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'COGNITIVE MAPPING': A CROSS-CULTURAL PERSPECTIVE

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ABSTRACT

This review is concerned with 'cognitive mapping' (spatial cognition) in a cross-cultural perspective with particular reference to the Australian Aborigines and Australians of European descent.

A 'cognitive map' is defined as a schematized representation that the individual carries in his head and refers to when moving around in his spatial environment. The process of 'cognitive mapping' is explored in terms of a model of human information processing and the general conclusions which emerge are:

1. 'Cognitive mapping' may be conceived as a dymanic process whereby selected information is integrated into a meaningful structure (a 'cognitive map') in relation to the individual's current schemata; his knowledge; and his 'world view'.
2. The 'cognitive map' may be a visual and/or a verbal representation and its structure will likely contain the topological; projective; and possibly the euclidean relationships inherent in the landscape.
3. The major integrative processes involved in 'cognitive mapping' may be described as simultaneous and/or successive synthesis.

It is suggested that there is considerable scope for cultural differences in 'cognitive mapping' at all stages in the human information processing model. This thesis is developed by comparing Aboriginal and European cultures with the emphasis on the Aborigines as the ethnographically unfamiliar culture.

Three features of Aboriginal 'cognitive mapping' are outlined: 1. a highly developed bushcraft; 2. the ability to use dynamic mental maps; and 3. an indelible knowledge of spiritually significant landmarks and Dream-time tracks. Aboriginal 'cognitive mapping' is discussed in view of the human ifnormation processing model previously developed, and possible cross-cultural research hypotheses are presented.

In conclusion, it is emphasised that an ethnographic approach, the nature of which is discussed, is the only viable approach to a cross-cultural investigation of large-scale 'cognitive mapping'.

INTRODUCTION

The integrating theme to be presented in this review is the notion of the 'cognitive map', a notion that has received considerable attention in recent years. Interest in the 'cognitive map' extends into many fields, for example Environmental Psychology, Geography and Town Planning. These fields of research are beyond the scope intended here, but have been reviewed extensively elsewhere (eg.Lynch, 1960; Ittelson, 1975; Gould & White, 1974; Tuan, 1975; Beck & Wood, 1976; Kuipers, 1978; Stokols, 1978).

The topic to be considered in this review is 'cognitive mapping' (spatial cognition) in a cross-cultural perspective with particular reference to the Australian Aborigines and Australians of European descent as representative of two very different cultural groups.

The 'Cognitive Map'

Tolman (1948) originally coined the term 'cognitive map' to describe the cognitive processes he assumed must intervene between the environmental stimulation and an organism's overt responses. Contrary to stimulus-response learning theory, Tolman argued that an organism actively constructs a 'cognitive map' or an overview of the spatial relations implicit in a space rather than remembering the specific spatial relations to which it was exposed (eg. left turn; right turn).

"The incoming impulses" writes Tolman (1948 p.192) "are usually worked over and elaborated in the central control room into a tentative, cognitive-like map of the environment. And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what responses, if any, the animal will finally release.".

In more recent literature on humans (eg. Miller, Galanter & Pribram, 1960; Siegel & White, 1975; Downs & Stea, 1977), a 'cognitive

map' is generally defined as an idiosyncratic, schematized representation that the individual carries in his head and refers to when moving around in his spatial environment. That is, contained within this spatial representation is structured information about location (distance and direction); and descriptive, evaluative and predictive information about objects and goals.

A more sophisticated extension of this definition distinguishes between the process of 'cognitive mapping' and the 'cognitive map' (Downs & Stea, 1973). The process of 'cognitive mapping' can be conceived as a series of transformations whereby spatial information received from the environment is encoded, stored, manipulated, decoded and continually updated over time as the individual moves about in space. A 'cognitive map', on the other hand, is a construct used to describe a static product of this process at a given point in time -- a particular mental image of the environment with which the individual organizes and directs his current spatial behaviour.

AN INFORMATION PROCESSING MODEL OF 'COGNITIVE MAPPING'

It is useful, for the purpose of this review, to go beyond the Downs and Stea (1973) distinction between process and representation and to conceptualize the notion of 'cognitive mapping' in terms of a simplified model of human information processing such as that outlined in Lindsay and Norman (1972). For convenience, the model may be interpreted as consisting of three parts:-

1. an input stage, where selected information from the environment is received and encoded; 2. an integrative stage, in which encoded information is structured into meaningful schemata; and 3. an output, or decoding and retrieval, stage.

The discussion to follow will concentrate on the first two stages of the model as it is generally assumed that the organization of

information in the cognitive system determines how, and with what facility, information is retrieved.

In the area of human cognition the literature is extensive and not without controversy (eg. Tulving & Donaldson, 1972; Klatzy, 1975; Baddeley, 1976; Cofer, 1976; Cohen, 1977; Eysenck, 1977; Kintsch, 1977; Craik, 1979; Simon, 1979). The model to be described, however, is intended only as a framework in which to conceive the range and complexity of the processes that may be involved in 'cognitive mapping'; and to highlight the considerable scope for cultural differences in encoding, integrative and decoding strategies.

Input

Implicit in all models of human information processing is the assumption that the environment is a large-scale, informationally complex and changing surface; in contrast, humans have a limited capacity to process information (eg. Shwartz, 1976; Shriffin & Schneider, 1977). More information is received by the senses than can be adequately processed at the higher levels of analysis. A selection mechanism is generally postulated, therefore, whereby information flowing back from the higher levels determines what environmental information is to be singled out for attention (eg. Dornic, 1977).

It has been suggested (Cole & Scribner, 1974; Serpell, 1976) that people from different cultural groups, who live in variable physical and cultural environments, will attend to different aspects of the environment. The hunter, for example, with his experience and skill in the bush will be primed to notice signs indicative of food sources, signs which would likely go unnoticed by a European in the same bush landscape.

