H. Freeman.
Oatley, K. 1977. Inference, navigation, and cognitive maps. In *Thinking* (ed.) P. N. Johnson-
    Laird. Cambridge: Univ. Press.