Selected information then passes into what is generally described in the literature as a short-term store (STS). The capacity of the STS

has been variously estimated (eg Miller, 1956; Simon, 1974; Broadbent, 1975) and may depend on such variables as the task and the individual's familiarity with the stimulus materials. Master chess players, for example, can remember many more pieces from a chessboard, given a brief exposure time, than can novices (Chase & Simon, 1973). The strategies used by the Master players to encode the array probably involve the abstract relationships between the pieces whereas novices may group the pieces in terms of colour, identity or proximity (Bartram, 1978). The implications to be drawn are that individual differences may occur both in the contents and in the organization of information in the STS as a result of variable experience in encoding a given array, with some processing strategies being more efficient than others; and that STS capacity may be increased if the incoming stimuli are structured by the perceiver into meaningful 'chunks' (Simon, 1974). As a corollary, it may be expected that peoples living in very different physical environments (to mention extreme examples a desert and a city), and pursuing very different life styles (eg. hunting/gathering or urban life styles), may not only attend to different aspects of the environment, but may also vary in their preferred 'chunking' strategies.

Integration and Output

The STS has a time limitation and information is lost if it is not operated on sufficiently so that it may pass into the long-term store (LTS). The organization of the LTS is not well understood. The general consensus in the literature, however is that information in the LTS must be highly interrelated and structured in order to be preserved and to facilitate retrieval. Numerous organizational and mnemonic techniques have been demonstrated (eg. see Atkinson & Shriffin, 1968; Bower, 1970 (a) & (b); Gilmartin et al., 1976). One powerful mnemonic

device, for example, is the 'method loci', whereby items to be remembered are located at a particular place in an imagined scene (Yates, 1969); another device is 'grouping' where lengthy strings of stimuli are parsed into subgroups, for example by category membership or by the temporal or spatial properties of the stimuli (Bower, 1972).

Verbal - Visual Representation and Successive - Simultaneous Synthesis

There is some evidence from both Cognitive Psychology and Neurophysiology that the representation and processing of verbal and visual informstion may involve functionally independent, though interconnected systems (eg. Gazzaniga, 1970; Paivio, 1971, 1975; Kimara, 1973; Luria, 1966; Das, 1973; Das, Kirby & Jarman, 1975).

According to Paivio (1971, 1975), for instance, the imagery system processes information concerning concrete objects and events synchronously while the verbal system is specialized for discrete linguistic units and organizes information sequentially. Paivio (1975) concedes, however, that non-verbal information can be transformed into verbal information and vice versa.

Das, Kirby and Jarman (1975), basing their conclusions on the work of Luria with brain damaged patients, similarly postulate two major types of information processing which they describe as simultaneous and successive synthesis. These authors (eg. see also Cummins & Das, 1977; Kirby & Das, 1977, 1978) claim that simultaneous synthesis involves the integration of information into simultaneous and primarily spatial groups, all parts of which are immediately surveyable. A type of processing they propose is "required in the formation of any holistic gestalt or in the discovery of the relationships among two or more objects" (Cummins & Das, 1977 p.246). Successive synthesis, in contrast, is described as involving the integration of information into temporally organized series, whose elements are only surveyable in sequence.

Examples given of this type of processing include logical argument and narrative speech. Das et al. (1975) prefer to emphasize simultaneous and successive processing rather than the visual-verbal distinction. They argue that within the framework of Luria's model the synchronous and serial aspects of both verbal and non-verbal behaviours may be considered.

In this review, however, a distinction will be made between representation and process, such that human cognition may be described in terms of two modes of representation which utilize either a predominantly visual or a predominantly verbal encoding system; and two major integrative processes - simultaneous and successive synthesis. The literature has tended to emphasize the polarity of both visual-verbal and the simultaneous-successive dimensions. It is proposed that a preferable interpretation would be to consider these extreme poles in a model (see Fig.1) which provides for all possible combinations along these dimensions.

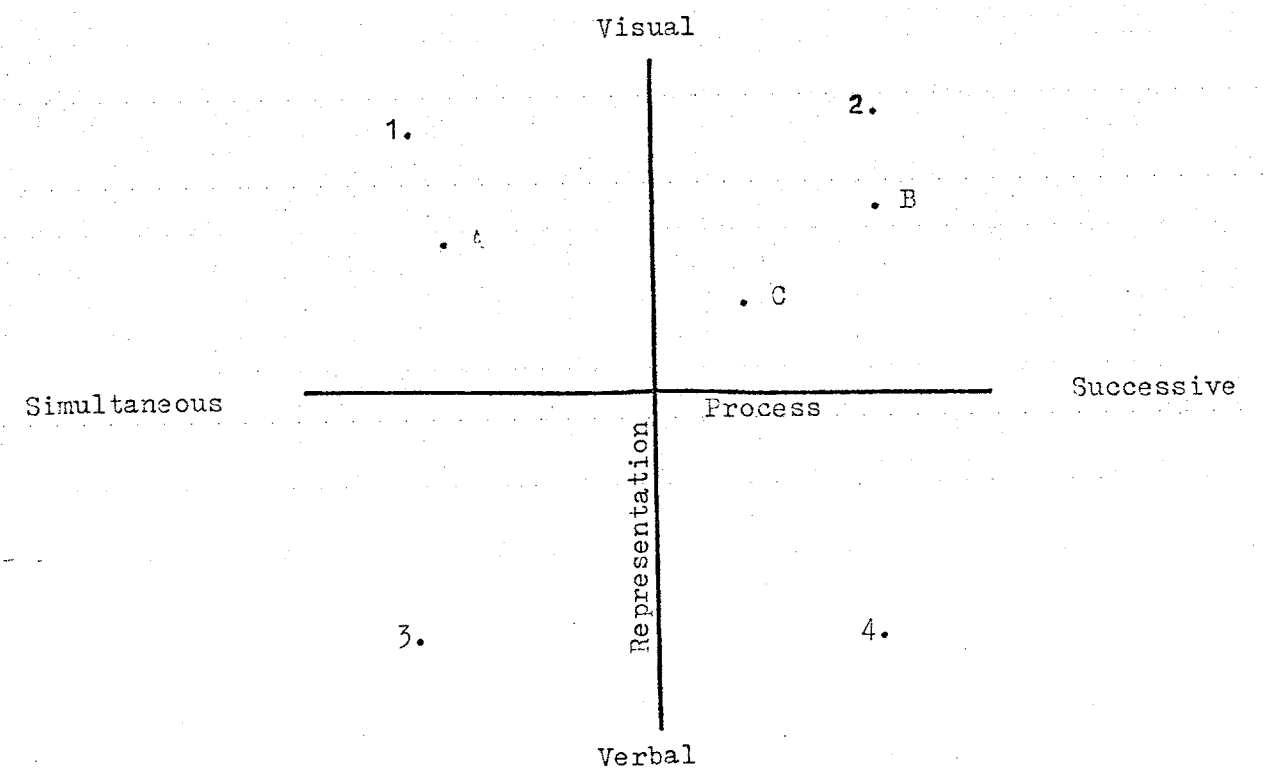

Figure 1. A model of visual-verbal representation and simultaneous-successive synthesis.

Both modes of representation and both processes may be involved to some degree in 'cognitive mapping'. For example, map and compass way-finding implies an understanding of a cartographic language (a verbal component), but must also involve an imaginal conceptualization of self in relation to the other elements in the space (a visual component). Research into adult way-finding behaviour in large-scale urban environments (eg Lynch, 1960; Kuipers, 1978) has indicated that the two important features of 'cognitive mapping' are route-finding and discovering relative-position in a coordinated frame of reference. Route-finding may be defined as a predominantly successive information processing task; while relative-position problems likely depend on simultaneous synthesis. As an illustration, points A, B and C in Figure 1 may characterize three hypothetical 'cognitive maps' for a given spatial area. It is suggested that both individual and group differences may be depicted in this manner, with individuals from a particular cultural group being more highly represented in one quadrant of the model.

There is some evidence to suggest that cultural groups may differ in the way they represent and process visuo-spatial information. For example, in relation to the Aboriginal/European comparision, Kearins (1974, 1977) inferred that on tasks requiring the recall and reconstruction of visual arrays, Aboriginal children predominantly imposed a visual encoding system on the objects to be remembered, whereas European children predominantly employed a less efficient, verbal naming system. Similarly, Davidson (1977) found that in the card game Baccarat Aboriginal players use a system of visual pattern recognition in identifying the face value of the cards in their hand, whereby they may simultaneously access any card. European players, on the other hand, invariably use the method of sequentially recognizing and

counting the numbered cards. More recently, Davidson & Klich (1979) demonstrated that in a free recall task, which involved the serial presentation of three mounted pictures, Aboriginal subjects preferred to retrieve the remembered pictures as a spatial unit rather than in terms of the temporal order of presentation. The reverse was found to be the case for European subjects.

The evidence is minimal and not unequivocal. Drinkwater (1976) and Harris (1977), for example, were unable to replicate Kearins' results. Kearins (1978) has argued that these studies did not precisely follow her experimental procedures, and used Aboriginal subjects who were not from the 'desert habitat' stipulated in her genetic inheritance hypothesis. Alternatively, these problems of replication may be inherent in Kearins' experimental design. Kearins used observational data to infer the encoding systems that were being employed by the two cultural groups. The European children's mouthing of the names of the objects was given as evidence for verbal encoding whereas the Aboriginal subject's silence, together with their superior performance on the task was interpreted by Kearins as highly suggestive of visual encoding. A quantifiable criteria to distinguish between the use of verbal as distinct from visual encoding systems. The Davidson and the Davidson & Klich experiments, furthermore, may encourage simultaneous processing in Aboriginal subjects, but be very task-specific i.e. to card playing and the processing of a set of three pictures.

It is proposed, however, that the possibility of cultural differences in processing a visual array is still a viable hypothesis. The available evidence would suggest that the Aborigines may best be represented by quadrant 1 in Figure 1. (high on the visual and simultaneous dimensions) and the European by quadrant 4 (high verbal/

successive), but considerable research is needed to clarify the area.

Topological, Projective and Euclidean Relations

Piagetian theory on the child's acquisition of spatial knowledge Piaget, Inhelder & Szeminska, 1960; Piaget & Inhelder, 1967) is suggestive of how a 'cognitive map' may be structured. Piaget describes three major types of relations or properties of space - topological; projective and euclidean. Topological properties concern the simple relations in space such as proximity-separation, open-closed; projective properties are relations in terms of a particular viewpoint; and euclidean or metric properties involve relations in a system of axes or coordinates whose equivalence depends on mathematical and geometric equality. Piaget says the child first grasps topological relations before reaching an understanding of projectives and euclidean relations.

In Piaget's theory, euclidean relations depend on formal operational thought whereby the child may manipulate all the implicit quantitative relations internally and in an abstract, hypothetical manner. However, cross-cultural Piagetian research (eg. Dasen, 1972, 1975, 1977; Berry & Dasen, 1974) implies that Non-Western cultures, including the Australian Aborigines, may prefer to process information at a concrete operational level of topological and projective relations. It is likely, and will be discussed more fully at a later stage, that European culture tends to encourage a reliance on map-compass or euclidean way-finding techniques, whereas Aboriginal culture may encourage the individual to rely on concrete cues and relationships in operating in his spatial environment. This is not to imply that Aboriginal people are incapable of formal operational thought. Aboriginal children adopted and fostered by European families, for instance, have been found to reason like European children on Piagetian tasks (Dasen et al.,

1973; Seagrim, 1974). Rather, it is argued that Aboriginal culture likely encourages concrete operational thinking; European culture, on the other hand, encourages a developmental progression toward formal operational thought.

Dynamic View of 'Cognitive Mapping'

Finally, it is important to take a broad overview of how 'cognitive mapping' might operate. Current theory in cognition (eg. Norman & Bobrow, 1975; Baddeley, 1976) describe memory as a "dynamic and integrative system" (Lindsay & Norman, 1972 p.431) -- a theory that relates to the concept developed by Piaget, of adaptation (assimilation and accommodation). For Piaget (eg. 1969) the acquisition of knowledge involves the assimilation of incoming information into the individual's thought structures (schemata) and when these thought structures are inadequate the accommodation or transformation of these thought structures in response to the environment. The implication is that incoming stimuli are structured and made meaningful in terms of the individual's past experiences, including his current conception of how the world is organized and his available schemata. Piaget is concerned with the universal developmental changes in thought processes that occur systematically as a result of experience with the environment. An alternative interpretation, and one not entirely ignored by Piaget (see Piaget 1966, 1972), is that superimposed on these universal cognitive trends is cultural learning which is also instrumental in influencing how the individual orders his environment and his preferred methods of processing information. Elkin (1969) takes such a view and suggests that Aboriginal people process and interpret current experience differently to Europeans largely because of their mythological view of the cosmos. For the Aborigine events are preordained and reality is not

seen in terms of the logico-scientific explanations which are basic to the European conception of the world.

1. In conclusion, 'cognitive mapping' may be conceived as a dynamic process whereby selected sensory information is integrated in terms of the individual's current schemata, his knowledge and his 'world view' into a 'cognitive map' which is useful to the individual when operating in his particular environment.
2. The 'cognitive map' may be a visual and/or verbal representation and its structure will likely contain the topological; projective; and possibly the euclidean relationships inherent in the geographical landscape.
3. The major integrative process involved in 'cognitive mapping' may be described as simultaneous and/or successive synthesis.
4. There is considerable scope for cultural differences at all stages in the human information processing model.

The hypothesis of possible cultural differences in 'cognitive mapping' and spatial behaviour will be discussed in relation to the Aborigines of Central Australia and Australians of European descent, with particular emphasis on the Aborigines as the ethnographically unfamiliar culture.

It is proposed to take a broad look at Aboriginal 'cognitive mapping' in an attempt to determine the types of encoding-decoding strategies that may be relevant to this culture and to suggest possible hypotheses for future research. This overview will be the background to a final brief discussion of the possible direction that cross-cultural research may take in the area of 'cognitive mapping'.

'COGNITIVE MAPPING' IN ABORIGINES AND EUROPEANS

The Pattern of Life in Traditional Aboriginal Society

The Aborigines of Central Australia were traditionally nomadic hunters and food gatherers, living successfully in a harsh, uncompromising desert landscape (Meggitt, 1962; Berndt & Berndt, 1968; Elkin, 1974).

Before contact with European people, the Aborigines were solely dependent on the natural environment for survival and as a result a large proportion of the daily activity would have been devoted to hunting and foraging. That the Aborigines had a deep knowledge of their environment and its resources is well documented (eg. Kaberry, 1939; Berndt & Berndt, 1968).

It can be assumed that the Aborigines' movements within their tribal territory were dictated by the seasons and the availability of food and water. These movements may have been far ranging, particularly in times of scarcity. Mobility was important for a whole host of reasons, but especially to find food and water to survive; to enable small groups to congregate for ceremonial acts; and to visit sacred places. For these reasons, journeys often lasting weeks and months were made on foot. Brokensha (1975) has suggested that mobility, stemming from similar reasons is still a current priority today with the Aboriginal people of Central Australia.

Given the importance of mobility in Aboriginal culture and the Aborigines' record of successful survival in a desert environment, it may be assumed with some confidence that the Aborigines have highly developed spatial orientation and route-finding concepts and techniques. The next question to ask is - How does the Aborigine operate in his spatial environment and what may be inferred from this behaviour about the contents of his 'cognitive map' and his 'cognitive mapping' processes?

Aboriginal Culture and 'Cognitive Mapping'

There is no psycholcgical literature which is specifically

concerned with large-scale spatial behaviour in Aboriginal people. However, the anthropological evidence, in particular an article by Lewis (1976), is highly suggestive of the cognitive processes that may be involved in Aboriginal 'cognitive mapping' and it is this article which is the main source for the following discussion.

According to Lewis, the most salient features of spatial orientation and route-finding, as practised by the desert Aborigines are: 1. A highly developed bushcraft; 2. the ability to use dynamic mental maps, and to continually monitor changes in direction; and 3. an indelible knowledge of spiritually significant landmarks and Dream-time tracks.

1. Bushcraft: The Aborigine is renowned for his acute visual perceptiveness as exemplified by his superior ability to recognize even the faintest signs indicative of a food or water source (eg. Magarey, 1898; Wallace, 1968). His skill in following tracks over virtually any terrain and in interpreting their meaning with considerable accuracy is also legendary (Strehlow, 1964; Lahiri, 1965).

There is, however, no evidence to support a physiological basis for superior visual acuity in Aborigines (Verney, 1969). A possible psychological interpretation is that the Aborigine, like the Master chess player, as a result of his extensive experience in the desert together with his culturally inherited knowledge and cognitive skills, knows the environmental features that deserve specific attention and can meaningfully 'chunk' information from his particular environment with considerable efficiency. It is an equally valid argument that the European familiar with an urban environment can be just as effective in processing city-like information. However, the kind of information selected for processing and the organization habitually imposed on this information by individuals from the two cultures will likely be very different.

More specifically, it is suggested that the Aborigines' hunting/gathering life style has operated to encourage a heavy reliance on visual coding and visuo-spatial memory -- for example in memorizing the geography of the land, the details of animal tracks, edible foods and signs indicating water. The patterned spatial relationships among various environmental features would be important in the cognitive organization of this visual information, for example, the collective signs recognized and interpreted as a water source or the tracks of animals.

It is argued that European culture with a tradition of written language does not make such exacting demands on visual memory. In moving around in a city, for instance, maps of roadway systems and verbal signs indicative of routes, the location of the shopping centres etc. operate to lighten the load of what environmental information must be committed to memory.

There is some evidence from psychology that the encoding and decoding strategies habitually used by the Aborigines in processing visuo-spatial information are not only different, but possibly superior to those used by Europeans -- perhaps with the Aborigines relying more than the Europeans on a simultaneous mode of processing such as is required in the formation of any holistic gestalt or discovering relationships among objects.

- In the Kearins experiment (1974, 1977), Aborigines were found to be superior to Europeans on a visual memory task.
- Davidson (1977) and Davidson and Klich (1979) found that Aborigines prefer to encode and decode information synchronously.
- Berry (1971, 1976), from a battery of tests of visuo-spatial skills, concluded that as a result of ecological demands a hunter/gatherer life

style precludes superiority in visual discrimination and spatial skill. - And it was demonstrated by Dasen (1974), in a Piagetian framework that Aborigines do better on spatial than on logico-mathematical tests. The reverse was found to be true for Europeans.

The evidence is again minimal and the main criticism to be levelled at this research is that the cognitive strategies being used by the Aboriginal subjects may be specific for the experimental task and not those strategies habitually used in processing 'bush' information. Kearins (1974, 1977) showed some sensitivity to this problem in her care to select arrays of objects familiar to both the Aboriginal and European subjects. However, Kearins' objects were displayed on grid-marked card and it is suggested that this matrix design both detracted from her aim of providing a "natural" setting for the Aborigines and imposed a row/column encoding strategy on the task, particularly for the European subjects.

Despite the poverty of research, the hypothesis of Aboriginal superiority in visuo-spatial memory is still suggested as a valid hypothesis. It is hoped, however, that in the future experimental situations will be designed that are relevant to the cultures sampled. For example, one feasible design could be to organize two visual memory tasks, to be presented to both an Aboriginal and a European sample, one made up of a city-like array in a natural context, the other a bush-like array in context.

2. Mental Maps: Lewis (1976) suggests that Aborigines are capable of superior skill and accuracy in orientating in their spatial environment, quite apart from their acute perceptiveness. Most commonly, Aborigines indicate direction by visualizing themselves at some distant point of reference, usually a significant landmark.

Landmarks are not, however, a necessary feature of the Aborigines' orientating ability. Lewis witnessed a kangaroo hunt across a featureless stretch of mulga through which visibility was poor and which was devoid of obvious landmarks. After a circuitous chase, the Aborigines were able to return, without apparent difficulty directly to their starting point, an accomplishment for which Lewis needed a map and compass.

Lewis described this exceptional orientating ability in terms of a "dynamic mental map", "which was continually updated in terms of time, distance and bearing, and more radically realigned at each change of direction, so that the hunters remained at all times aware of the precise direction of their base and/or objective." (Lewis, 1976. p.262)

It is argued that Europeans in their way-finding behaviour tend to rely on supportive external aids such as maps, compasses, directory signs, road routes etc. That is not to say that some Europeans may not be highly skilful in practical orientation without a map and compass, and certain leisure activities (eg. bushwalking) or professions (eg. surveying) may encourage the development of these skills. However, in a nomadic society where disorientation could have disasterous consequences, and where there are no external aids (as in the kangaroo hunt), it is to be expected that accurate "dynamic mental mapping" must be an important survival skill for all individuals.

It may be, therefore, that in the absence of external aids, in an unfamiliar environment, Aborigines may be superior to Europeans in 'cognitive mapping'. A possible corollary to this hypothesis is that in their dynamic mental mapping, Aborigines may employ a predominantly simultaneous processing strategy, whereby the relationships of the kangaroo, themselves and the starting point are synchronously surveyable. However, as the next section on Aboriginal route-finding illustrates, synchronous processing is

likely to be one strategy employed by the Aborigines and may relate to a particular situation, such as a hunt; and that in a different situation simultaneous and/or serial information processing may be the dominant strategy. This relates to the notion of task specific coding strategies previously mentioned and is a particular problem inherent in cross-cultural research, which must be accounted for in designing an experiment around hypotheses such as the one suggested here.

3. Mythology: In the Dream-time, Mythological beings were supposed to have emerged from an eternal sleep and travelled throughout the country-side, creating in their tracks and by their exploits, all the prominent features of the present day landscape. "The whole Western Desert", writes Berndt (1959, p.97) "is criss-crossed with the meandering tracks of ancestral beings, mostly though not invariably following the known permanent and impermanent waterhole routes". The Aborigines consider themselves reincarnations of these mythological ancestors who are still believed to be magically potent in the present day landscape.

Ceremonial and ritualistic observations are powerfully important in Aboriginal life and children from an early age are taught the stories and songs of their country's Dream-time and are imbued with a fear and respect for magical spirits. As both Kaberry (1939) and Strehlow (1947) have stressed, during initiation ceremonies boys are taken to sacred sites and the experience forms such an indelible impression on them that they remember the landscape in great detail even if they do not return for many years. Lewis (1976, p.271) was similarly impressed with the "almost total recall of every topographical feature of any country they had ever crossed".

Mythology provides the Aborigine with a coherent system of sacred landmarks and a network of mythical routes with which to organize

cognitively his geographical environment. A system preserved in stories, song and dance and made all the more memorable because of its religious significance.

The inference drawn in the anthropological literature (eg. Hardwood, 1976; Hage, 1978) is that in a non-literate society concrete spatial location functions as a mnemonic device (method of loci) to aid the storage and recall of myths. The reverse is also conceivable whereby the myth, continually rehearsed in ritual songs, corroborees and stories, operates to preserve the location and the ordered sequence of routes. Narration and rhyme have been shown experimentally to be powerful mnemonic devices (eg. Bower & Clarke, 1969; Bower, 1970 (b); Bower, 1972).

The informative content of Aboriginal myths often extends into unfamiliar territory. Lewis points out, however, that this information is likely to be very general and when travelling through a foreign territory the Aborigine will learn the new layout through "topological gossip" (Lewis, 1976, p.276) in the same way as a European would acquire a map of a new city.

Aborigines do not use maps but their works of art are suggestive of how their mythologically organized 'cognitive maps' may be represented. These 'maps' often depict locations as circles connected by lines or ancestral foot prints, which are generally accurate as to the topological relation and to direction but not as to distance - except in the relative sense of a 'long way' or a 'short way' (Berndt & Berndt, 1968; Munn, 1973). Strehlow (1964) puts forward an explanation of Aboriginal artistic 'maps' in terms of looking downwards to "read the ground" like a "plan view" which preserves the significant terrestrial features and their interrelationships.

In conclusion, the Aborigines' mythological system of geography is illustrative of mnemonic techniques that have been culturally developed

to reduce the demands made on the memory in a non-literate society. Furthermore, it is apparent that by utilizing this system, the Aborigine is able to operate successfully in his spatial environment at a concrete level of topological and projective relations without recourse to formal operational thought and the euclidean relations inherent in map/compass way-finding. Thus, Aboriginal 'cognitive mapping' strategies in moving around in his environment may be described in terms of a coherent, integrated body of knowledge about the geographical landscape contained in a myth and the concrete cueing of landmarks along a route implicit in the serial narrative content of the myth.

The only hypothesis to be drawn from this section is that Aboriginal people use different orientational and route-finding strategies to Europeans and it is debatable whether these strategies are superior to those used by Europeans or vice versa. The Aboriginal strategies, however, are likely generalizable to other situations. Kean (personal communication, 1979) for example, pointed out that a traditional Aborigine can operate extremely effectively in a city environment using similar mnemonic strategies to those described above.

A CROSS-CULTURAL PERSPECTIVE OF 'COGNITIVE MAPPING'

A recent review (LCHC, 1979) has argued that the major problem inherent in cross-cultural cognitive research, particularly in relation to "exotic" cultural groups, is one of insufficient knowledge both of 'culture' as the independent variable and of the behaviours that constitute the substance of the dependent variable. Culture is defined as "a human-produced, patterned set of experiences", and these authors warn that although we "need to 'unpackage' culture as an independent variable", in doing so we may "destroy the network of relations which gave the variable its (unpackaged) meaning in the first place" (LCHC, 1979

p. 147). Psychologists rely, furthermore, on experimental manipulation in order to test hypotheses concerning cognitive processes. "But our ignorance of the multiple,system behaviors that give rise to the criterion behavior too often leaves us mute regarding an unambiguous interpretation of the outcome" (ibid p.147).

This problem of providing an adequate interpretation of the variables is likely to be multiplied when the cultural groups to be compared are very different, as is the case with Aborigines and Europeans; and when the criterion behaviour is as complex as large-scale 'cognitive mapping'.

There is some research in anthropology which has addressed itself specifically to the question of 'cognitive mapping', the research on Aboriginal orientation and way-finding by Lewis (1976) -- a major source in this review and a field-study by Gladwin (1970) together with an extended interpretation by Hage (1978) on the system of inter-island navigation used by the Puluwats of Micronesia. The ethnographic approach to cross-cultural psychology (eg. see Jahoda, 1977; Davidson, 1978; & LCHC, 1979), an approach adopted in part by Lewis and Gladwin, is advocated here as the most appropriate for the study of 'cognitive mapping' and one which does not entail the "unpackaging" of the 'culture' variable.

The starting point of analysis in ethnographic psychology is an anthropologically orientated field study. The aim of the field study is to provide a systematic description of the criterion behaviour as it is organized and as it functions within the everyday activities of a given cultural group. For example, both Lewis (1976) and Gladwin (1970) spent considerable time with the Aborigines and the Puluwat, respectively, and in both cases found a system of navigation which was "complex, rational, efficient and almost entirely non-European in origin" (Gladwin, 1970, Preface p.3).

It is possible, given a thorough intracultural description of 'cognitive mapping', to make the transition from ethnography to psychology. That is, tentative explanations, in terms of an understanding of psychological theory, can be made as to the cognitive processes that may be involved in Aboriginal or Puluwatan 'cognitive mapping'. Gladwin (1970), for example, surmised that although a relatively high order of abstraction existed in the Puluwatan system, innovation and formal operational problem solving was inappropriate since all the possible solutions were represented within the system. A similar reliance on 'concrete thinking' in Aboriginal 'cognitive mapping' was discussed earlier in this review.

The validity and the reliability of such explanations may then be tested in specific experimental or other investigatory frameworks within the culture. Gladwin (1970), for example, followed up his concrete thinking hypothesis by giving selected Puluwatan mariners Piagetian tests for classificatory ability.

Cross-cultural research into large-scale 'cognitive mapping', according to the ethnographic approach, must be preceeded by a vigorous intracultural investigation. It is argued (eg. see Davidson, 1978; LCLHC, 1979) that the value of this approach is that:

1. It minimizes the problem of ethnocentricity, a criticism which is often levelled at cross-cultural research (eg. Dasen, 1977).
2. The intracultural investigation is a source of hypotheses relating to cross-cultural expectations.
3. And, it provides an extensive, within culture background from which to make inferences concerning the influence of 'culture' as an independent variable and to interpret adequately the experimental results.

The requirements of an ethnographic to a cross-cultural study of 'cognitive mapping' are extensive and call for long-term, inter-

disciplinary and large-scale projects. It is suggested, however, that piece-meal, independent research will not contribute a great deal to an adequate knowledge of this area. No research project of the magnitude intended here has been carried out in the area of cross-cultural 'cognitive mapping' behaviour, but the importance of the work of Lewis (1976) and Gladwin (1970) demonstrates that such a project is not beyond possibility.

References

Atkinson, R.C., & Shriffin, R.M. Human memory: A proposed system and its control processes. In K.W. Spence & J.T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory (Vol.2). New York: Academic Press, 1968.

Baddeley, A.D. The psychology of memory. New York: Basic Books, 1976

Bartram, D.J. Post-iconic visual storage: chunking in the reproduction of briefly displayed visual patterns. Cognitive Psychology, 1978, 10, 324 - 355.

Beck, R.J. & Wood, D. Cognitive transformation of information from urban geographic fields to mental maps. Environment & Behavior, 1976, 8, 199-238.

Berndt, R.M. The concept of "the tribe" in the Western Desert of Australia. Oceania, 1959, 30, 81-107.

Berndt, R.M. & Berndt, C.H. The World of the First Australians. Sydney: Ure Smith Pty. Ltd., 1968.

Berry, J.W. Ecology and cultural factors in spatial perceptual development. Canadian Journal of Behavioral Science, 1971, 3, 324-336.

Berry, J.W. Human ecology and cognitive style: Comparative studies in cultural and psychological adaptation. New York: John Wiley & Sons, 1976.

Berry, J.W., & Dasen, P.R. (Eds.), Culture and cognition: Reading in cross-cultural psychology. London: Methuen & Co. Ltd., 1974.

Bower, G.H. Analysis of a mnemonic device. American Scientist, 1970, 58, 496-510. (a)

Bower, G.H. Organizational factors in memory. Cognitive Psychology, 1970, 1, 18-46. (b)

Bower, G.H. A selective review of organizational factors in memory. In E. Tulving & W. Donaldson (Eds.), Organization of memory. New York: Academic Press, 1972.

Bower, G.H. Experiments in story understanding and recall. Quarterly Journal of Experimental Psychology, 1976, 2, 456-466.

Bower, G.H., & Clark, M.C. Narrative stories as mediators of social learning. Psychonomic Science, 1969, 14, 181-182.

Broadbent, D.E. Division of function and integration of behavior. In F.O. Schmitt & F.G. Worden (Eds.), The Neurosciences. Third Study program. Cambridge, Mass.: MIT Press, 1974.

Brokensha, P. The Pitjantjatjara and their crafts. North Sydney: Aboriginal Arts Board, Australia Council, 1975.

Chase, W.G., & Simon, H.A. Perception in chess. Cognitive Psychology, 1973, 5, 55-81.

Cofer, C.N. The structure of human memory. San Francisco: W.H. Freeman & Co., 1976.

Cohen, G. The psychology of cognition. London: Academic Press, 1977.

Cole, M., & Scribner, M. Culture and thought: A psychological introduction. New York: John Wiley & Sons, Inc., 1974.

Craik, F.I.M. Human memory. Annual Review of Psychology, 1979, 30, 63-102.

Cummins, J., & Das, J.P. Cognitive processing and reading difficulties: A framework for research. Alberta Journal of Educational Research, 1977, 23, 245-256.

Das, J.P. Structure of cognitive abilities: Evidence for simultaneous and successive processing. Journal of Educational Psychology, 1973, 65, 103-108.

Das, J.P., Kirby, J., & Jarman, R.F. Simultaneous and successive synthesis: An alternative model for cognitive abilities. Psychological Bulletin, 1973, 82, 87-103.

Dasen, P.R. Cross-cultural Piagetian research: A summary. Journal of Cross-cultural Psychology, 1972, 3, 23-29.

Dasen, P.R. The influence of ecology, culture and European contact on cognitive development in Australian Aborigines. In J.W. Berry & P.R. Dasen (Eds.), Culture and cognition: Readings in cross-cultural psychology. London: Methuen & Co. Ltd., 1974.

Dasen, P.R. Concrete operational development in three cultures. Journal of Cross-Cultural Psychology, 1975, 6, 156-172.

Dasen, P.R. Piagetian psychology. Cross-cultural contributions. New York: Gardiner Press, Inc., 1977.

Dasen, P.R., de Lacey, P.R., & Seagrim, G.N. Reasoning ability in adopted and fostered Aboriginal children. In G.E. Kearney, P.R. de Lacey, & G.R. Davidson (Eds.), The psychology of Aboriginal Australians. Sydney: Wiley Books, 1973.

Davidson, G.R. An ethnographic psychology of Aboriginal cognitive ability. Oceania, 1979, 59, 270-294.

Davidson, G.R., & Klich, L.Z. Cultural factors in the development of temporal and spatial ordering. Child Development, 1979 submitted for publication.

de Lacey, P.R. Verbal intelligence, operational thinking and environment in part-Aboriginal children. Australian Journal of Psychology, 1971, 23, 145-149.

Dornic, S. Attention and Performance. Hillsdale, N.J.: Erlbaum, 1977.

Downs, R.M., & Stea, D. (Eds.), Image and environment: Cognitive mapping and spatial behavior. Chicago: Aldine Publishing Co., 1973.

Downs, R.M., & Stea, D. Maps in minds: reflections on cognitive mapping. New York: Harper Row, 1977.

Drinkwater, B.A. Visual memory skills of medium contact Aboriginal children. Australian Journal of Psychology, 1976, 28, 37-44.

Drinkwater, B.A. A reply to Kearins Australian Journal of Psychology, 1978, 30, 115-118.

Elkin, A.P. Elements of Australian Aboriginal philosophy. Oceania, 1969, 40, 85-98.

Elkin, A.P. The Australian Aborigines (Revised edition) Sydney: Angus & Robertson, 1974.

Eysenck, M.W. Human memory: Theory, research and individual differences. Exter, England: A. Wheaton & Co., Pergamon Press, 1977.

Gazzanigia, M.S. The bisected brain. New York: Appleton-Century-Crofts, 1970.

Gladwin, T. East is a big bird: Navigation and logic on Puluwat Atoll. Cambridge, Mass: Harvard Uni. Press, 1970.

Gilmartin, K.J., Newell, A., & Simon, H.A. A program modeling short-term memory under strategy control. In C.N. Cofer (Ed.), The structure of human memory. San Francisco: Freeman, 1976.

Gould, P., & White, R. Mental maps. New York: Penguin Books, 1974.

Hage, P. Speculations on Puluwatese mnemonic structure. Oceania, 1978, 49, 81-95.

Harris, S.A. Milingimbi Aboriginal learning contexts. Unpublished Ph.D. Thesis, Uni. of New Mexico, Albuquerque, New Mexico, 1977.

Hardwood, F. Myth, memory and oral tradition: Cicero in the Trobriands. American Anthropologist, 1976, 78, 783-796.

Ittelson, W.H. Environment and Cognition. New York: Seminar Press, 1973.

Jahoda, O. Psychology and anthropology: Possible common ground in cross-cultural research. Annals N.Y. Academy of Sciences, 1977, 285, 13-18.

Kaberry, P.M. Aboriginal woman sacred and profane. London: George Routledge & Sons, Ltd., 1939.

Kean, J. Coordinator of Aboriginal art at Papunya, West of Alice Springs. Personal communication, 1979.

Kearins, J. Skills of desert Aboriginal children. In C.E. Kearney & D.W. McElwain (Eds.), Aboriginal cognition: Retrospect and prospect. Canberra: Australian Institute of Aboriginal Studies, 1976. Paper delivered at Australian Institute of Aboriginal Studies Conference, Canberra, June 1974.

Kearins, J. Visual spatial memory in Australian Aboriginal children of desert regions. Unpublished Ph.D. Thesis, Uni. of W. Aust., 1977.

Kearins, J. Visual memory skills of Western Desert and Queensland children of Australian Aboriginal descent: A reply to Drinkwater. Australian Journal of Psychology, 1978, 30, 1-5.

Kimara, D. The asymmetry of the human brain. Scientific American, 1973, 288, 70-78

Kintsch, W. Memory and cognition. New York: Wiley, 1977.

Kirby, J.R., & Das, J.P. Reading achievement, IQ, and simultaneous-successive processing. Journal of Educational Psychology, 1977, 69, 564-570.

Kirby, J.R., & Das, J.P. Information processing and human abilities. Journal of Educational Psychology, 1978, 70, 71-79.

Klatzky, R.L. Human memory: Structures and processes. San Francisco, W.H. Freeman & Co., 1975.

Kuipers, B. Modeling spatial knowledge. Cognitive Science, 1978, 2, 129-153.

Laboratory of Comparative Human Cognition (LCHC). What's cultural about cross-cultural cognitive psychology? Annual Review of Psychology, 1979, 30, 145-172.

Lahiri, T.K. Tracking as a fine art. Citation, 1965, Dec., 6-9.

Lewis, D. Observations on route finding and spatial orientation among the Aboriginal peoples of the Western Desert region of Central Australia. Oceania, 1976, 47, 249-282.

Lindsay, P., & Norman, D. Human information processing. New York: Academic Press, 1972.

Luria, A.R. Human brain and psychological processes. New York: Harper Row, 1966.

Luria, A.R. The working brain: An introduction to neuropsychology. Ringwood, Victoria: Penguin Books, Aust. Ltd., 1973.

Lynch, K. The image of the city. Cambridge, Mass.: The MIT press, 1960.

Magarey, A.T. Australian Aborigines' water-guest. Royal Geographical Society of Australasia: South Australia - Proceedings, 1885-98, Vols. 1-3, 67-82.

Meggitt, M.J. Desert people. Chicago: Uni. Chicago Press, 1962.

Miller, G.A. The magical number seven, plus or minus two: Some limitations on our capacity for processing information. Psychological Review, 1956, 63, 81-97.

Miller, G.A., Galanter, E., & Pribram, K.H. Plans and the structure of behavior. New York: Holt, Rinehart & Winston, 1960.

Munn, N.D. Walbiri iconography: Graphic representation and cultural symbolism in a Central Australian Society. Ithaca, N.Y.: Cornell Uni. Press, 1973.

Norman, D.A., & Bobrow, D.G. On the role of active memory processes in perception and cognition. In C.N. Cofer (Ed.), The structure of human memory. San Francisco: W.H. Freeman, 1975.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart & Winston, 1971.

Paivio, A. Imagery and long-term memory. In A. Kennedy & A. Wilkes (Eds.), Studies in long-term memory. London: John Wiley & Sons, 1975.

Piaget, J. Need and significance of cross-cultural studies in genetic psychology. International Journal of Psychology, 1966, 1, 3-13.

Piaget, J. The psychology of the child. New York: Basic Books, 1969.

Piaget, J. Intellectual evolution from adolescence to adulthood. Human Development, 1972, 15, 1-12.

Piaget, J., & Inhelder, B. The child's conception of space. New York: Norton, 1967.

Piaget, J., Inhelder, B., & Szeminska, A. The child's conception of geometry. New York: Basic Books, 1960.

Scribner, S., & Cole, M. Cognitive consequences of formal and informal education. Science, 1973, 182, 553-559.

Seagrim, G.N. Cognitive development of the Aborigine. In W.G. Coppell (Ed.), Centre for Advancement of Teaching Monograph. No.6. Education and the Aboriginal Child. Sydney, C.A.T., Macquarie Uni., 1974.

Serpell, R. Cultures' influence on behavior. London: Methuen & Co. 1976.

Shriffin, R.M., & Schneider, W. Controlled and automatic information processing: II Perceptual learning, automatic attending, and a general theory. Psychological Review, 1977, 84, 127-190.

Shwartz, S.P. Capacity limitations in human information processing. Memory and Cognition, 1976, 4, 763-768.

Siegel, A.W., & White, S.H. The development of spatral representations of large-scale environments. Advances in Child Development and Behavior, 1975, 10, 10-55.

Simon, H.A. How big is a chunk? Science, 1974, 183, 482-488.

Simon, H.A. Information processing models of cognition. Annual Review of Psychology, 1979, 30, 363-396.

Simon, H.A., & Gilmartin, K.A. A simulation of memory for chess positions. Cognitive Psychology, 1973, 5, 29-46.

Strehlow, T.G.H. Aranda traditions. Melbourne: Melbourne Uni. Press, 1947.

Strehlow, T.G.H. The art of the circle, line and square. In R.M. Berndt (Ed.), Australian Aboriginal art. Sydney: Smith, 1964.

Strehlow, T.G.H. Culture, social structure and environment in Aboriginal Central Australia. In R.M. Berndt, & C.H. Berndt (Eds.), Aboriginal man in Australia. Sydney: Angus & Robertson, 1965. pp. 121-145.

Tolman, E.C. Cognitive maps in rats and men. Psychological Review, 1948, 55, 189-208.

Tuan, Y.F. Images and mental maps. Ann. Assoc. America Geography, 1975, 65, 205-213.

Tulving, E., & Donaldson, W. Organisation of memory. New York: Academic Press, 1972.

Verney, N. The visual care of the Australian Aboriginal. Australian Journal of Science, 1969, 32, 192-196.

Wallace, N.M. Tracking ability - Pitjantjatjura men of the Musgrove Ranges, 1968. From the file of Prof. Seagrim A.N.U. Canberra

Yates, F.A. The art of memory. London: Routledge & Kegan Paul, 1966.